Folia Geobotanica 35: 289–313, 2000

SYNTHESIS OF SEMI-NATURAL GRASSLAND VEGETATION OF A BIOGEOGRAPHICALLY HETEROGENEOUS AREA: MESOPHILOUS SPECIES-RICH MEADOWS IN SWITZERLAND

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Keywords: *Arrhenatherion*, *Agrostio-Festucion*, Classification, *Chrysopogonetum*, *Mesobromion*, *Polygono-Trisetion*

Abstract: For a hundred years semi-natural species-rich meadow vegetation has been described from various areas of Switzerland. The first description dates from 1892 by Stebler and Schröter. In the present study, relevés of 65 semi-natural mesophilous meadow associations and communities reported by 26 authors, which were collected throughout the century, are summarized. An increasing number of descriptions dating from the 1980s and 1990s is included. A numerical classification of these 65 types resulted in four main groups of meadow-types. When compared with the existing literature of alliances a high correlation is found with the *Polygono-Trisetion* BR.-BL. et R. TX. ex MARSHALL 1947, the *Arrhenatherion* W. KOCH 1926, the *Agrostio-Festucion* PUŞCARU et al. 1956, the *Mesobromion* BR.-BL. et MOOR 1938 em. OBERDORFER 1957, and with the *Chrysopogonetum* W. KOCH 1943. The *Agrostio-Festucion* is characteristic for the montane belt in southern Switzerland and was until recently poorly known. This alliance is discussed in detail. Some classifications of meadow types by the original authors had to be rearranged for the present purpose. The present classification coincides well with the one Stebler and Schröter gave in 1892. Today, after a century of intensive changes in land use, their four main types are still valid.

INTRODUCTION

More than a hundred years ago STEBLER & SCHRÖTER (1892) proposed the first overview of Swiss meadow vegetation. Their 21 "main types" (as they called their vegetation units) of all altitudinal levels include 18 extensively-cultivated types of dry to fresh (12 types) and of moist to wet soils (6 types) and 3 more intensively-cultivated types. The most widespread types in the main Swiss agricultural regions (200–1500 m) are the types of *Bromus erectus* and the one of *Arrhenatherum elatius*. The type of *Agrostis tenuis* (with a subtype of *Trisetum flavescens*) occurs in numerous valleys in the Alps between 800 and 1700 m (STEBLER & SCHRÖTER 1892).

Until today, this typification of Swiss semi-natural grassland vegetation remained the only one for the whole area of the country. After Stebler and Schröter attention has been mainly put on the development of reliable methods to describe vegetation (BRAUN-BLANQUET 1928, see also WESTHOFF & VAN DER MAAREL 1973). With these new methods numerous authors wrote vegetation monographs of single valleys or of Swiss regions (STUDER-EHRENSBERGER 1995). MARSHALL (1947) was the first to describe the *Trisetetum flavescentis* for several

Swiss regions, based on Stebler and Schröter's ideas. A few years later SCHNEIDER (1954) in an analogous way studied the *Arrhenatheretum* in the Swiss lowlands and the northern Prealps.

The main type of *Bromus erectus* by STEBLER & SCHRÖTER (1892) lead to an early description of the *Brometum* in SCHERRER (1925), based on relevés from a valley near Zürich. This association was revised by BRAUN-BLANQUET & MOOR (1938) who distinguished between the *Mesobromion* and the *Xerobromion* suballiances of the *Bromion* alliance. The *Mesobromion* got an alliance status by OBERDORFER (1957), the *Xerobromion* by MORAVEC (in HOLUB et al. 1967). Already at the time of Braun-Blanquet and Moore as well as later on, associations of the two suballiances were described from numerous localities in Switzerland (ZOLLER 1954).

The *Agrostis tenuis* type by Stebler and Schröter appears several times in the Swiss literature on grassland vegetation: RÜBEL (1912) described an *Agrostietum vulgaris* from the south-eastern Alps and LÜDI (1921) reported it from the western parts. PFISTER (1984) published relevés from north-facing slopes in the western Prealps, which he summarized in "meadow vegetation of nutrient-poor and moist soils" and called them *Festuco-Agrostietum*. A phytosociological discussion of the affiliation of his community to a higher vegetation unit is missing. The term "*Festuco-Agrostietum*" is further used by THOMET et al. (1989) and PESTALOZZI (1990). Only LUTZ (1991) gives a detailed description of the association at the subalpine belt of the western Prealps and discusses the higher vegetation units. He follows the south-eastern European phytosociologists and adds the *Festuco-Agrostietum* to the *Agrostio-Festucion* alliance and to the *Arrhenatheretalia*. The present relatively vague descriptions of the *Festuco-Agrostietum* may have three reasons: (1) the community is difficult to describe, as it is lacking strongly differentiating species (see below); (2) due to the introduction of artificial fertilizers at the beginning of the 20th century (STUDER-EHRENSBERGER 1995) the *Agrostis tenuis* meadows, a vegetation type which was easy to intensify, lost a great part of its distribution range and as a consequence its phytosociological interest; (3) the grassland vegetation of southern Switzerland was only recently investigated (STUDER-EHRENSBERGER 1993a,b, HÄFELFINGER 1996) and the importance of *Agrostis tenuis-Festuca rubra* meadows in this region was discovered. In southern Switzerland several vegetation types (forests and grasslands) of calcareous soils occur at the western distributional limit, a fact that floristically relates the *Festuco-Agrostietum* of southern Switzerland to that of south-eastern Europe.

Since the first vegetation descriptions by early phytosociologists, several decades of intensive research in limited areas brought a great number of local and regional presentations of vegetation types. This increasingly dense network of phytosociological descriptions requires a synopsis of semi-natural grasslands for the whole of Switzerland.

In the present paper the numerous significant descriptions of semi-natural grassland vegetation for the whole country are collected, all of them concerning in one way or another the discussed types by STEBLER & SCHRÖTER (1892). This material was examined in a unifying numerical analysis of floristic similarity of vegetation types without considering the regional syntaxonomical properties of species (e.g. WESTHOFF & VAN DER MAAREL 1973). In an overview of floristically-similar grassland types edaphic-ecological and geographical heterogeneity is discussed and links are drawn to existing terms such as "*Mesobromion*", "*Arrhenatherion*" and others. The sociological properties of the species are discussed for the whole investigation area and compared to earlier sociological interpretations. This synthesis

Table 1. Biogeographical regions and ecological variation of Switzerland with natural vegetation formations.

	Jura Mountains	Central Lowlands	Northern Alps	Central Alps	Southern Alps
Altitude (m)	500–1600	450–600	600–2500	550–4550	200–2000
Mean temperature (°C)					
January	1 to -4	0.5 to -1	-3 to -6	-1 to -6	3 to -2
July	19 to 10	19 to 17	15 to 9	19 to 13	21 to 13
Annual precipitation (mm)	810–1540	1110–1030	1280–2150	580–700	1750–2060
Vegetation formation (indicated are dominant species)	*Fagus* (west) *Quercus-Carpinus* (east)	*Fagus*	*Fagus* subalpine coniferous forests with *Larix decicua*, *Pinus cembra* alpine meadows	*Pinus* subalpine forests with *Picea abies*, *Larix decidua* alpine meadows	*Carpinus*, *Ostrya*, *Castanea*, *Fagus*

may be the basis for a successful conservation of the last remnants of semi-natural species-rich meadows in Switzerland.

STUDY AREA

The altitude, mean January temperature (in low and high situated localities), mean July temperature, annual precipitation and the dominating natural vegetation define the main biogeographical regions of Switzerland from the NNW to SSE (Tab. 1; HEGG et al. 1993, WOHLGEMUTH 1996).

Apart from the alpine regions, natural grassland vegetation occurs only in the central alpine valleys of Zermatt and Saas, where steppe vegetation is found (HEGG et al. 1993). Since the Neolithic human impact has changed extensive areas of the natural vegetation into, e.g. semi-natural grasslands (STUDER-EHRENSBERGER 1995) in all the regions of Switzerland.

METHODS

For the present study descriptions of mesophilous meadow vegetation by 26 authors from the literature have been compiled. Papers as well as unpublished relevés on *Arrhenatherion* W. KOCH 1926, *Polygono-Trisetion* BR.-BL. et R. TX. ex MARSHALL 1947, *Agrostio-Festucion rubrae* PUŞCARU et al. 1956 and *Mesobromion erecti* BR.-BL. et MOOR 1938 em. OBERDORFER 1957 from five different regions of Switzerland including Jura, Central Lowlands, Pre-Alps, Western Central Alps, Southern Alps have been collected. Emphasis has been put on meadows from the colline and montane belts. The list does not pretend to be complete and the number of types of the *Agrostio-Festucion* is relatively high as they mainly originate from one investigation (HÄFELFINGER 1996). The available relevés date from 1882 to 1994.

The 65 different meadow types (listed in Appendix 1) are presented in a frequency table (Tab. 2). In this table each meadow type is represented in a column. For one column generally 6 (minimally 3, if not more available, maximally 12) randomly chosen relevés of a group of relevés specified by the corresponding author in the original description were chosen. The

