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Zoological Arguments for managing the abandoned grasslands on Monte San Giorgio – based on data of three invertebrate groups (Lepidoptera, Araneae, Saltatoria)

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On Monte San Giorgio, a site listed in the inventory of Swiss landscapes of national importance, faunistical and ecological studies on three invertebrate groups (Lepidoptera, Araneae, Saltatoria) were made with the intention to provide arguments for the establishment of a management plan. Hereby the habitat preferences, the conservation status and the spatial distribution of the taxa in the vegetation mosaic, brought about by secondary succession since the late fifties, were evaluated. The present state of succession of the grasslands on Monte San Giorgio is reflected by the composition of the invertebrate groups recorded. More than 50 % of the Lepidoptera and grasshoppers prefer undisturbed late successional stages. On the other hand, less than 30 % are typical inhabitants of open managed grasslands. The importance of the grasslands on Monte San Giorgio for spiders is highlighted by the presence of twelve species recorded for the first time in Switzerland and three species new to science. Depending on the invertebrates studied, different parts of the vegetation mosaic appear to be of importance. Endangered butterflies and grasshoppers depend mainly on a mosaic of shrubs and low-turfed vegetation, whereas many rare spiders were restricted to the vegetation type dominated by *Molinia arundinacea*. Based on these results, a spatially differentiated management plan for the conservation of the diversity encountered on Monte San Giorgio has been elaborated and is currently implemented by the Nature Conservation Bureau of the Canton Ticino. An efficient scientific monitoring program is included as an integral part of this management plan.

Keywords: Monte San Giorgio, conservation, management plan, abandoned grasslands, invertebrates, Lepidoptera, Araneae, Saltatoria.

INTRODUCTION

For the conservation of biological diversity, the application of classical scientific methodology is called for (MURPHY, 1990). Thus for successfully establishing and maintaining a nature reserve, scientific concepts and methods should be applied. To formulate precise and sustainable aims there is need for:

- an up-to-date evaluation of the site to be protected, including as many groups of organisms as possible,
- records from the past,
- comparisons on a regional and overregional scale,
- formulation of an effective monitoring program designed to accompany the management and detect any deviation from the aims formulated (HÄNGGI, 1989a; BRÖRING & WIEGLEB, 1990; MURPHY, 1990).

Lowland grasslands in central Europe are to the greatest extent man-made ecosystems, created and maintained by agriculture. Until about 50 years ago, such grasslands have been managed in a considering way for hundreds or even thousands of years. Industrialization of agriculture has led either to a more intensive use of these grasslands or to their abandonment. Both trends are possible reasons for a considerable loss of diversity of plants and animals (e.g. ERHARDT, 1985; BRIEMLE, 1987).

Within a multi-disciplinary project on the ecology and conservation of semi-natural grasslands of marginal economic value (directed by Prof. O. HEGG, Botanical Institute, University of Berne, Switzerland), the abandoned grasslands of Monte San Giorgio were studied. One of the aims of these studies was to establish the scientific basis for a management concept for this site, which is listed in the inventory of landscapes of national importance (BLN-Inventory) (EDI, 1977).

In this paper we present some of the results originating from the zoological studies conducted on three invertebrate groups (Lepidoptera, Araneae and Saltatoria) in the years 1988-90. A parallel paper dealing with the arguments based on botanical data is presented by STAMPFLI *et al.* (1994).

MATERIAL AND METHODS

Study site

Monte San Giorgio (elevation 1097 m) is situated at the southern edge of the Alps in the very south of Switzerland in canton Ticino, about 10 km south of Lugano. The grasslands studied are located on the south facing slope of the mountain top (Fig. 1) and are nowadays separated from lowland grasslands by at least 1 km of forest covering 400 meter difference in altitude. During the last glacial, the lower half of Monte San Giorgio was covered by ice. The mountain top arose above the ice as a nunatak covering about 50 ha (HANDTKE, 1983). Since then the aspect of the region probably changed from a steppe-like vegetation to a closed wood 12'000 years BP (SCHNEIDER, 1985; WICK, 1989), with perhaps only the mountain ridge remaining unwooded. This wood was eventually cleared by human activity. Documents of agricultural use of the grasslands on Monte San Giorgio date back to at least the end of the 16th century (MARTINOLA, 1973). Grazing and hay-making had been common practice since that time until the late fifties of this century, when agriculture was stopped due to unrentability. After that, succession including occasional natural fires went on in an unhindered course shaping the actual vegetation and its associated fauna.

The result today is a mosaic of basically three vegetation types (for details see GUGGISBERG, 1990):

1) on shallow soils, a short-turfed, species-rich vegetation dominated by the sedge *Carex humilis*, the grass *Bromus erectus* and herbs such as *Hippocrepis comosa* or *Teucrium chameadrys* (type "Carex")

2) on deeper soils, a high-turfed, species-poor vegetation dominated by the grass *Molinia arundinacea* and the herbs *Potentilla erecta* and *Serratula tinctoria* (type "Molinia")

3) groups of shrubs and trees including *Sorbus aria, Laburnum anagyroides* and *Quercus pubescens* (type "Shrubs").