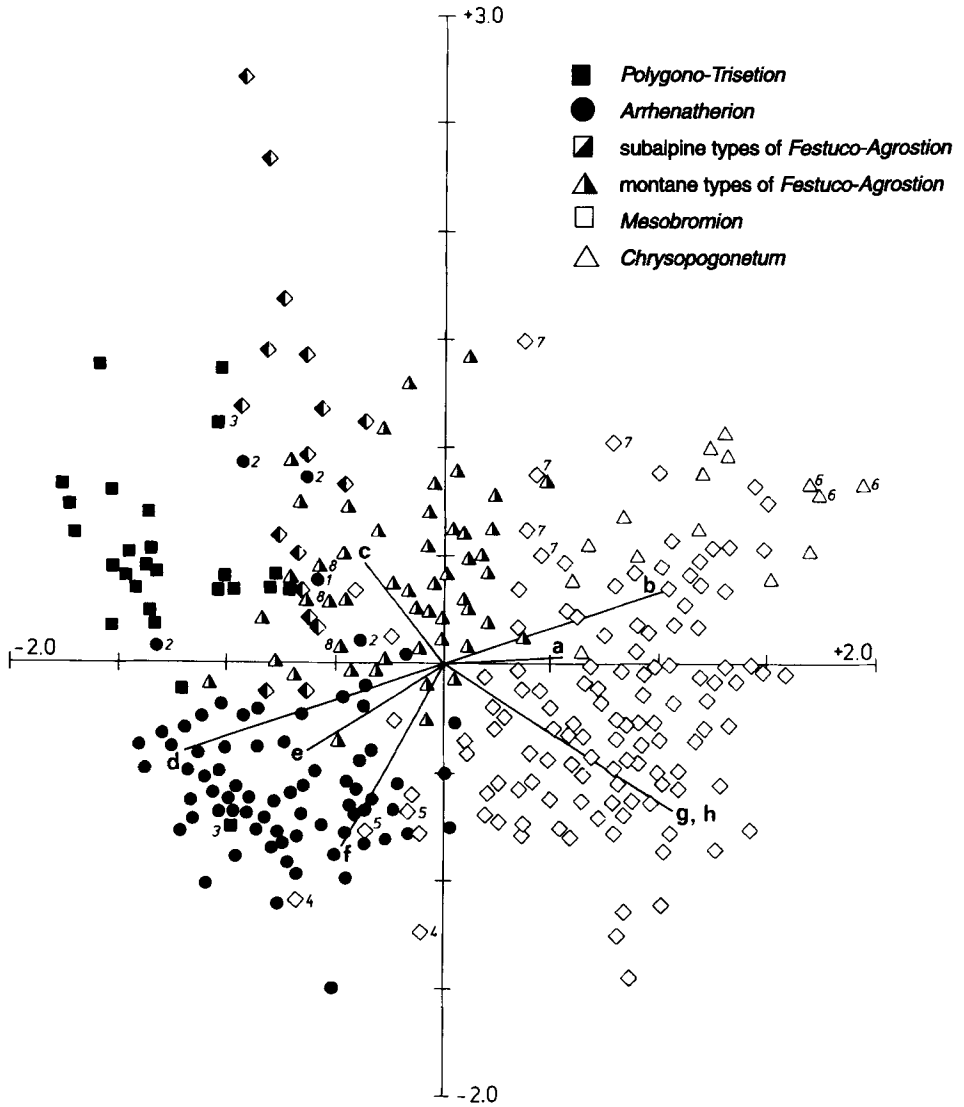

Fig. 1 Ordination diagram of the total 345 relevés (single relevés; DCCA, CANOCO). Environmental variables are a – relative light intensity, b – temperature, c – altitude, d – soil humidity, e – soil humus content, f – soil dispersion (and deficiency of aeration), g – soil reaction, h – continentality. (p.p. after LANDOLT 1977). 1 and 2 – *Arrhenatheretum* from Valais (WERNER, unpubl. relevés, DELARZE & THEURILLAT, unpubl. relevés), 3 – *Trisetetum* (STEBLER & SCHRÖTER 1892), 4 – *Mesobrometum* (STEBLER & SCHRÖTER 1892), 5 – excluded *Mesobrometum* (WAGNER 1984), 6 – *Chrysopogonetum* (KOCH 1943), 7 – acidophilous *Mesobrometum* (STUDER-EHRENSBERGER 1993a), 8 – *Trisetetum* from lower Leventina (MARSHALL 1947).

frequency of the species in this group of relevés was determined and classified in classes between 1 and 5.

To test whether a relevé belonged to the alliance given in the literature in the context of all 345 relevés, a cluster analysis (van der Maarel coefficient, complete linkage; WILDI & ORLÓCI 1996) was made to indicate problematic relevés (referred to as "alliance test"). A total

Table 3. Number of species with ecological indicator value i of species-group clusters I to X (Tab. 2), after LANDOLT (1977).

	i	I	II	III	IV	V	VI	VII	VIII	IX	X
(a) soil humidity	1						1		3		1
	2	2	9	2	27	2	15	18	42	13	16
	3	5	7	16	17	14	8	9	8	11	7
	4	14		31	3	2	1	1	1	1	1
(b) soil reaction	1				2						1
	2	2	4	1	15	1	2	1	2	2	2
	3	18	9	43	24	14	13	15	18	10	14
	4	2	3	5	6	3	10	12	34	13	7
(c) nutrient availability	1				2		2	2	11	2	12
	2		3	7	13	4	9	19	35	13	9
	3	15	10	35	30	14	13	7	7	10	4
	4	7	3	7	2		1		1		

of 16 relevés (< 5%) were in a different alliance than their author mentioned and were excluded from the calculations of the frequency table (* in Appendix 1). Meadow type 66 (two samples of *Trisetum* meadows by STEBLER & SCHRÖTER (1892), Appendix 1) was excluded as well, because it is built of two floristically-different relevés (see e.g. Fig. 1, "3") from the most-northern and the most-southern regions of Switzerland. After this elimination, all the vegetation types in Tab. 2 originate from geographically-restricted areas in Switzerland.

The floristic relationships between the initial 345 relevés are shown in an ordination diagram (Fig. 1) of detrended canonical correspondence analysis (DCCA), calculated in CANOCO (version 4., April 1998) and drawn by CanoDraw. The environmental variables for the direct gradient analysis are the elevation above sea level and the calculated mean indicator values (after LANDOLT 1977) of each relevé.

The final arrangement of species and meadow types in the frequency table (Tab. 2) was clustered with MULVA (van der Maarel coefficient, complete linkage; method described by WILDI 1986, with the final rearrangement of the two subalpine *Agrostio-Festucion* meadow types and some species groups). Tab. 2 gives the occurrences of all species present in more than three columns. The rare species can be found at http://sgiserv.unibe.ch/K_Studer-Ehrensberger.htm. These are species which may occur only once in an original relevé but may also be dominant in a single association (e.g. *Achillea roseo-alba* or *Cardaminopsis halleri* in the *Arrhenatherion* (19) of southern Switzerland (OBERDORFER 1964). The 320 species of Tab. 2 are classified in 51 groups. This number of 51 groups results, if the species cluster is cut at the 5th lowest similarity level (i.e. similarity level of 0.072, e.g. WOHLGEMUTH 1996, Fig. 3). No special procedure to reduce species with low frequencies was used, so as to be able to demonstrate the phytosociological behaviour of all species in the present analysis.

For every species the sociological behaviour (after ELLENBERG 1974 and ELLENBERG et al. 1991), altitudinal distribution and floral element (after STUDER-EHRENSBERGER 1993b), the indicator values of nutrient availability, of soil humidity and of soil reaction (after LANDOLT 1977) were compiled and summarized in Tab. 3 and 4. The values of Tab. 3 were used to name species clusters I to X in Tab. 2.

The clusters of the meadow types (Fig. 2) and their differentiating species groups (i.e. the species with prevalence to a certain group of meadow types, Tab. 2) were then compared to

the original typification of the meadow types in the literature (Appendix 1). A group of meadow types (Fig. 2, Tab. 2) was given the name of the most-frequently-occurring original name of the alliance (e.g. meadow types 40 to 65 all *Mesobromion* (except 62: *Xerobromion*), and types 9 to 20 all *Arrhenatherion*; Fig. 2). For the meadow-type groups with a heterogeneous original indication of an alliance, the floristic dissimilarity to the meadow types of the indicated alliance was decisive (e.g. groups 23 to 36 are floristically dissimilar to the classical *Mesobromion* types and therefore, cannot be *Mesobromion* types; Tab. 2, Fig. 2); an alternative alliance was chosen in that case.

Nomenclature of taxa follows BINZ & HEITZ (1986).

RESULTS AND DISCUSSION

The ordination diagram (Fig. 1) shows the detailed separation of all initial 345 relevés. The *Arrhenatheretalia* meadows, i.e. *Arrhenatherion* (types 5 to 20, Tab. 2; named by their original authors) and *Polygono-Trisetion* (types 1 to 4) are well separated from the extensively-cultivated meadows, i.e. the *Mesobrometum* (types 37 to 60, 64, 65), the *Chrysopogonetum* (types 61 to 63) and the montane *Festuco-Agrostietum* (HÄFELFINGER 1996, PESTALOZZI 1990, types 23 to 36), along the first ordination axis. This axis represents a separation of the mesic and nutrient-rich meadow types from the low-productive meadow types with low vegetation cover of thermophilous habitats. The second axis separates the lowland meadows (*Arrhenatherion*, types 5 to 20) from the meadows of higher altitudes (*Polygono-Trisetion*, subalpine *Festuco-Agrostietum*, types 1 to 4, 21 and 22) and the more thermophilous *Chrysopogonetum* (types 61 to 63) and *Mesobrometum* from the Ticino (types 64, 65) but not unambiguously the rest of the *Mesobrometum* types.

Identification of problematic meadow relevés

The relevé with dominant *Arrhenatherum* (1) in Fig. 1 between the *Polygono-Trisetion* relevés originates from Valais and belongs to meadow type 5 (Appendix 1). In the "alliance test" (see methods) this relevé was clustered near the others of type 5 (from a mean altitude of 890 m), even if it originates from 1120 m, wherefore it is included in the frequency table.

The four relevés of fertilized meadows with *Arrhenatherum* in Fig. 1 marked with (2) are relevés of type 8 (DELARZE & THEURILLAT, unpubl. relevés, THEURILLAT, unpubl. relevés) from montane Valais which are clustered with the *Arrhenatherion* (Fig. 2). Details are discussed further.

Polygono-Trisetion (meadow types 1 to 4)

The floristic similarity between *Polygono-Trisetion* and *Mesobromion* is loose (Fig. 2). Closer relationships exist between *Polygono-Trisetion* and *Agrostio-Festucion* (especially the subalpine *Festuco-Agrostietum* by LUTZ 1991; 21 and 22) and the *Arrhenatherion*.

The *Polygono-Trisetion* types 1 to 4 are differentiated by species of groups 3 and 4 (Tab. 2) with nitrogen-indicator values between 3 and 4 mostly. Fifteen of the total 22 species with environmental indicators occur preferably on moist, seven on damp sites (Tab. 3). The geographical distribution of many species is limited to central- and south-European mountains and to subalpine and alpine belts (Tab. 4). In addition to the dominating amount of *Molinio-Arrhenatheretea* species, *Epilobietea angustifolii* and *Betulo-Adenostyletea* species are most frequent.

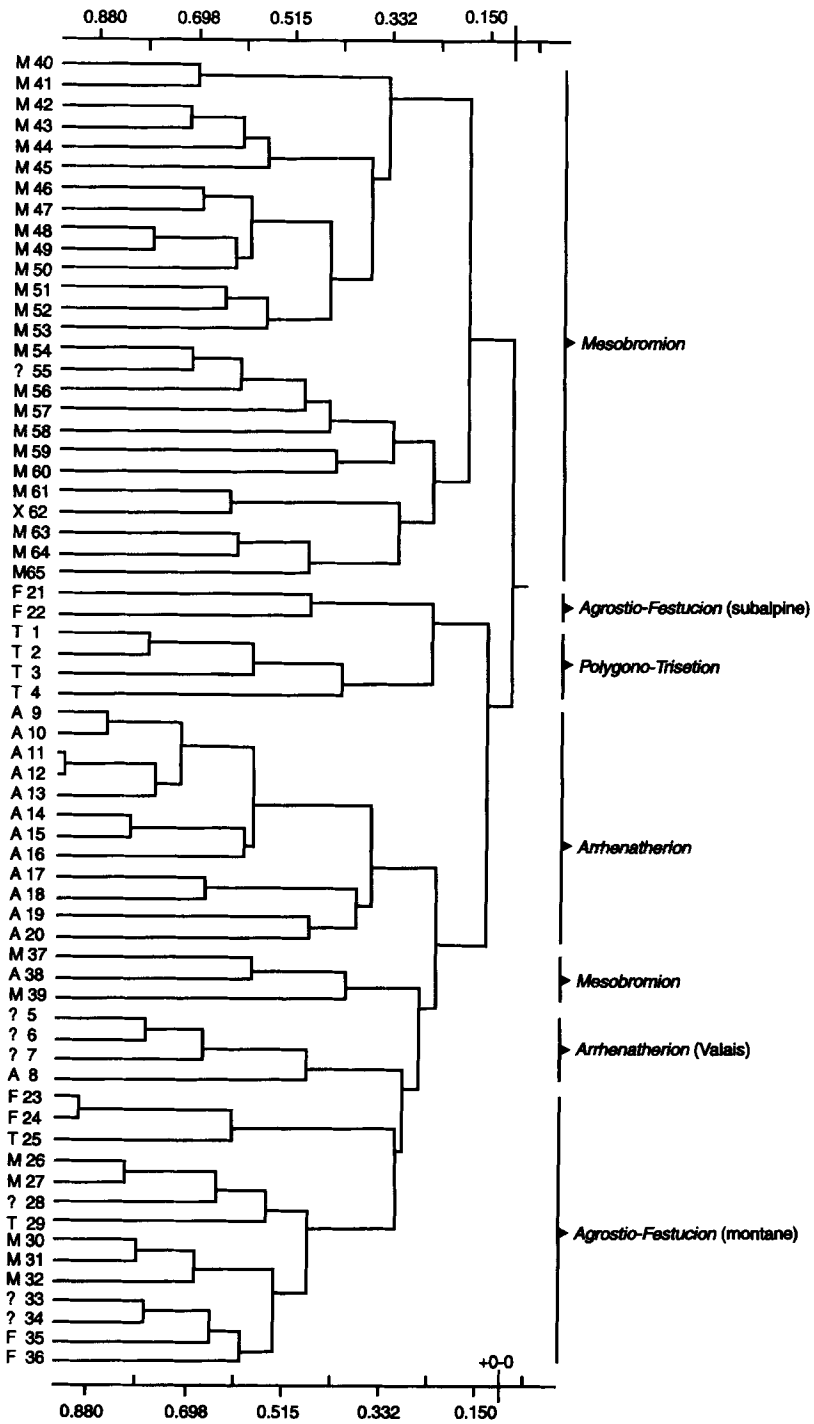

Fig. 2 Cluster diagram of the 65 types of Swiss species-rich meadows (frequency relevés; MULVA (van der Maarel similarity coefficient; complete linkage)) and original indication of the alliance in the literature. A – *Arrhenatherion*, F – *Agrostio-Festucion*, M – *Mesobromion*, T – *Polygono-Trisetion*, X – *Xerobromion*, ? – no indication. For the numbers of the meadow types see Appendix 1.

Agrostio-Festucion (meadow types 21 to 36)

In an analysis of the meadow vegetation of the area of montane Ticino (types 23 to 36), HÄFELFINGER (1996) assigned types 23, 24 and 35 to the *Festuco-Agrostietum*, type 25 to the *Polygono-Trisetion*, types 26, 27, 30–32 to the *Mesobromion* and types 28, 33 and 34 remained undefined (Appendix 1). This classification does not hold in the present context.

The *Agrostio-Festucion* (Tab. 2) is well-differentiated against the *Polygono-Trisetion*, the *Arrhenatherion* and the *Mesobromion* at the alliance level. Neither type 25 (*Polygono-Trisetion*; HÄFELFINGER 1996) nor type 29 (*Trisetetum*; MARSHALL 1947) are assigned to the *Polygono-Trisetion* (Tab. 2). MARSHALL (1951) assigned the latter *Trisetetum* from lower Leventina, which originates from the surroundings of three neighbouring villages in the upper montane belt (mean altitude 970 m, 16 relevés), to a separate regional variant ("Gebietsvariante") of the *Trisetetum*. The variant is differentiated from the rest of the *Trisetetum* by species of the *Agrostio-Festucion* groups 18 (*Thalictrum minus*, *Clinopodium vulgare*, *Phyteuma betonicifolium*) and 23 (*Paradisia liliastrum*) as well as of *Mesobromion* species groups 33 (*Centaurea jacea*, *Ranunculus bulbosus*) and 36 (*Scabiosa columbaria*, *Thymus serpyllum*). It is an example of the extensively used species-rich meadows of the montane belt of Ticino and mediates between the more eutrophic *Polygono-Trisetion* of the subalpine belt and relevés by HÄFELFINGER (1996; Tab. 2).

Similarly the *Mesobromion* types by HÄFELFINGER (1996; types 26, 27, 30, 31, 32) are not classified together with the *Mesobromions* of colline to submontane Ticino (types 64, 65) in Tab. 2.

The *Agrostio-Festucion* types in Tab. 2 are divided into three groups: The subalpine *Festuco-Agrostietum* (types 21 and 22) which is well-differentiated against the *Polygono-Trisetion* (Tab. 2) and the *Festuco-Agrostietum* of montane Ticino (types 23 to 36) with types 23 to 25 from north-facing slopes of the Centovalli. The altitudinal distribution of the constituent species varies largely and ranges from the colline up to the sub(alpine) belt (Tab. 4b). *Nardo-Callunetea* species are important, followed by *Molinio-Arrhenatheretea*, *Caricetea curvulae* and *Elyno-Seslerietea* species (Tab. 4c). Numerous species are restricted to central- and south-European mountains (Tab. 4a) and indicate dry to moist and acidic to very acidic soils (Tab. 3a, b). They are indicators of sites with low to moderate availability of nutrients (Tab. 3c).

Which are the characteristics of the *Agrostio-Festucion*? ELLENBERG & STÄHLIN (1952) mention *Agrostis tenuis* meadows from southern Germany, which had existed already before the agricultural intensification of the 19th century, an interpretation which GLAVAC (1983) verifies with historical documents for the Dönche, a meadow area near Kassel (Germany). He sees his *Festuca rubra-Agrostis tenuis* community as a relict central association (after DIERSCHKE 1981), which means that the association is weakly differentiated against others, and the differentiating species are missing. This applies well to the present meadows from montane Ticino. As a result of the current palynological knowledge it is well possible that *Festuca rubra-Agrostis tenuis* meadows are the original central-European grassland communities (STUDER-EHRENSBERGER 1995).

For Switzerland, STEBLER & SCHRÖTER (1892) described mown *Agrostis tenuis* meadows, with species of groups 4 (*Polygono-Trisetion*), 11 (*Arrhenatherion*), 16, 27, 33 (*Centaurea jacea*, *Knautia arvensis*, *Plantago media*, *Salvia pratensis*, *Bromus erectus*) and *Agrostis tenuis* (group 17), *Campanula rotundifolia* (group 34), *Arabis hirsuta* (group 35), *Briza media* (group 36), *Polygala amarella* (group 38) and a few sporadic ones. They are neither identical

Table 4. Number of (a) geographical, (b) altitudinal and (c) sociological elements in species-group clusters I to X (Tab. 2); a and b – after STUDER-EHRENSBERGER (1993b), c – after ELLENBERG (1974).

	I	II	III	IV	V	VI	VII	VIII	IX	X
(a) geographical distribution										
Worldwide		2	1			1		1	1	
N-Hemispheric		1	2			8	7			
Asiatic-Eurasiatic	3	4	22	16	4	7	11	15	8	6
European	6	6	15	13	11	2	7	28	5	11
Mediterranean		1	3	2		4	3	5	4	2
Orophytes	12	2	2	17	1			5	4	4
(b) altitudinal distribution										
Colline			1	2				3	1	2
Colline/montane		4	24	9	5	9	17	33	15	13
Col./mont./subalpine	4	7	19	19	10	8	11	15	5	8
Montane/subalpine	6	1	4	7	1	3		1		
Subalpine/alpine	10	2		11		1		1	1	
Colline-alpine		2		2	2	1		1		1
(c) sociological elements										
Epilobietea, Betulo-Adenostyletea	4			1					1	
Molinio-Arrhenatheretea	8	7	28	7	10	5	4	2	1	
Caricetea curvulae, Elyno-Seslerietea	1			6		2		1	1	
Ruderals	2	1	9	2		1	1	2		1
Nardo-Callunetea	3	5	1	12	3	1	4	3		2
Querco-Fagetea, Quercetalia robori-petraeae			2	2		5		2		4
Trifolio-Geranietea				3	1	1	3	10		3
Festuco-Brometea				1		7	11	21		8
Sedo-Scleranthetea					1		1	1	1	1

to types 21 and 22, nor to types 23 to 36 as frequent species of both meadow-type groups are missing in Stebler and Schröter's meadows. Further, their *Agrostis tenuis* meadows are a separate meadow type and not synonymous to the *Trisetetum* of MARSHALL (1947), as the latter was persuaded. MARSHALL (1947), in the context of his study of subalpine fertilized meadows, was thinking of the *Agrostis tenuis* dominated meadows of the Tavetsch and stated that Stebler and Schröter's *Agrostis tenuis* type is named after the visually most striking grass species in the stands. He argued with BROCKMANN-JEROSCH (1907) that *Agrostis tenuis* is not a constant species of intensively-cultivated montane and subalpine meadows only, but occurs in a broad range of meadow types and classified his associations to the *Trisetetum*. In the Val Poschiavo (south-eastern Switzerland) *Agrostis tenuis* names a subtype of the *Trisetetum* often found on north-facing slopes or in hollows (BROCKMANN-JEROSCH 1907).

The classification difficulties with *Trisetum flavescens* and *Agrostis tenuis* meadows are found in numerous studies by RÜBEL (1912; Bernina region), BRAUN-BLANQUET (1915; Cevennes (France) and south-eastern Switzerland), BÄR (1918; Val Onsernone (southern Switzerland)), ROTH (1919; central Pre-Alps), BOLLETER (1920; eastern Pre-Alps), LÜDI (1921; western Pre-Alps) and BERGER (1922; Schanfigg (central Alps)).