Methods

Inventories of the following groups of invertebrates were established: Butterflies (Rhopalocera including Hesperiidae and Zygaenidae), spiders (Araneae) and grasshoppers (Saltatoria). The three groups cover a variety of ecological require-

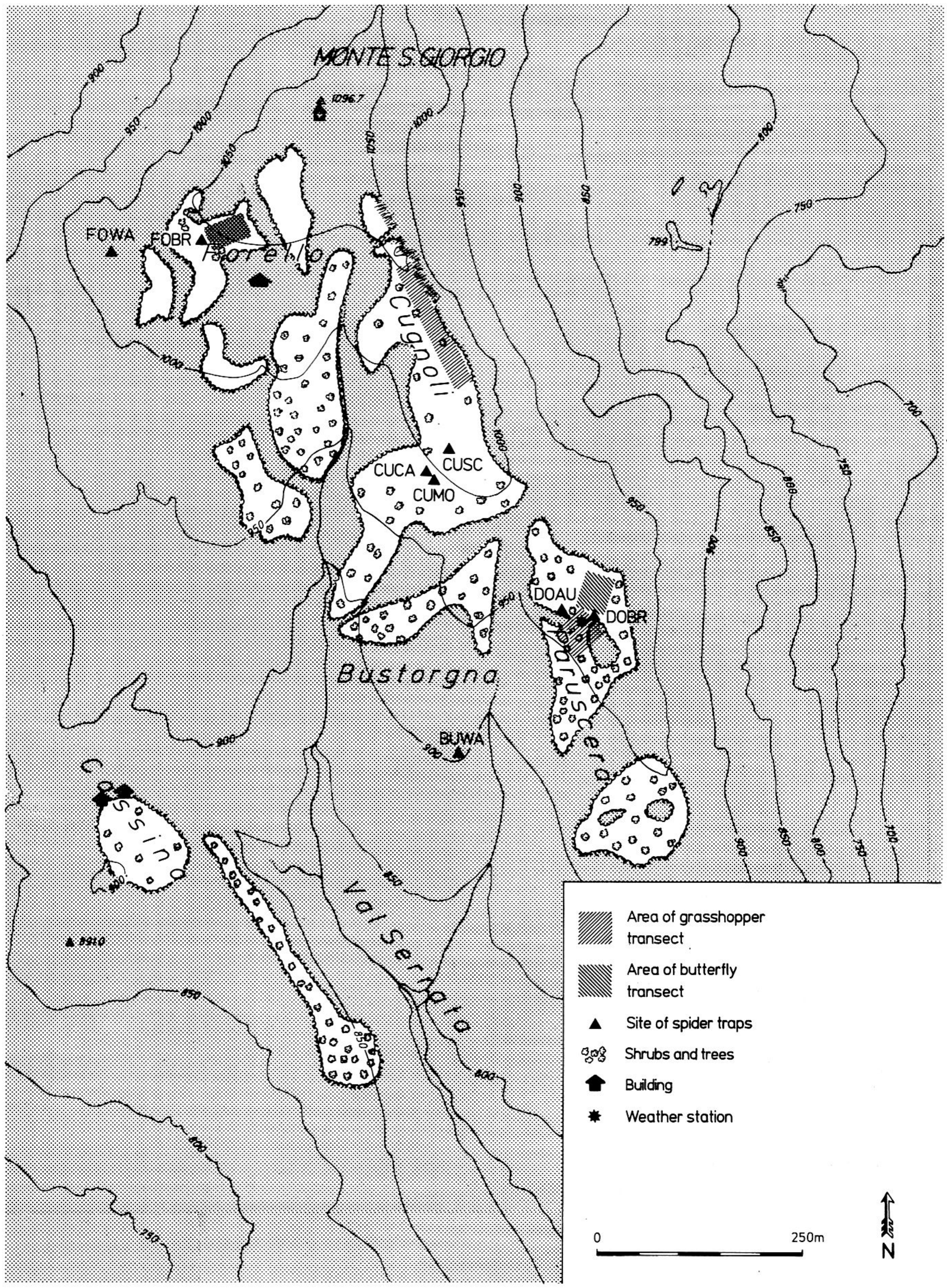

Fig. 1. Mountain top of Monte San Giorgio with areas of butterfly and grasshopper transects and location of spider traps (designated with letter abbreviations, e.g. DOAU).

ments and are assumed to have reacted quite differently to the succession taking place on Monte San Giorgio. Butterflies are bound to their habitat partly due to the often oligophagous food requirements of the larvae and the adults but also due to the microclimatical demands of both developmental stages (e.g. SBN, 1987; MORRIS & THOMAS, 1990; THOMAS, 1991). Spiders are carnivorous and depend mainly on microclimatic conditions resulting from structural properties, whereas the geographical setting plays a less important role (HÄNGGI, 1989a). Grasshoppers are either herbivorous or herbivorous/carnivorous and predominantly depend on vegetation structure and the resulting microclimatic conditions (OSCHMANN, 1973; SÄNGER, 1977). In addition the structure of the soil can play an important role for oviposition in some species (HARZ, 1969, 1975; MORRIS, 1971).

Data on butterflies and grasshoppers were collected using the transect method introduced by DOUWES (1976) and modified as in ERHARDT (1985). Transects were carried out at two sites for butterflies and at three sites for grasshoppers. Butterfly data were obtained from a meadow-like surface dominated by a vegetation mosaic of types "Molinia" and "Carex" ("Forello" in Fig. 1) and a mosaic of all three vegetation types ("Paruscera" in Fig. 1). Grasshoppers were studied on the same two types of vegetation as butterflies, but in addition a surface of the mountain ridge containing all three vegetation types was incorporated in the study ("Cugnoli" in Fig. 1).