From the Balkan Peninsula, *Festuca rubra* and *Agrostis tenuis* meadows are recorded by HORVAT (1951) and classified as *Festuco-Agrostietum* by CSÜRÖS & RESMERIŢA (1960). These meadow types occur at the montane belt, in mesic habitats and have elements of the *Arrhenatheretalia* (*Achillea millefolium, Dactylis glomerata, Leucanthemum vulgare* (all 27), *Stellaria graminea* (17)), the *Festuco-Brometea* (*Salvia pratensis* and *Sanguisorba minor* (both 33), *Trifolium montanum* (34), *Scabiosa columbaria, Betonica officinalis* (both 36), *Pimpinella saxifraga* (37) and *Dianthus carthusianorum* (47)) and the *Agrostio-Festucion* (after COSTE 1977) (*Agrostis tenuis* (17), *Festuca rubra, Anthoxantum odoratum,* (both 27), *Hypochoeris radicata* (35) and *Briza media* (36)). Such phytosociological links do not exist only for the *Festuca rubra-Agrostis tenuis* meadows, but also for forest vegetation (e.g. *Ostrya carpinifolia* forests, ANTONIETTI 1968) and grassland types (e.g. *Seslerio-Brometum condensati, Bromo condensati-Diplachnetum* STUDER-EHRENSBERGER 1993a), which reach in southern Switzerland the most western edge of their south-east European distribution range.

After OZENDA (1985) strong phytosociological links exist in a periadriatic area which includes the Dinarids, the southern border of the Alps and the Apennino. In this area the sequence of the vegetation belts from the lowland to the highest elevations is the same as in the north-western Carpathians (OZENDA 1985) and probably also in the Transylvanian Alps of south Romania, where the montane *Agrostio-Festucion* occurs in connection with *Fagus silvatica* and *Picea abies* (CSÜRÖS & RESMERIŢA 1960, HORVAT et al. 1974).

RESMERIŢA (1977) discusses the *Molinio-Arrhenatheretea* of the Romanian Carpathians and assigns the *Festuco-Agrostietum* to the *Cynosurion cristati* TX. 1947. As this alliance unifies the mesophilous European pasture vegetation in which *Cynosuros cristatus* plays an important role, it is not considered the appropriate alliance for the mown *Festuco-Agrostietum* meadows in which *Cynosuros cristatus* plays a subordinate role.

For Munţii Bucegi (south-eastern Carpathians, Romania), PUŞCARU et al. (1956) describe an order of the *Molinio-Arrhenatheretea* called *Agrostio-Festucetalia* which they separate into the three geographically-defined alliances *Agrostio-Festucion rubrae* from the colline, montane and subalpine belts, respectively. The latter one is described in detail. CSÜRÖS & RESMERIŢA (1960) concentrate on the montane *Agrostio-Festucion* which is a very widespread meadow type in Transylvania and occurs between 600 and 1250 m. Two associations are most important: the *Festuco-Agrostietum tenuis* (connected with *Fagus sylvatica* forests) on south-facing slopes and the *Festucetum rubrae* on north-facing slopes in connection with *Picea abies* and *Picea-Fagus* forests.

Where is the *Agrostio-Festucion* to be affiliated? The order *Agrostio-Festucetalia* by PUŞCARU et al. (1956) is not convincing in the context of the present study: numerous important grass species (e.g. *Agrostis rupestris, Deschampsia caespitosa, Poa nemoralis*) do not occur in the Swiss montane *Agrostio-Festucion* types. The graminoids *Luzula nemorosa, Carex leporina* and *Juncus effusus* are missing, whereas *Danthonia decumbens* is present with low frequency (group 19). *Leucanthemum vulgare, Achillea millefolium* (both 27) and *Galium verum* (34) are frequent in Swiss *Arrhenatherion* and *Mesobromion* meadows as well and are not suitable as differential species of the *Agrostio-Festucetalia* order.

HORVAT et al. (1974) place the *Agrostietum tenuis* (with an atypical species composition, no nutrient-demanding species) of south-eastern Europe in between the *Nardetalia* and the *Arrhenatheretalia*. They assign the *Festuco-Agrostietum* by HORVAT (1962) of little intensive cultivation to the *Arrhenatherion elatioris* (HORVAT et al. 1974) and mention the south-west European centre of distribution of this alliance (a remark relating to the original south-west

European distribution area of *Arrhenatherum elatius*; STUDER-EHRENSBERGER 1995). Also this interpretation seems inadequate for the Swiss *Agrostio-Festucion* meadows. Even if they show some floristic relations to the *Arrhenatherion* (Fig. 2) they cannot be in the same alliance: On the one hand, they have less species in common with the *Arrhenatherion* types 9–20 than do the *Arrhenatherion* types from the Valais (types 5–8). On the other hand, they have a considerable number of differentiating species with high frequencies in the *Agrostio-Festucion*. This justifies the arrangement of meadow types 23–36 a separate alliance with close relationships to the *Arrhenatherion*. Meadow types 21 and 22 are not *Polygono-Trisetion* types and are called *Festuco-Agrostietum* by LUTZ (1991). They probably represent a subalpine association of the *Agrostio-Festucion*. To underline the close links of the *Agrostio-Festucion* with the *Polygono-Trisetion* and the *Arrhenatherion* the alliance is with LUTZ (1991) and PUŞCARU-SOROCEANU et al. (1981), aggregated to the *Arrhenatheretalia*.

Arrhenatherion (meadow types 5 to 20)

The *Arrhenatherion* types are clustered together with the other *Arrhenatheretalia* communities (Fig. 2). They are clearly separated in types 9–20 of the northern and southern parts of Switzerland and the irrigated ones from Valais (5–8). The latter are intermediate to a group of *Mesobrometum* types of nutrient-rich habitats (types 37–39) and the montane *Festuco-Agrostietum* from Ticino (types 23–36).

The classification of the *Arrhenatherion* types from Valais (5 to 8) is controversial: THEURILLAT (1992) classified meadow type 8 as *Anthrisco-Trisetetum* (MARSHALL 1951) DIETL ex PFISTER 1984, a *Polygono-Trisetion* association intermediating the subalpine *Polygono-Trisetion* and the colline and montane *Arrhenatherion* meadows (THEURILLAT 1992). In the present context, where not only one alliance as in THEURILLAT (1992) but also the ecologically-neighbouring alliances are considered, type 8 is left with the other *Arrhenatherion* types from Valais because together with types 5–7 it shows closer relationships to this alliance than to the *Polygono-Trisetion* (see Fig. 2). In Fig. 1 the meadow types 5-7 are ordinated between the *Arrhenatherion* types. In Fig. 1 the symbols of type 8, originally a "fertilized meadow with *Arrhenatherum elatius*" (BERTHOUD et al. 1987), is partly situated between the *Arrhenatherion* relevés and the ones indicated with (2), which are found at the zone between *Polygono-Trisetion* and *Agrostio-Festucion*. Indeed, the floristic composition of type 8 corresponds well with that of the other Valaisan *Arrhenatherion* types (Tab. 2) with a low frequency of typical *Polygono-Trisetion* species of montane to alpine distribution. Differential species of the *Arrhenatherion* (group 11) are not as frequent as in the other *Arrhenatherion* types 9–20, but occur more often than do the differential species of the *Polygono-Trisetion*. This species composition demonstrates the unique character of the Valaisan irrigated and fertilized meadows of the high montane belt (880–1140 m).

The rest of the *Arrhenatherion* types is floristically rather homogeneous and the types of warmer regions of Switzerland (types 17 to 20 from Brienz, Ticino and Genève) lack differential species. For the Insubrian type 19, 11 additional rare species may be found.

Species which are most frequent in *Arrhenatherion* types are indicative for moist and slightly acidic soils with moderate to high nutrient availability (Tab. 3a,b,c, III). The European west-Asiatic, central-European and south-European floral elements of the colline and montane (some even of the subalpine) belts are most frequent (Tab. 4a,b, III). The sociological elements are mostly *Molinio-Arrhenatheretea* species (Tab. 4c, III).

Mesobromion and the *Chrysopogonetum* (meadow types 37 to 65)

The dendrogram in Fig. 2 shows the unambiguous separation of the *Mesobromion* types (except 37 to 39) from the rest. The *Mesobromion* types form two large groups: the more mesophilous types (40–53) from regions 1–4 (see Tab. 2) and the xero- or thermophilous ones (54–65) from the calcareous Jura mountains and Ticino. Types 37–39 are transitional to the *Arrhenatherion* and *Agrostio-Festucion*: the *Mesobromion* species are rather sparse and have a high amount of *Arrhenatherion* species; type 38 is even classified as an *Arrhenatheretum* by FREY (1982, Appendix 1). Nevertheless, they are classified to the *Mesobromion* with which they have the highest similarity.

The meadow types 40 to 60 are the more eutrophic *Dauco-Salvio-Mesobrometum* and *Mesobrometum* types from the Valais and the north side of the Alps. The *Mesobrometum* types 40–53 are vaguely subdivided (see species groups 37 and 38). In the first group with irrigated *Mesobromion* types from Valais (types 40, 41 and 45) as well as mesophilous *Dauco-Salvio-Mesobrometum* types (42–44) from northern Switzerland, several indicator species of dry to extremely dry soils (Tab. 2, VIII) are missing. In the second subgroup (46–53), *Teucrio-Mesobrometum* types (46, 47, 49 and 53), the most xerophilous *Mesobrometum* from the Jura mountains, and *Mesobrometum* as well as *Dauco-Salvio-Mesobrometum* (51) from northern Switzerland are clustered together. The *Gentiano-Brometum* (type 50) is slightly outstanding with species group 28 (*Euphrasia rostkoviana*, *Ajuga genevensis*, *Polygala chamaebuxus* and *Carex ornithopoda*) which differentiates the species-rich meadows (43, 50) at the lake of Brienz.

Types 54–60 are again xerophilous *Teucrio-Mesobrometum* (types 54, 56, 58) and typical *Mesobrometum*, all from the submontane to montane Jura mountains. The *Mesobrometum* from the Lake of Bienne (type 59) is characterized by the presence of species of group 46. In type 60 from the region of Genève (WEBER 1958) *Tetragonolobus maritimus* and *Molinia arundinacea* (group 31) are highly frequent together with the two less-frequent *Molinion* species *Succisa pratensis* and *Genista tinctoria*.

The fourth group of *Mesobromion* types includes the most xerophilous types from Ticino: the *Chrysopogonetum* by KOCH (1943; type 62, which is in fact considered a *Xerobromion* association (STUDER-EHRENSBERGER 1993a), but as a single meadow type cannot be distinguished from the proper *Mesobromion* types), two *Chrysopogonetum* types by MEYER (1976; types 61 and 63) and two *Mesobrometum* types from the colline belt of Ticino by STUDER-EHRENSBERGER (1993a; types 64, 65). These meadows have numerous thermophilous (groups 47–49 p.p.) or southern species (i.e. *Centaurea bracteata*, *Polygala pedemontana*, *Chrysopogon gryllus* (all group 48) and *Scabiosa portae* (group 49)) in common.

Edaphic-ecological, geographical and sociological behaviour of species

The alliances of Tab. 2 are differentiated by the species-group clusters I to X. Cluster I differentiates the *Polygono-Trisetion* types, III the *Arrhenatherion*, IV the *Agrostio-Festucion* and VIII the *Mesobromion*. X is important in *Mesobromion* types from southern Switzerland.

For each cluster of species-groups the number of species with a specific ecological indicator value has been determined (Tab. 3). The species clusters I-X can be divided into equal halves. Clusters I to V indicate rather moist to damp and slightly acidic soils with a good availability of nutrients (Tab. 3). Clusters VI-X are indicative of dry soils of low nutrient availability

where numerous species of alkaline soils occur. They are more frequent in the *Mesobromion* types (Tab. 2).

The same division is possible based on the geographical distribution and sociological elements (Tab. 4). Clusters VI–X with a pronounced amount of lowland species, mostly of European and Asiatic-Eurasiatic distribution, are dominated by *Festuco-Brometea* species. In the other half, with elements from higher altitudes, the *Molinio-Arrhenatheretea* species are most important, except in cluster IV (differentiating for the *Agrostio-Festucion*), where numerous *Nardo-Callunetea* species are present. Sociological elements of deciduous forests, forest fringes and the *Festuco-Brometea* (Tab. 4c) are missing in clusters I–III (the *Polygono-Trisetion* and the *Arrhenatherion* differentiating species, respectively) and sparse in clusters IV (differentiating for *Agrostio-Festucion*) and V.

In species clusters (IV), VII–X the situation is different: the sociological elements that are important in the previous clusters occur in combination with the dominating elements of the *Festuco-Brometea*. This high diversity in sociological elements suggests the unique possibilities of coexistence in *Mesobromion* meadow types in contrast to the *Arrhenatherion* and *Polygono-Trisetion* types, due to an extensive cultivation that promotes a considerable microsite heterogeneity (SHMIDA & WILSON 1985). The *Agrostio-Festucion* shows a similar potential.

CONCLUSIONS

At the beginning of the 20th century BRAUN-BLANQUET (1928) introduced his phytosociological methods. With these methods numerous vegetation units were described in various regions of Switzerland following two aims: (1) a regional monograph where some authors described the whole vegetation coverage with several ecologically-different units of a geographically-restricted area (e.g. LÜDI 1921); (2) a study of one vegetation unit (association) of a specified habitat in a larger region (e.g. SCHNEIDER 1954, eastern-central lowland and north-eastern Prealps; ZOLLER 1954, Jura).

For the description of the semi-natural meadow vegetation of Switzerland these two attempts posed the following difficulties: (1) The monographs of the different regions cannot simply be unified for the whole area of Switzerland. Otherwise some regionally well-defined associations may lose their differentiating species. Such species are selected to differentiate between the ecologically-changing vegetation types of one region and not to differentiate between one vegetation type of a specific habitat in various biogeographical regions (e.g. BRAUN-BLANQUET 1961). (2) The habitats of semi-natural meadow vegetation are not separated clearly enough from each other. The floristic composition of the meadows is gradually changing with slight shifts in one of the ecological factors (which may be the result of the cultivation or site conditions) and as a consequence a great number of patterns is realized. Therefore, the precise delimitation of one vegetation unit is very difficult.

The present study has a scale between the one of regional monographs and the one on the variability of a single vegetation type, e.g. the study of the *Festuco-Brometea* by ROYER (1991) or the *Mesobrometum* by ZOLLER (1954). Therefore, it has its own differentiation pattern.

The four resulting alliances are based on the classification of frequent species in Swiss semi-natural meadows (Tab. 2). More than three hundred rare species, of which several are important for the differentiation of associations, are not included in Tab. 2.

The four alliances are named after the same species as the four main types of mown meadows and pastures in Switzerland, which the pioneers of the description of meadow vegetation, STEBLER & SCHRÖTER (1892), had discovered a hundred years ago. Since then, the description of three (*Polygono-Trisetion, Arrhenatherion, Mesobromion*) of the four types has gained considerably in content. The *Agrostio-Festucion* corresponds well with the main type of *Agrostis tenuis* by STEBLER & SCHRÖTER (1892), which has a few species of groups 4, 11, 16 and 17, a major number of group 27 and some further species of groups 33 to 36. This meadow type is revised and given the status of alliance. After a century of changing land use, the *Agrostio-Festucion* is still to be found: in Switzerland at the montane belt of the southern parts of the country, where the intensification of these meadows has not been so complete as elsewhere.

Acknowledgements: My thanks are due to Sonja Häfelfinger for the early access to her data and her collaboration during the study as well as to Jean-Paul Theurillat for an intensive discussion of an earlier version of the present paper. This study was partly supported by the Swiss National Science Foundation grant No. 31-30055.90.

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Received 9 August 1999, revision received 27 March 2000, accepted 6 April 2000
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APPENDIX 1

List of the 65 seminatural species-rich meadow types from Switzerland in Tab. 2, the excluded type 66 and the original relevé numbers (* – excluded for calculation of Tab. 2 (see methods). Swiss cantons are AG: Aargau, BE: Bern, BL: Basel Land, GE: Genève, JU: Jura, SO: Solothurn, SH: Schaffhausen, VD: Vaud, ZH: Zürich).

1: *Trisetetum*; upper Leventina, Ticino; MARSCHALL (1947, Tab. 7: 36–38, 148–150).
2: *Trisetetum*; Val d'Hérence, Valais; MARSCHALL (1947, Tab. 8: 106–111).
3: *Trisetetum*; Tavetsch; MARSCHALL (1947, Tab. 6: 85–89a).
4: *Poo alpinae-Trisetetum flavescentis centauretosum nervosae*; Dötra, Ticino; WACKER (1986: no. 259, 260*, 261–264).
5: Meadow; central Valais; WERNER (unpubl. relevés, PVS: 3661, 3662, 3003, 3060, 2858, 3918).
6: Eutrophic dry meadow; Valais; DELARZE & THEURILLAT (unpubl. relevés, PVS: 3014, 3233, 3194, 2988*, 3701, 3702).
7: Eutrophic dry meadow with *Filipendula hexapetala*; Valais; WERNER (unpubl. relevés, PVS: 3849, 3800, 3825, 3872, 3836, 3853).
8: Fertilized meadow with *Arrhenatherum elatius* = *Anthrisco-Trisetetum*; Valais; DELARZE & THEURILLAT (unpubl. relevés) and THEURILLAT (1992, PVS: 3422, 3451=RT1305, 3430=RT1318, 3469=RT1321, 3431, 3457=RT1311).
9: meadow with *Arrhenatherum*, meadow with *Trifolium pratense*, meadow with *Trifolium repens*; BL, SO, ZH; STEBLER & SCHRÖTER (1892: p. 185, 186, 190, 191).
10: *Arrhenatheretum*; Limmat valley; SCHERRER (1925: p. 90–92, no. 1–6).
11: *Arrhenatheretum* subass. of *Ranunculus bulbosus*; ZH; SCHNEIDER (1954: no. 93, 25, 56, 26, 60, 76).
12: *Arrhenatheretum* var. of *Salvia pratensis*; ZH; SCHNEIDER (1954: no. 41, 64, 116, 54, 107, 53).
13: *Arrhenatheretum elatioris*; AG-Jura; MARSCHALL (1947, Tab. 10: 46–51).
14: *Arrhenatheretum* subass. of *Lysimachia nummularia*; ZH; SCHNEIDER (1954: no. 104, 1, 105, 7, 72, 83).
15: *Arrhenatheretum* typicum; ZH; SCHNEIDER (1954: no. 19–21, 88, 101, 106).
16: *Arrhenatheretum elatioris*; BE-Jura; KRÄHENBÜHL (1968, Tab. 6: 1–4).
17: *Alchemillo-Arrhenatheretum*; Lake of Brienz; DOHRN (1989, Tab. 1: 2305, 2340, 2370, 2330, 2314, 2333*).
18: *Arrhenatheretum elatioris*; Lake of Brienz; DOHRN (1989, Tab. 1: 2242, 2031, 2208, 2223, 2034, 2215).
19: *Centaureo dubiae-Arrhenatheretum*; Insubria; OBERDORFER (1964, Tab. 9: 1, 3, 5, 7, 9).
20: *Arrhenatheretum*; GE; WEBER (1958, Tab. 4: 40, 41*, 42).
21: *Festuco-Agrostietum, trifolietosum repens*, facies of *Nardus stricta*; Adelboden; LUTZ (1991: no. 133–138).
22: *Festuco-Agrostietum* typum, facies of *Crepis pyrenaica*; Lake of Brienz; LUTZ (1991: no. 36, 37*, 38, 34, 40, 41).
23: *Festuco-Agrostietum*; Ticino; HÄFELFINGER (1996: no.H39, H51, B25).
24: *Festuco-Agrostietum intermedium*; Bordei (Centovalli, Ticino); PESTALOZZI (1990: no. A42, A33, A43, A39, A40, A27).
25: *Polygono-Trisetion*; Ticino; HÄFELFINGER (1996: no. H20, B29).
26: *Mesobromion*; northern Ticino; HÄFELFINGER (1996: no. 160, 046, 267, 270, 552, B38).
27: *Mesobromion*; northern Ticino; HÄFELFINGER (1996: no. 308, 307, 316, 290, 144, 143).
28: extensively cultivated meadow; northern Ticino; HÄFELFINGER (1996: no. 269, 264, 263, 315, 314, 279).
29: *Trisetetum*; lower Leventina, Ticino; MARSCHALL (1947, Tab. 9: 5*, 6–10).
30: *Mesobromion*; southern Ticino; HÄFELFINGER (1996: no. 134, 118, 059, B36, 235, 126).
31: *Mesobromion*; southern Ticino; HÄFELFINGER (1996: no. B30, B31, 036, 238, 123, 285).
32: *Mesobromion*; southern Ticino; HÄFELFINGER (1996: no. 297, B02, 009, B03, 004, B05).
33: extensively cultivated meadow; southern Ticino; HÄFELFINGER (1996: no. 310, 258, B21, 133, B20, 166).
34: extensively cultivated meadow; southern Ticino HÄFELFINGER (1996: no. 311, 295, 229, 171).
35: *Festuco-Agrostietum*; Ticino; HÄFELFINGER (1996: no. 029, 183, 167, 302, 172, 184).
36: *Festuco-Agrostietum*; Ticino; STAMPFLI (unpubl. relevés: no. 3*, 9, 16).
37: *Mesobrometum*; SO-, JU-, BL-Jura; FREY (1982: no. 54, 70, 106).
38: *Arrhenatheretum*; SO-Jura; FREY (1982, Tab. 15: 58, 67*, 71, 72*, 96).
39: meadow with *Bromus*, meadow with *Festuca pratensis*, meadow with *Carex montana*, meadow with *Lotus corniculatus*; SO, ZH, SH; STEBLER & SCHRÖTER (1892: p. 107–108, 108–109, 109, 110, 112–113, 114).