Adult butterflies and grasshoppers were usually determined in the field by sight or by sound (stridulating of male grasshoppers) during transects. Problematic individuals of both groups were collected and determined in the laboratory. Grasshoppers found in the pitfall traps were also included in the analysis.

The epigeic spider fauna was sampled at eight sites (see Fig. 1), including the main vegetation types occurring on Monte San Giorgio by means of pitfall traps. The sampling period stretched over at least one year. Spiders caught were determined in the laboratory.

Information on preferred habitats were drawn from several sources for all species recorded on Monte San Giorgio (Butterflies: BLAB & KUDRNA, 1982; BALLETTO & KUDRNA, 1985; SBN, 1987; EBERT, 1991; Spiders: MAURER & HÄNGGI, 1990; Grasshoppers: FRÜHSTORFER, 1921; NADIG, 1987, 1991).

The conservation status was assigned to every species according to the red list of Swiss butterflies (GONSETH, 1987) and the red list of Swiss grasshoppers (NADIG & THORENS, 1994). As no Red List exists yet for Swiss spiders, potentially endangered species based on their faunistic importance and their very restricted ecological requirements were chosen according to MAURER & HÄNGGI (1990).

The conservation interest of the three main vegetation types ("Carex", "Molinia" or "Shrubs") was estimated through the attribution of potentially endangered species to these types based on the distribution of adults and the occurrence of the larval foodplant(s) for the butterflies, on the occurrence of spiders in pitfall traps catching in a particular vegetation type and on direct observations of grasshoppers during the transects.

RESULTS

We observed a total of 63 butterfly species (two transect areas), 117 spider species (eight stations) and 24 grasshopper species (three transect areas). The complete faunistic list of all groups is presented in the appendix. These values can be considered high, especially if the numbers of species per transect area or pitfall trap station are compared with the numbers of species recorded on other sites included in the project on semi-natural grasslands of the canton Ticino (see Tab.1). In all groups on average a higher number of species was observed than in the remaining parts investigated in Ticino.

In butterflies, 55 % of the species prefer little disturbed, transitorial habitats between an open meadow and a closed wood (numbers III, IV and VI in Fig. 2) while only 28 % prefer open, managed meadows (numbers II, V, VII and VIII in Fig. 2). More than 50 % of the spider species are known to prefer dry, rather open habitats (Habitat C in Fig. 3). All the 12 species new for Switzerland mentioned below belong to this group, underlining thereby the importance of the grasslands on Monte San Giorgio as a habitat for xerophilous species. We found a remarkably low proportion of euryoecious spider species (7 %), which indicates the presence of undisturbed, but also very specialized habitats. Of the 24 grasshopper species five were observed exclusively on xerothermic, short-turfed surfaces (vegetation type "Carex"), whilst seven species were observed exclusively on long-turfed surfaces (vegetation type "Molinia"), six species exclusively on or beneath shrubs (type "Shrubs") and five in the transition zone between areas with an open vegetation structure and type "Shrubs" (Fig. 4). The two species *Tetrix bipunctata kraussi* and *T. tenuicornis* were only caught by pitfall traps in vegetation type "Carex".

Of the 63 butterfly species recorded on Monte San Giorgio five are rated as heavily endangered and one is considered rare (GONSETH, 1987). Twelve spider species caught on Monte San Giorgio were recorded for the first time in Switzerland and thirteen for the first time in the canton Ticino (HÄNGGI, 1989b, 1990, 1993). Five species from the former and six from the latter group were caught only on Monte San Giorgio and Monte Generoso, a nunatak close by (see Tab. 2). Probably all these species can be considered to be potentially endangered in Switzerland. Besides them, several other species with very narrow ecological requirements must be considered to be potentially endangered (see Tab. 3). In addition three species recorded are new for science (THALER, 1991; MAURER, 1992). Of the 24 grasshopper species recorded on Monte San Giorgio, thirteen species are contained in the list of endangered Swiss grasshoppers (NADIG & THORENS, 1994). However, three of them are not considered endangered in the southern part of Switzerland. Four of

Tab. 1. Comparison of total, maximum and minimum number of species and average number of species per sample unit (transect area or spider traps) recorded on Monte San Giorgio and other sites in canton Ticino. NTot = Total number of species, Min = mimum number of species, Max = maximum number of species, $\hat{x}$ = mean number of species, N = number of sites.