40: continental *Mesobromion* with *Filipendula hexapetala*; Valais; WERNER (unpubl. relevés: no. 3863, 3873, 3875, 3835, 3842, 3862).
41: *Mesobromion*; central Valais; WERNER (1987: no. 3712, 3850, 3840, 3837, 3857, 3838).
42: *Dauco-Salvio-Mesobrometum*; BL-Jura; FIECHTER (1989).
43: *Dauco-Salvio-Mesobrometum*; Lake of Brienz; DOHRN (1989: no. 2033, 2006, 2023, 2401, 2041, 2234).
44: *Dauco-Salvio-Mesobrometum*; Lake of Bienne; STYNER & HEGG (1989: no. 1, 2, 3).
45: *Mesobromion*; upper Valais; THEURILLAT (unpubl. relevés: no. 3412, 3420, 3426, 3436, 3439, 3453).
46: *Teucrio-Mesobrometum*; eastern AG-Jura; MÖCKLI (1987: no. 92, 97, 99, 101, 102, 110).
47: *Teucrio-Mesobrometum*; eastern AG-Jura; ZOLLER 1954 in MÖCKLI (1987: no. 150, 406, 148, 149).
48: former *Mesobrometum*; SO-Jura; PAULSEN (1988: no. 29a, 30, 31, 32a, 33, 34a).
49: former *Teucrio-Mesobrometum*; SO-Jura; PAULSEN (1988: no. 1a, 2a, 3, 4a*, 5a, 6a).
50: *Gentiano vernae-Brometum*; Lake of Brienz; DOHRN (1989, Tab. 1: 2009, 2403, 2303, 2238, 2032, 2026).
51: *Dauco-Salvio-Mesobrometum*; SO-, BE-, JU-, BL-Jura; FREY (1982: no. 32, 45*, 97, 26).
52: *Brometum bromosum*; Limmat valley; SCHERRER (1925: p. 62–64, no. 1–6).
53: *Teucrio-Mesobrometum*; eastern AG-Jura; ZOLLER 1954 in MÖCKLI (1987: no. 418, 99, 495a).
54: *Teucrio-Mesobrometum*; SO-, BE-, JU-, BL-Jura; FREY (1982: no. 104, 46, 80, 90, 63a, 93).
55: pastures, fallows, meadows; region of Basel; WAGNER (1984: no. 3*, 5*, 7, 8*, 14, 19).
56: *Teucrio-Mesobrometum*; SO-, BE-, JU-, BL-Jura; ZOLLER (1954) in FREY (1982: no. 46.36, 46.34, 53.22, 53.24).
57: *Mesobrometum*; BE-Jura; KRÄHENBÜHL (1968, Tab. 11: 1, 3, 5).
58: *Teucrio-Mesobrometum*; region of Basel; ZOLLER (1954) in WAGNER (1984: no. 3, 4, 22, 34).
59: Extensively cultivated mesophilous meadow; Lake of Bienne; STYNER & HEGG (1984: no. 7–11).
60: *Mesobrometum*; Genève; WEBER (1958, Tab. 2: 17, 105, 54, 55, 59, 60).
61: *Carici humilis-Chrysopogonetum*; Insubria; MEYER (1976: no. 63, 68, 121, 110, 54, 16).
62: *Andropogonetum = Helianthemo-Xerobrometum condensati chrysopogonetosum* (STUDER-EHRENSBERGER (1993a)); Mendrisiotto; KOCH (1943: no. 1-3).
63: *Holco-Chrysopogonetum galietosum*; Insubria; MEYER (1976: no. 75, 78, 109, 79).
64: *Phyteumo-Mesobrometum*; Insubria; STUDER-EHRENSBERGER (1993a: no. 87, 95, 105, 113, 121, 127).
65: *Coronillo-Mesobrometum*; Insubria; STUDER-EHRENSBERGER (1993a: no. 1, 7, 15, 21, 31, 37).
66: meadow with *Trisetum flavescens*, *Trisetum* meadow with *Chaerophyllum villarsii*; VD-Jura, Ticino; STEBLER & SCHRÖTER (1892: 198, 201).

Table 2. Frequency table of seminatural species-rich meadows in Switzerland. *P.-T.*: *Polygono-Trisetion*; N-indicator value after LANDOLT 1977. Region: 1 – Jura, 2 – Central Lowlands, 3 – Prealps, 4 – Western Central Alps, 5 – Southern Alps.

Alliance	*P.-T.*	*Arrhenatherion*	*Agrostio-Festucion*	*Mesobromion*
Number of meadow types		11111111112	22 222 22223333333	333 44444444445555 5555556 66666
(Appendix 1)	1234	5678 901234567890	12 345 67890123456	789 01234567890123 4567890 12345
Date of relevés	1111	1111 111111111111	11 111 11111111111	111 11111111111111 1111111 11111
	9999	9999 899999999999	99 999 99999999999	998 99999999999999 9999999 99999
	4448	8888 925545568865	88 989 99949999999	889 88888885888825 8856585 74788
	3336	5555 043333376646	99 393 33333333334	220 55863453886243 2337336 42477
Region	5445	4444 222212213351	33 555 55555555555	110 44131411113121 1111111 55555
Altitude (m /x10)	111	1	11 11 111	
	4847	8918 545455546634	67 887 90099900099	554 69566855876645 6566563 43455
	2835	9248 391435236641	30 105 51678232381	575 88164975057070 5180629 42355
Mean number of species/relevé	3433	3334 334443353333	23 442 44353344433	432 23344543565322 4449442 44333
	6177	7333 651226512411	29 609 25608891438	795 90473114703567 7624478 62948
Number of additional	1	1 1	22 1 1	1 11 1 81111
rare species	8333	6340 240102072712	71 601 37344095585	010 27200361428280 2884677 15673
Mean N-indicator value	3333	3222 333333333323	22 223 22232222222	232 22222222222222 2222222 22222
	....	....	.. ..	... .
	4243	0989 323125434191	56 782 55705458798	607 53767533564856 4323221 32345
	0875	4961 246557725898	47 429 83747540633	908 45095878976679 6740966 81932
I: Nutrient indicators of moist to damp soils (often higher altitudes):				
1:				
Geum montanum	2..1	...1	.. ..	... .
Soldanella alpina	21.1	....	.1	... .
2:				
Peucedanum ostruthium	...4	....	.1	... .
Veratrum album s.l.	22.4	....	.1	... .
Potentilla aurea	1..3	...1	.1 ... .1.	... .
Crepis aurea	...4	1...	21	... .
3:				
Myosotis scorpioides	2.5.	....14..111.	.. 2.3	... .
Chaerophyllum aureum	245.	...1	.. ..	... .
Campanula scheuchzeri	3154	....	.3 ... ...4.....	... .
Rumex alpinus	3152	....	.. ..	... .
Hypericum maculatum s.l.	2.54	....	2.	... .
Acer campestre	..3.	....	.. ..	.2. .....2..... 1..... .....
4:				
Carum carvi	5552	21.2 311.5..315..	.. ..5..11..5	..1 ...3.....2.... ....
Ranunculus frieseanus	5545	....5...55..	.. ..3.....	... ...3.2....3... ....
Alchemilla vulgaris s.l.	5555	.... 2...15.5....	41 2.3 ..44..2..23	... .
Campanula rhomboidalis	55..	42.5 .....4...	.. ..	... .
Geranium silvaticum	4525	5225 .....1..3...	.. .1. ..342..221.	... .
Silene dioica	55.5	...1 2....5.....	.. ... .124.....1.	1
Rumex alpestris	5555	....	.. ..	... .
Myosotis silvatica	351.	22.3	.. ..5.....	... .2.. ....
Poa alpina	55.5	....	.1 ... ...5.....	... .
Phleum alpinum s.l.	3525	....	.. 2..	... .
Crocus albiflorus	53.5	....	.. 443 ..1..112...	... .
II: Indicators of low to moderate nutrient availability and moist soils:				
5:				
Agrostis stolonifera	.2..	.... 2.....	.. ..	... .2..
Trifolium badium	.4..	...2	.1	... .1..... ....
Gentianella campestris	.3..	1..1	1.	... .
6:				
Luzula multiflora	...1	...1	.1	... .
Cuscuta epithymum	....	..11	.. ..	... 1..... ....
Avenella flexuosa	....	...2	.1 ... .11.....	... .
Campanula barbata	....	...1	.1 ... .1.....	... .