		NTot	Min	Max	$\hat{x}$	N
Butterflies	Giorgio	63	55	58	56.5	2
	Ticino	72	9	42	24.6	17
Spiders	Giorgio	117	38	59	48.3	7
	Ticino	225	27	54	41.3	29
Grasshoppers	Giorgio	24	14	21	18.3	3
	Ticino	28	6	20	11.9	20

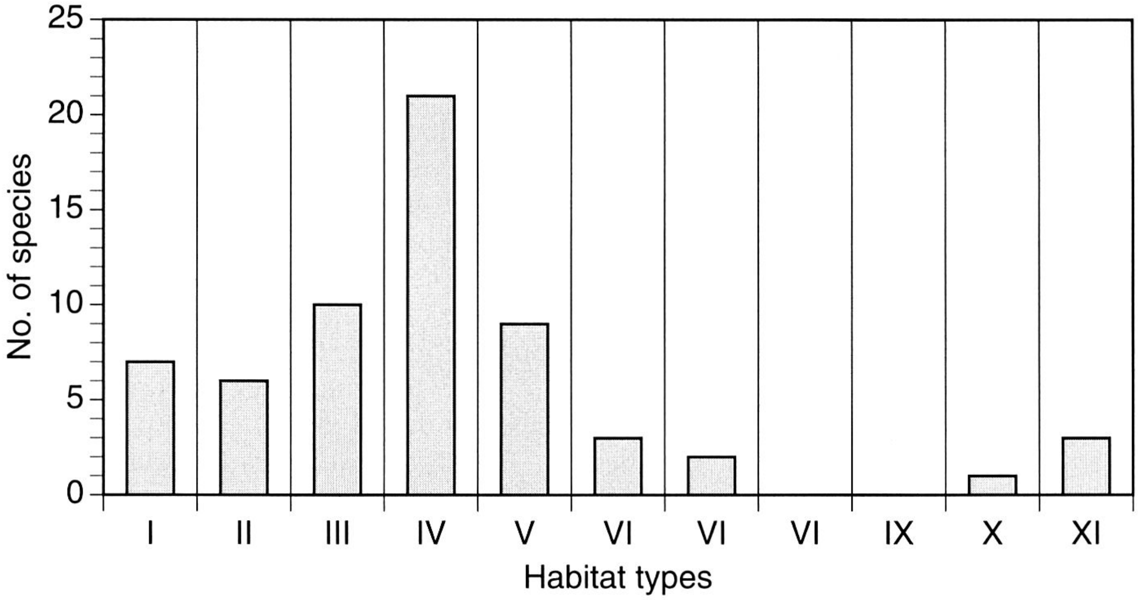

Fig. 2. Preferred habitat types for butterflies recorded on Monte San Giorgio (following BLAB & KUDRNA, 1982, and KUDRNA & BALLETTO, 1985). I = ubiquitious species, II = open areas, III = Transition open areas/shrubs, IV = Transition shrubs/forest, V = xeric open areas, VI = xeric open areas with shrubs and trees, VII = wet meadows, X = montane species, XI = uncertain status.

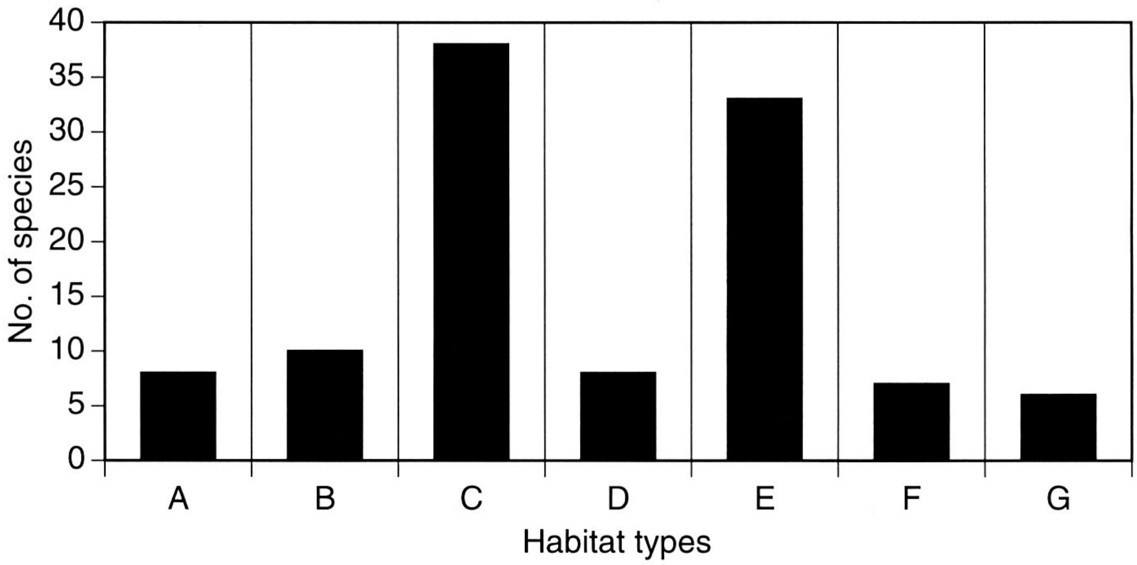

Fig. 3. Preferred habitat types of spiders recorded on Monte San Giorgio (following MAURER & HÄNGGI, 1990). A = ubiquitious species, B = extensively used meadows, C = xeric sites, D = shrubs, E = woodland, F = others, G = unclear status.

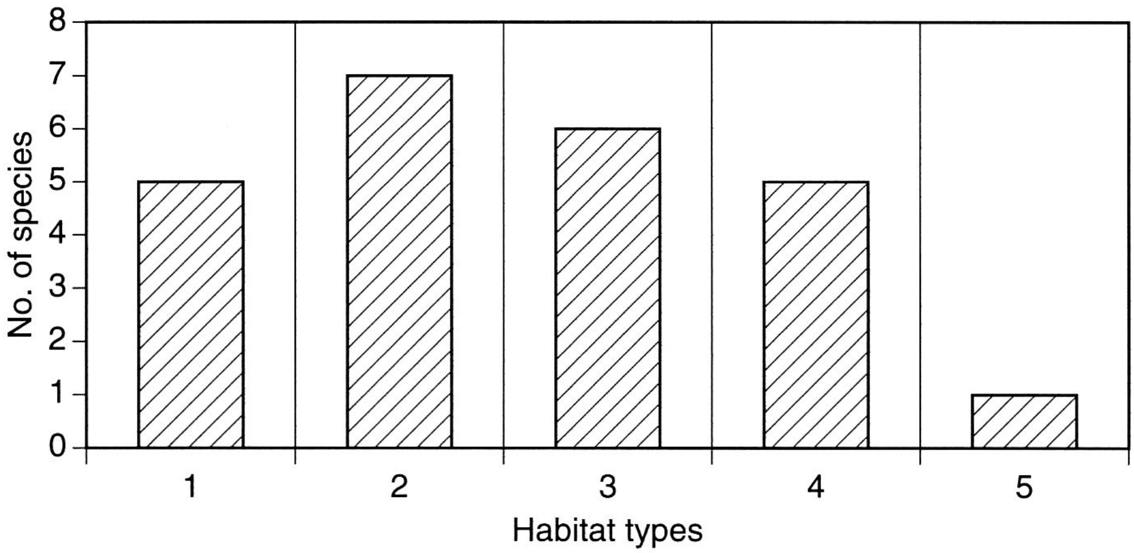

Fig. 4. Preferred habitat types of grasshoppers recorded on Monte San Giorgio (personal observations and following FRÜHSTORFER, 1921, and NADIG, 1987, 1991). 1 = xeric sites, 2 = dense meadows, 3 = shrubs, 4 = open areas with shrubs, 5 = ubiquitious species.

five species endemic for the insubric region (NADIG, 1991) can be found on Monte San Giorgio (see appendix).

The three invertebrate groups show different distributions over the three vegetation types dominating the former meadows on Monte San Giorgio (Tab. 3). Three out of six rare butterfly species were attributed to vegetation type "Shrubs". For spiders it is in the vegetation type "Molinia" where most of the species of faunistic and/or conservation interest were recorded. Endangered grasshoppers were mainly observed either in the vegetation type "Shrubs" or type "Carex". In all three groups there were species that could be attributed to more than one vegetation type. This indicates the need for a mosaic of different habitat structures necessary for their survival.

DISCUSSION

Arguments for managing Monte San Giorgio

When defining management aims and actions for a given site, it is necessary to incorporate various factors including not only biological data defining the present state, but also the history of the site, socio-economic circumstances and the large-scale geographic setting.

Today the grasslands of Monte San Giorgio are isolated from the valley below and are in an advanced stage of succession with many woody plants having invaded the former grasslands, functioning as a refuge for animal species that have been lost in the intensively used surroundings. However, a large part of the fauna depends on transitory undisturbed habitats, whereas typical inhabitants of open managed surfaces, indicative of a traditional agricultural use, are still present but clearly play a minor role and many have most likely disappeared already.

Tab. 2. Spiders of special biogeographic interest. New for = recorded for the first time in Switzerland (CH) or Canton Tessin (TI). + indicates records of the same species at other sites of the canton Ticino during the study period. n.sp. = new described species. nunatak = found on the nunataks Monte San Giorgio (GIO) and/or Monte Generoso (GEN).

	new for	nunatak
Harpactea thaleri	CH+	GIO, GEN
Eperigone trilobata	CH+	–
Erigone autumnalis	CH+	–
Hypsocephalus paulae	CH+	GIO, GEN
Mecopisthes latinus	CH+	–
Panamomops inconspicua	CH+	–
Peponocranium orbiculatum	CH+	–
Rhaebothorax foveatus	CH	GIO
Lepthyphantes aridus	CH+	–
Trochosa hispanica	CH	–
Histopona italica	CH+	–
Zelotes atrocaeruleus	CH	GIO
Oxyptila secreta	CH+	GIO, GEN
Neon levis	CH	GIO
Pocadicnemis juncea	TI+	–
Tapinocyboides pygmaea	TI	GIO
Centromerus serratus	TI+	–
Dipoena prona	TI+	–
Pholcomma gibbum	TI	GIO
Tegenaria agrestis	TI	GIO
Hahnia pusilla	TI+	–
Apostenus fuscus	TI	GIO
Phrurolithus minimus	TI+	–
Scotina celans	TI	GIO
Zelotes villicus	TI+	GIO
Zora silvestris	TI	GIO
Neon reticulatus	TI+	–
Bolyphantes sp.	n.sp.	GIO, GEN
Tapinocyba maureri	n.sp.	–
Cybaeus intermedius	n.sp.	–

The importance of Monte San Giorgio for rare or faunistically important species is not the same in the three invertebrate groups. In butterflies, about 10 % of the recorded species are considered rare. The isolation of the mountain top in a strongly industrial Sottoceneri which cannot serve as source area for the immigration of species as well as the advanced state of succession may be responsible for this low proportion. In spiders and grasshoppers, the function of the mountain top as a nunatak during the last glacial may represent the key factor for its importance (NADIG, 1968; HANDTKE, 1983; MAURER & HÄNGGI, 1988). Among the 30 potentially endangered spider species (26 % of the total), 14 were recorded exclusively on Monte San Giorgio and partly on Monte Generoso, both nunataks. Four grasshopper species detected on Monte San Giorgio are endemic to the insubric region and 10 of the 24 recorded species are listed in the red list of Swiss grasshoppers.