Alliance	*P.-T.*	*Arrhenatherion*	*Agrostio-Festucion*	*Mesobromion*
Number of meadow types (Appendix 1)	1234	5678 901234567890	12 345 67890123456	789 012345678901 23 4567890 12345
7:				
Angelica silvestris	....	124. .....2....	.. ..	... .
8:				
Sanguisorba officinalis	....	.11.	2.	... .
Hieracium silvaticum	....	....	2.	... .11... ....
Platanthera bifolia	....	....	3.	... .1..... 1.....1 .....
9:				
Botrychium lunaria	.1..	...1	3	... .
Dactylorhiza maculata	....	...1	.1 3	... .1....1... ....
Narcissus poeticus	....	....	.. ..1.....3	... .1.
10:				
Campanula patula s.l.	....	.... ..33..1.....	.. ... 11.....	... .
Silaum silaus	....	..1. ...2.....	.. ..	... .1.... ....
III: Indicators of moderate to high nutrient availability and moist soils:				
11:				
Lolium perenne	..4.	11.. 555555551125	.. ..5 ...1.....33	.4. ....4....21... 2..... 1
Taraxacum officinale	5554	2..2 5555555555.5	.. ..3 ..15.....3	545 ...253....15.. 22...3. .....
Anthriscus silvestris	....	4321 24554555221.	.. ..	... ...2.....4.. ....
Crepis biennis	1.5.	1... 4555355513.5	.. ..	421 ...1.1...2.4.. 12..... .....
Bellis perennis	.15.	12.. 255455453535	.. ..4.....	..2 ..224...2222.. 1..... .....
Poa trivialis s.l.	455.	11.1 553.5555121.	.. .25 ...2....21.	.5. ....2....1.... 2..... .....
Bromus hordeaceus	..2.	.... 435335551.1.	.. ..12.....	... .
Tragopogon orientalis	421.	5555 4555512..2.3	.3 ... ...4.....	..2 1..1.2..... ....
Heracleum sphondylium s.l.	355.	43.5 45525555351.	.. ..3 .154...4223	24. ...3.2..2.22.. ....
Ranunculus acris s.l.	....	5553 5554.555..53	.. 555 1.1.1.13313	242 32..... 2..... .....
Trifolium repens	5555	2.43 545555553535	.2 455 2135...3253	.21 ..2251..33.... 15..... .....
Vicia sepium	433.	3..4 3545255513..	.1 ... ..11.....1.	42. ...1....1.121. ....
Cardamine pratensis s.l.	2...	.... 3141445531..	.. ..5.....	... .
Cerastium holosteoides	4452	.1.2 555554555425	.. 555 .1.51.12443	24. ..5.54..22.4.. 34...2. ...12
Glechoma hederacea	....	.... 3.33155.31.3	.. ..	..1 ....
Festuca pratensis s.l.	.11.	3541 3254535.55..	24413	..1 ..3322..431... 1..... .....
Holcus lanatus	..1.	2222 555555554535	 31142445443	552 ..4424..2124.. 3..... ..31.
Galium mollugo	45..	.... 45555555..53	.. .13 111122.542.	451 .....54. ...4... 4.212
Veronica chamaedrys	5452	3..1 3.545555432.	.1 555 .225313254.	251 ..23.21.1312.. 12..... .....
Arrhenatherum elatius	....	5553 455555554355	.. ..3 2135...3215	251 52445212334512 1....1. 3..24
Ajuga reptans	....	2..1 34..555.352.	5. 555 1..2.12.2..	.21 .....3..1.32.. ....
Veronica arvensis	..4.	11.. .255325.22.3	.. ... 3114...1...	... .21..33...2 ....
Myosotis arvensis	....	121. 3454123511..	.1 ... 121...11...	... .2....5.... ....
Trifolium dubium	....	.... 2.454..4....	.. ..	.21 ..... 1...2.. .....
Picris hieracioides s.l.	....	.2.. 41555.....	.1 ... .1...	221 ..41..2.331... ..... 1..11
Cynosurus cristatus	..5.	2223 334.52241123	.. ..3..2..13	24. ...1.5..23.... 22..... .....
Prunella vulgaris	145.	1112 3155.553.41.	44 555 2..22.1133.	.24 .1.2.1.53.3... .245... ...1.
12:				
Pimpinella major	....	22.5 ..331143433.	.4 ... .1....1.	24. ...1....1.12.. 11
Alchemilla xanthochlora	....	2..5 .....5...	.2 .2.	... .
Polygonum bistorta	1...	4..3 .....3....	.2	... .
Galium boreale	....	3.33	.. ..	... .2...1..... ....
Knautia dipsacifolia s.str.	21..	1..5	.2	42. .....1.....2.. 3..... .....
13:				
Cirsium oleraceum	....	....5..12..	.. ..	..1 ....
Rumex obtusifolius	....	1..1 .....4.221..	.. ..3 .....1...	... .
Ranunculus ficaria	..1.	....5..1...	.. ..	... .
Primula elatior	....	...1 .1...3.....	.. ..	... .
14:				
Phleum pratense s.l.	....	11.. 3.....5....	.. ..2.	... .1.... ....
Lolium multiflorum	....	.... ..1...35....	.. ..	... .
Alopecurus pratensis	..1.	.... 2....2.51..3	.. ..	... .
Ranunculus repens	..1.	1... .....5....	.. ..3	..1 ....
Geum rivale	....	1..1 .....2....	.. ..	... .

Alliance	*P.-T.*	*Arrhenatherion*	*Agrostio-Festucion*	*Mesobromion*
Number of meadow types (Appendix 1)	1234	5678 901234567890	11111111112 22 345 67890123456	222 22223333333 333 789 01234567890123
				444444444455555 5555556 66666 4567890 12345
Aegopodium podagraria	....	....31...	.. ... .11.....1.	2.. ....
Cruciata laevipes	....	....2....	.. ..	.2. .....11.... ....
Artemisia vulgaris	....	....2....	.. ... .1.....	1
Thesium pyrenaicum	....	...1 .....2....	.1	... . .2.2... .....
Tragopogon pratensis	...3	....5....	.. ... 212...11...	22. ..3...1324.2.4 ....1.
15:				
Pastinaca sativa s.l.	....	..1. 21...1.....3	.. ..1.....	... .
Convolvulus arvensis	....	.... 2.....3	.. ..	..1 ....
Potentilla reptans	....	....1.3	.. ..1....	... .1..... ....
IV: Indicators of low nutrient availability and acid soils:				
16:				
Trollius europaeus	31.4	11.3	14 3	... .
Chaerophyllum villarsii	2..4	1..2	15 42. 111.1....3.	... .
Polygonum viviparum	...2	....	43	... .
Carex sempervirens	....	....	14 ... 1.....	... .1..... ....
Phyteuma orbiculare	....	11.. .....1..	33 3	... .1.3.1....3... ....
Astrantia major	....	1...	.4 ... .3.2.3	... .
Gentiana lutea	....	....	.3	... 1.....1..... ...2... .....
Ranunculus nemorosus s.l.	....	....	.3	.2. ..1...3211..1. ...2... .....
17:				
Lychnis flos-cuculi	....	...1 2.114154..1.	.. 443	... .1..... ....
Veronica serpyllifolia s.l.	4231	.... ..1.....2...	.. .45	... .11.... ....
Crepis conyzifolia	...2	1..2	.. 45.	... .
Stellaria graminea	..2.	....2.1.	1. 555 42433	... .
Carex pallescens	....	...1 .....1.	.. 553 1...1....3.	... .
Ranunculus polyanthemophyllus	....	....	.. 423	... .
Carex leporina	....	....	.. 433 .....1...	... .
Hieracium lactucella	....	....	.. 44. ..1...1.2..	... .
Agrostis tenuis	5452	1..5	54 555 35235442253	221 .....1..1..... ..252.. ...2.
Centaurea nigrescens subsp. *transalpina*	....	....5.	.. 555 14144454543	... . 2..13
Leontodon autumnalis	....	....	.. 543 .....2.	..1 ..... 1..55.. .....
Potentilla erecta	....	...2 .....12.	.5 553 32.15422223	2.2 ...1.2..1.5... 1425..2 ..33.
18:				
Viola tricolor s.l.	5113	....	.. ... 34552212.2.	... .
Poa chaixii	....	...1	.. 42. 133413.1...	... .
Phyteuma betonicifolium	5214	....	.. 553 45553545.3.	... .23.
Clinopodium vulgare	....	1..1 .1.3.....12.	 45352235443	... ...3.2..... 1...4... ..422
Thalictrum minus s.l.	1...	...1	.. 45. 54542414313	... .5.. 1.2.2
19:				
Dianthus seguieri	....	....	.. ..232...	... . 1..3.
Galium rubrum	....	....	.. ... 24..1353.13	... . 1...1
Festuca tenuifolia	....	....	.. ... 4...2341.1.	... .2.
Danthonia decumbens	....	....	21 ... 21...43....	... .2... ...2... ..33.
20:				
Nardus stricta	...1	....	.1 41. .1..51.....	... .1..... ....
Carex fritschii	....	....	.. 2.. ....55.1...	... . 1.2..
21:				
Narcissus verbanensis	....	....	.. 21. .....2....	... .
Lilium croceum	....	....	.. .1. 1.....1....	... .
Viola canina	....	....	.. 2.. .1....2....	... .
Veronica officinalis	....	....	.. 21. .1..1.1.2..	... .11
Cerastium arvense subsp. *strictum*	....	....	.. ... 1.....3.2..	... .
Centaurea triumfettii	....	....	.. ..2..1.	... . 12..1
22:				
Biscutella laevigata	....	....	.. ... .1311.....	... . 2...1
Rumex acetosella s.l.	....	....1.	.. ... 115.2213.1.	... .34.