Tab. 3. Attribution of endangered species and/or species of special biogeographic interest to the three basic vegetation types occurring on Monte San Giorgio.

Vegetation type "shrubs"	Vegetation type "Molinia"	Vegetation type "Carex"
Butterflies		
Iphiclides podalirius *Lopinga achine* *Nordmannia ilicis*	*Heteropterus morpheus*	*Iphiclides podalirius* *Satyrus ferula* *Erebia styx*
Spiders		
Apostenus fuscus	*Hahnia pusilla* *Lepthyphantes aridus* *Eperigone trilobata* *Hypsocephalus paulae* *Panamomops inconspicua* *Peponocranium orbiculatum* *Oxyptila secreta* *Neon levis*	*Rhaebothorax foveatus* *Eperigone trilobata* *Oxyptila secreta* *Neon levis*
Grasshoppers		
Barbitistes obtusus *Leptophyes laticauda* *Pholidoptera fallax* *Antaxius pedestris* *Ephippiger vicheti* *Miramella f. formosanta* *Aiolopus strepens*	*Metrioptera bicolor* *Metrioptera fetschenkoi minor* *Pholidoptera littoralis insubrica* *Aiolopus strepens*	*Antaxius pedestris* *Tetrix bipunctata kraussi* *Oedipoda caerulescens* *Aiolopus strepens* *Chorthippus mollis*

As to the importance of the components of the mosaic of habitat types brought about by secondary succession, there are differences between the three groups of invertebrates and the flora as well (STAMPFLI *et al.*, 1994). All three vegetation types contain a number of endangered species. Rather unexpectedly, the species poor vegetation type dominated by *Molinia arundinacea* turned out to be of particular conservation interest for the fauna, especially for spiders. Grasshoppers were found to depend on all three parts of the vegetation mosaic with several species depending on a combination of them. An analysis of the botanical data (STAMPFLI *et al.*, 1994) revealed that species which formerly were abundant on deeper soils are nowadays most threatened because *Molinia arundinacea* invades mainly this soil type. The vegetation on shallow soils seems to be rather stable and therefore still contains a species-rich flora (STAMPFLI *et al.*, 1994). This situation creates conflicting priorities, as for spiders the conservation of the present structure of the vegetation type "Molinia" has prime importance, while for plants a resumption of a traditional land use on this soil type seems to be necessary.

Proposed management aims for Monte San Giorgio

Based on the historical development of landuse on Monte San Giorgio and the zoological and botanical results discussed above, three main aims for a management plan have been formulated (STAMPFLI *et al.*, 1992):

a) Preserving the biodiversity observed in the study period (1988-90), i.e. preserving the status quo of animal and plant diversity.

b) Retransformation of some of the former meadows to a state representing the hey meadows before the cessation of landuse.

c) Letting the succession run its course on selected areas.

As seen above, these three aims are not only not compatible but even contradictory on a single surface. Therefore a spatially differentiated management of the grasslands has to be achieved.

Possible management measures

For managing unfertilized meadows and their early successional stages several management measures are applied, including mowing, grazing and burning (e.g. BLAB, 1986; BUTT, 1986; KAULE, 1991; KIRBY, 1992). The effects of several managements on the vegetation on Monte San Giorgio have been studied (STAMPFLI, 1992). Some studies are still continuing and should allow more precise predictions to be formulated in the future. A preliminary investigation on the use of donkeys for managing the grasslands on Monte San Giorgio has given encouraging results (unpubl.).

Invertebrates were not included in these analysis, so for choosing the proper management measures for invertebrates, we had to rely on published information from different sources. Mowing is a common method for managing grasslands and, carried out in a considering manner (e.g. one cut per season), creates well balanced conditions for competition among many plant species (MORRIS, 1971). This in turn allows many invertebrate species to exist in such grasslands (e.g. ERHARDT, 1985). The drastic change in microclimate following the breakdown of the vegetation structure can be positive or negative for invertebrates (e.g. BUTT, 1986; KIRBY, 1992; THORENS, 1993). The timing of this intervention is of great importance and in general, an intervention late in summer is advocated (BLAB, 1986). In addition, adjacent surfaces can play an important role as compensatorial habitats. Therefore a spatially differentiated mowing regime is proposed (DETZEL, 1985; SZIJJ, 1985; BLAB, 1986). Grazing by a range of animals such as sheep, goats or donkeys is a further important management measure in grassland conservation and is particularly advocated for butterfly habitat management (BUTT, 1986). Since animals tend to graze selectively, a low grazing intensity creates an increased structural habitat diversity, which is also positive for a large part of the invertebrate fauna (MORRIS, 1971; KIRBY, 1992). ERHARDT (1985) for instance found a richer butterfly fauna on extensive pastures than on adjacent unimproved meadows. However, the intensity of grazing can have an important influence on the invertebrate community (e.g. CAPINERA & SECHRIST, 1982). A third management measure is controlled burning. Fire is part of the natural vegetation dynamics in this region. As a management measure for invertebrate habitats however, it is generally not recommended (BUTT, 1986; KIRBY, 1992).

A consideration of the available botanical and zoological information led to the choice of the following management measures:

- mowing once in summer with composting of the litter
- grazing by donkeys
- cutting out of shrubs (with and without mowing)
- mowing in fall (in differing intervals, i.e. every 2 or 3 years)

As mentioned above, these measures have to be applied in a spatially differentiated manner.

Conclusions

A management concept for Monte San Giorgio was elaborated, which is based on the above listed results and discussions. The proposed conservation measures demand a great input of manpower and finances. To justify such an investment it is indispensable to monitor how the vegetation and fauna will react in the long term to the management actions chosen. This enables a timely detection of eventual deviations from the aims formulated and the eventual adjustment of the measures if the aims are to be kept upright. Therefore an efficient monitoring is proposed as an integral part of the management plan.

The high costs related to the construction of this management plan raised the question whether the amount of research and money invested were worth the results presented. For the following reasons we believe that they were:

1) The formulation of the management concept for Monte San Giorgio is just one result of these studies.

2) The high conservation value of the vegetation type dominated by *Molinia arundinacea* for the invertebrates was not to be expected. The weight this vegetation type now takes in the management concept would most likely have been much lower without the analysis conducted here.

3) If conservation actions are to be efficient and successful, a control of the impact of these measures is indispensable. Such a control however is only feasible with a known starting point.

ZUSAMMENFASSUNG

Auf den verbrachenden Wiesen des Monte San Giorgio wurden in den Jahren 1988-1990 faunistische und ökologische Studien an drei Invertebraten-Gruppen (Lepidoptera, Araneae, Saltatoria) durchgeführt. Ein Teil der erhobenen Daten wurde für die Formulierung eines Pflegeplans für diesen im BLN-Inventar der Landschaften von nationaler Bedeutung aufgelisteten Berg ausgewertet. Die Habitatspräferenzen und der Gefährdungsgrad der einzelnen Arten sowie deren Verteilung im durch sekundäre Sukzession entstandenen Vegetationsmosaik wurden hierbei analysiert. Der gegenwärtige Zustand der verbrachten Wiesen findet auch seinen Ausdruck in der Artenzusammensetzung der untersuchten Invertebraten. Mehr als 50 % der erfassten Tagfalter und Heuschrecken bevorzugen als Lebensraum späte Sukzessionsstadien. Im Gegensatz dazu gelten weniger als 30 % als Bewohner von offenen genutzten Wiesen. 12 Spinnenarten wurden zum erstenmal für die Schweiz nachgewiesen und deren drei wurden als neue Arten beschrieben. Je nach untersuchter Tiergruppe haben die Komponenten des Vegetationsmosaiks ein unterschiedliches Gewicht. Für gefährdete Tagfalter und Heuschrecken spielen vorwiegend Übergangsbereiche zwischen Wiese und Gebüsch eine wichtige Rolle, für Spinnen scheint hingegen der von *Molinia arundinacea* dominierte Vegetationstyp von besonderer Bedeutung zu sein. Aufgrund dieser zum Teil widersprüchlichen Aussagen wurde den Naturschutzbehörden des Kantons Tessin eine räumlich differenzierte Pflege mittels Mahd zu verschiedenen Zeitpunkten, Ausholzen von Gebüschen und Bäumen und Beweidung durch Esel vorgeschlagen. Als integraler Teil des Pflegeplanes wird eine effiziente wissenschaftliche Erfolgskontrolle durchgeführt.

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APPENDIX

Lepidoptera

Nomenclature according to SBN (1987). Species of the Red List are indicated by *.

Papilionidae: *Parnassius apollo, Papilio machaon, Iphiclides podalirius**.
Pieridae: *Leptidea sinapis, Colias alfacariensis, Colias crocea, Gonepteryx rhamni, Aporia crataegi, Pieris brassicae, Artogeia rapae/mannii, Artogeia napi.*
Nymphalidae: *Apatura iris, Limenitis camilla, Nymphalis antiopa, Inachis io, Vanessa atalanta, Cynthia cardui, Aglais urticae, Polygonia c-album, Argynnis paphia, Mesoacidalia aglaia, Fabriciana adippe, Fabriciana niobe, Issoria lathonia, Clossiana selene, Mellicta athalia.*

Satyridae: *Melanargia galathea, Satyrus ferula**, *Erebia styx**, *Erebia aethiops, Maniola jurtina, Hyponephele lycaon, Coenonympha pamphilus, Coenonympha arcania, Coenonympha darwiniana, Pararge aegeria, Lasiommata maera, Lasiommata petropolitana, Lopinga achine**.

Lycaenidae: *Lampides boeticus, Quercusia quercus, Nordmannia ilicis**, *Callophrys rubi, Heodes virgaureae, Heodes tityrus, Aricia agestis/artaxerxes, Lysandra coridon, Lysandra bellargus, Celastrina argiolus.*

Hesperiidae: *Heteropterus morpheus**, *Carterocephalus palaemon, Pyrgus alveus, Spialia sertorius, Thymelicus lineola, Thymelicus silvestris, Hesperia comma, Ochlodes venatus.*

Zygaenidae: *Adscita globulariae, Zygaena purpuralis, Zygaena viciae meliloti, Zygaena loti, Zygaena filipendulae, Zygaena transalpina.*

Araneae

Nomenclature according to MAURER & HÄNGGI (1990). One species is not yet determined and may be a new species: *Bolyphantes* sp. (see HÄNGGI, 1993). The following species were described based on specimens found during the study or were not yet included in MAURER & HÄNGGI (1990): *Cybaeus intermedius* (MAURER, 1992), *Rhaebothorax foveatus* (F. DAHL, 1912), *Tapinocyba maureri* (THALER, 1991), *Neon levis* (SIMON, 1871), *Zelotes atrocaeruleus* (SIMON, 1878). Species recorded for the first time in Switzerland are indicated by *.

Dysderidae: *Dysdera ninnii, Harpactea thaleri**.

Zodariidae: *Zodarion gallicum.*

Tetragnathidae: *Pachygnatha clercki.*

Araneidae: *Cercidia prominens.*

Mimetidae: *Ero furcata.*

Linyphiidae: *Ceratinella scabrosa, Dicymbium nigrum, Eperigone trilobata**, *Erigone autumnalis**, *Hypsocephalus paulae**, *Mecopisthes latinus**, *Metopobactrus nadigi, Micrargus herbigradus, Micrargus subaequalis, Minicia marginella, Panamomops inconspicuus**, *Peponocranium orbiculatum**, *Pocadicnemis juncea, Saloca diceros, Tapinocyboides pygmaeus, Walckenaeria acuminata, Walckenaeria cucullata, Walckenaeria furcinata, Walckenaeria mitrata, Bathyphantes gracilis, Centromerus aequalis, Centromerus leruthi, Centromerus sellarius, Centromerus serratus, Centromerus sylvaticus, Diplostyla concolor, Lepthyphantes aridus**, *Lepthyphantes cristatus, Lepthyphantes mengei, Lepthyphantes pallidus, Lepthyphantes tenebricola, Lepthyphantes tenuis, Linyphia hortensis, Meioneta mollis, Meioneta rurestris, Meioneta simplicitarsus, Microneta viaria, Sintula cornigera, Theonina cornix.*

Theridiidae: *Dipoena coracina, Dipoena prona, Enoplognatha thoracica, Episinus truncatus, Pholcomma gibbum.*

Lycosidae: *Alopecosa accentuata, Alopecosa pulverulentula, Alopecosa sulzeri, Alopecosa trabalis, Arctosa figurata, Aulonia albimana, Pardosa bifasciata, Pardosa lugubris, Pardosa riparia, Tricca lutetiana, Trochosa hispanica**, *Trochosa terricola.*

Agelenidae: *Coelotes mediocris, Histopona italica**, *Histopona torpida, Tegenaria agrestis, Tegeneria fuesslini.*

Hahniidae: *Hahnia nava, Hahnia ononidum, Hahnia pusilla.*

Liocranidae: *Agroeca brunnea, Agroeca cuprea, Agroeca proxima, Apostenus fuscus, Phrurolithus festivus, Phrurolithus minimus, Scotina celans.*

Clubionidae: *Clubiona diversa, Clubiona terrestris.*

Gnaphosidae: *Drassodes cupreus, Drassodes lapidosus, Drassodes pubenscens, Haplodrassus silvestris, Haplodrassus umbratilis, Phaeocedus braccatus, Poecilochroa variana, Zelotes apricorum, Zelotes praeficus, Zelotes erebeus, Zelotes latreillei, Zelotes pedestris, Zelotes petrensis, Zelotes villicus.*

Zoridae: *Zora silvestris, Zora spinimana.*

Philodromidae: *Thanatus formicinus.*

Thomisidae: *Oxyptila atomaria, Oxyptila secreta**, *Xysticus cristatus, Xysticus erraticus, Xysticus kochi, Xysticus ninnii, Xysticus robustus.*

Salticidae: *Euophrys aequipes, Euophrys frontalis, Evarcha arcuata, Heliophanus auratus, Heliophanus flavipes, Marpissa nivoyi, Neon reticulatus, Phlegra fasciata.*

Saltatoria

Nomenclature following NADIG & THORENS (1991). Species of the tentative Red List are indicated by *. Species endemic to the insubric region are indicated by #.

Tettigoniidae: *Barbitistes obtusus**, *Leptophyes laticauda**, *Metrioptera bicolor**, *Metrioptera fedtschenkoi minor*#*, *Pholidoptera aptera aptera*, *Pholidoptera littoralis insubrica*#*, *Pholidoptera fallax**, *Pholidoptera griseoaptera*, *Antaxius pedestris**, *Ephippiger vicheti**.
Gryllidae: *Nemobius sylvestris*.
Tetrigidae: *Tetrix bipunctata kraussi**, *Tetrix tenuicornis*.
Catantopidae: *Miramella f.formosanta*#*, *Odontopodisma decipiens insubrica#*.
Acrididae: *Oedipoda caerulescens**, *Aiolopus strepens**, *Chrysochraon brachyptera*, *Stenobothrus lineatus lineatus*, *Gomphocerippus rufus*, *Chorthippus scalaris*, *Chorthippus mollis mollis**, *Chorthippus dorsatus dorsatus*, *Chorthippus parallelus parallelus*.