Alliance	*P.-T.*	*Arrhenatherion*	*Agrostio-Festucion*	*Mesobromion*
Number of meadow types (Appendix 1)	1234	5678 901234567890	12 345 67890123456	789 01234567890123 4567890 12345
23:				
Poa violacea	....	....	.. ... 122.....	... .
Paradisea liliastrum	...1	....	.. ... 121..1.....	... .
Koeleria cristata	....	....	.. ... 121.....	... .
Alchemilla hybrida	....	....	.. ... .2..1.1....	... .
24:				
Acinos alpinus	.2..	1...	.. ... .223.....	... .
Valerianella locusta	....	....	.. ... 1.13.....	2.1 ....
25:				
Carex muricata s.l.	....	....1..	.. ..1.11.3...	... .
Crepis capillaris	....	....	.. ..1....221.	... .
Fragaria vesca	....	....1...	.. ... .1..1..221.	... .1... 1...2.. .....
26:				
Solidago virgaurea s.l.	....	.1..	.. ..12...1.	... .
Sedum telephium s.l.	....	....	.. ... .1...1.1...	... .
V: Indicators of moderate nutrient availability and moist soils:				
27:				
Rumex acetosa	.2..	5535 555455555445	.. 555 45555455555	441 2.3255..34141. 12..... ...1.
Trisetum flavescens	5555	4555 55555555232.	.. 553 55452344543	421 2155531.242..4 1....1. 1.224
Festuca rubra s.l.	5533	3..5 24555555542.	55 555 55555555455	422 ...2.5..1...1. 1.....3 ..4.2
Anthoxanthum odoratum s.l.	4555	3325 55555545445.	54 555 35455555555	443 ..3445..12441. 32.5... 2.543
Leucanthemum vulgare	555.	5555 555555551455	.. 555 12352343335	253 21555553544555 4435.1. 3.321
Colchicum autumnale	.4..	3254 31323.14131.	.. ... 1.1...2...3	42. ...1....1.1... 1..... .....
Trifolium pratense s.l.	5555	5555 5555555.5555	55 555 55555432455	542 1.545514555544 45352.1 ..222
Avenula pubescens	.3..	23.3 34554..323..	.2 ... 225.3.54223	.22 ...424...23... 1..5.1. ...1.
Dactylis glomerata	5551	5555 555555554555	45 435 55555555455	553 54545543555544 343551. 54425
Plantago lanceolata	.232	3435 555555554543	.. 553 55555555553	554 31545523455555 453544. 4.443
Lathyrus pratensis	.41.	3125 213..22413..	.1 ... .1131.124..	.41 21542322132.1. 22..... 1...1
Luzula campestris	13..	...2 ...45....13.	.2 55. 21334452213	2.1 ...425....24.. 12..... ...11
Rhinanthus alectorolophus	2534	4553 .....11..	43 ... 24.42141315	... 2112.32.1.3... .2...3. ..2..
Silene vulgaris s.l.	5555	5345 2243	.. 45. 55555525455	... 22.5451..11.1. ..... 2.2.3
Vicia cracca s.l.	355.	2145 .1.1...2.2..	.1 22. .124...4.13	54. 3124.4231232.. .....1 ..212
Leontodon hispidus s.l.	3514	4355 211.5125255.	.. 5.3 55555555555	521 2.4355545452.. 3425.2. 2.331
Achillea millefolium s.l.	5134	4342 22..1..52..5	.. 553 55555555555	422 32315552541552 44253.. ...23
Lotus corniculatus s.l.	.313	2355 34355..52435	.3 553 55454455553	554 41555554555525 5535455 35343
VI: Indicators of low nutrient availability and dry to moist soils (+ indicators of alkaline soils):				
28:				
Listera ovata	.1..	...1 .1.....	1.	.2. .....1....2... ....
Euphrasia rostkoviana	.1..	....2..	3. 2.. .12.11..22.	..1 ...1.....4... .2.2... .....
Carduus defloratus s.l.	....	....	.2	... .2... ...2... .....
Ajuga genevensis	....	....1.....	.. ..	... ...1.....2.1. .2..... .....
Polygala chamaebuxus	....	....	2. ... .1.....	... ...1.....4... 2..... .....
Spiranthes spiralis	....	....	.. ..	... .2... ..22... .....
Carex ornithopoda	....	....	.. ..	... ...1.....2.1. ..22... .....
29:				
Carex silvatica	....	....12..	.. ..	24. ...1..... ....
Rhinanthus minor	....	....3..	1.	44. ...1.....11... 1..... .....
Viola reichenbachiana	....	...1	.. ..11.1.2.	.2. ....
Rubus fruticosus s.l.	....	....	.. 2.. .....1.2.	22. ..... 1..... ...2.
30:				
Orchis ustulata	....	1..1	.. ..	... .1..... ..2..1. ...1.
Coeloglossum viride	....	....	1.	... .22... .....
Sesleria varia	....	....	1.	... . .222... 1....
Ophrys apifera	....	....	.. ..	... .1..... .23..1. .....
31:				
Equisetum arvense	..2.	11.2 .....1..	.1 ... 1.1.....	... .2..... .....3 .....
Populus tremula	....	....	.. ... 11.....	2.. ....13 .....

Alliance	*P.-T.*	*Arrhenatherion*	*Agrostio-Festucion*	*Mesobromion*
Number of meadow types (Appendix 1)	1234	5678 901234567890 11111111112	12 345 67890123456 22 222 22223333333	789 01234567890123 333 444444444455555 4567890 5555556 12345 66666
Succisa pratensis	....	....1..	1. 21. ....1.....	2.. .....2... 3.....3 .....
Genista tinctoria	....	....	.. ..	... . 1..2..4 ...1.
Tetragonolobus maritimus	....	....	.. ..	... .1... 1.....5 .....
Molinia arundinacea	....	....	.1 ... .1..1...	.2. .1.....3... .....5 ..21.
Carlina vulgaris s.l.	....	....	.. ..	... .11.... ..2.3.5 22.12
32:				
Veronica austriaca subsp. *teucrium*	....	..2.	.. ..	... 12..... ....
Potentilla pusilla	....	....	.. ... 11..1.....	... .2...1..... ..... 2..1.
Picea abies	....	....	.. ..	... .2.....1.1... 1..... .....
Filipendula vulgaris	....	112.	.. ..	... 45..... 1
VII: Indicators of low nutrient availability and dry soils (+ indicators of alkaline soils):				
33:				
Poa pratensis s.l.	2.2.	253. 255551554415	.. 21. 225..1.3.1.	2.3 54544422451445 1..5.1. ...21
Centaurea jacea	....	1.52 45555154.3.3	.. ..	222 53514353544554 1.32.12 .....
Knautia arvensis	.15.	455. 35555.5523.3	.. ..	542 55555354555554 443532. .....
Medicago lupulina	.1..	343. 25544...1415	.. ... 1..1..1....	422 21455423454235 442531. 1..11
Galium album	....	232. .....35..	.. ..	... 2.455342232..5 ....21. .....
Ranunculus bulbosus	....	32.. 215531...333	.. 553 3454343424.	2.3 ..555544545455 1.45.33 1.21.
Daucus carota	....	2.2. 3345.....55	.. ... 11.....442.	554 31525443445555 4235.51 2.432
Plantago media	14..	1..2 .4.54..513..	.2 ... .1....1....	5.3 225554543452.4 5535345 ...12
Salvia pratensis	.1..	2451 34154....235	.. ... 5355325242.	2.1 555555532555.5 1445.42 5.355
Bromus erectus s.l.	....	4443 .3.34...12..	.. ... 43....554.3	555 55555555555555 5555555 5.445
Sanguisorba minor	....	.11. 22.12..5....	.1 ... 524522455..	542 55545.54545555 5545551 55535
34:				
Onobrychis viciifolia	.2..	2541 .....2....	.. ..	4.. 55534443121215 2..5..1 .....
Campanula rotundifolia	....	234. ...1...3....	.. 2.. 142.212....	2.2 54..451.52.... 3424..1 ...1.
Polygala vulgaris s.l.	.1..	1.1.	.. 2.. ....11.....	... 22.3.5..315.1. ...5.45 .....
Galium verum	....	125. 5	.. ... 1.1.1251.1.	2.. 44.2....214... 5435.13 1.524
Trifolium montanum	....	1..1	.1 41. 55.2143....	2.1 34222413215... 2245434 1.32.
35:				
Knautia drymeia	....	....	.. ... 1.1.2.25523	2
Cruciata glabra	....	....1.	5255543	... . 2.3.1
Hypochoeris radicata	..4.	....1.	.. ... 2...2.3233.	... .121... 1..5... 1.34.
Galium lucidum	....	....	.. ..4..	... 1..... ..... 2.224
Arabis ciliata, A. hirsuta	31.2	.131 .1.1.....	.. .1. 414.2423413	... .23324..33.2.. .2.52.. 2.3.1
36:				
Briza media	.2..	1344 31123..5.13.	.3 54. 25.55452525	4.3 4234252353521. 5.35.35 25322
Silene nutans	....	...2 .....1.	.. 43. 344154514..	... .1..44..... ..25.2. 4.432
Thymus serpyllum s.l.	.4..	....1.....	.1 5.. 55545455543	4.1 ....4.....23. 3.45.42 ...53
Scabiosa columbaria	.1..	.... .1.....5.1..	.. 55. 554554544.3	221 ..144.53244252 5445222 .4.23
Peucedanum oreoselinum	....	....1.	.. ... .3..2541...	... 11..... .....5 55554
Betonica officinalis	....	.... .1.....1.	.. 22. .4..53534.3	4.1 1..1..1.3.3.3. 55253.. 25532
Carex caryophyllea	....	...2 ...2....111.	.. 51. 555.3554435	4.2 2.222532554.52 154.554 3552.
Helianthemum nummularium s.l.	....	..1.	13 ... 552225512..	2.. 35..2...21..1. 5.45.32 55553
Brachypodium pinnatum	....	.1.1 .....2.	.. ... 552.4555423	..2 3223.544544... 1.552.3 45454
VIII: Indicators of low nutrient availability and dry to extremely dry soils (+ numerous indicators of alkaline soils):				
37:				
Campanula glomerata s.l.	....	2121 ..112..2....	.. ..	22. 23...3..2..... 343.... 1....
Galium pumilum	....	3335	.3 2.. 1.1.11.....	... 32...532333... 12253.. .....
Helianthemum ovatum	....	....	.. ..	... ...1.42...4... .4..4.. .....
Primula veris s.l.	....	2..1 21.12...121.	.. ... 35.....1.	44. ..55..334454.2 45255.. ...1.
Carlina acaulis	....	....	52 ... 24...1....3	... .1.2....433... 34342.. ...1.
Polygala comosa	....	....	.. ..	2.1 .....13313.... 144.3.. .....
Cirsium acaule	.2..	...1	12	... 123.2213342... 154.412 .....
Thymus pulegioides	....	3.15 .....3.	51 .4.	... 2444.554545..2 .5..4.. 44311
Origanum vulgare	....	..3.	.. ..	22. 221...424..2.2 22354.. 15211
Centaurea scabiosa	.2..	1.3. ...1.....1..	.. ... 25..22....3	4.. 5214535.21521. 22.4.4. 45211

Alliance	*P.-T.*	*Arrhenatherion*	*Agrostio-Festucion*	*Mesobromion*
Number of meadow types (Appendix 1)	1234	5678 901234567890	11111111112 22 345 67890123456	222 333 444444444455555 5555556 66666 789 012345678901234 4567890 12345
Gymnadenia conopsea	....	....	.1 .1. .1....1....	... 11...153212... 1235.35 2....
Anthyllis vulneraria s.l.	.1..	22.5	.2 ... 3.12..1.4.3	..2 125.455432..32 4435221 353.2
Asperula cynanchica	....	....	.. ..	... 212..3521..... 34354.5 .....
Ononis repens,O. spinosa	....	1.2.	.. ..	4.. 5121253444421. 34.52.5 122.2
Globularia punctata	....	....	.. ..	... .1.....2..... 2444442 35..1
Linum catharticum	....	.2.3 ....1.....	22	522 1.44.444545... 5445255 1
Carex montana	....	....1.....	.2 ... .1....	5.1 ..14..35535252 55352.. .....
Prunella grandiflora	....	..1.	.. ... .3...24....	44. 21.3..23444... 5424235 35.12
Pimpinella saxifraga s.l.	....	1.2.	.. ... 222..2.322.	2.. 45225252255..2 142553. 452..
Euphorbia cyparissias	....	21..	.. ... .31.1..1...	4.1 ..3...52....2. 55455.2 25222
Carex flacca	....	....1..	23	441 ..2..155455214 4545445 1...1
Koeleria pyramidata s.l.	....	....	.. ... 1..1..1....	2.1 .....1433.... 4455443 45.1.
Hieracium pilosella	....	....1.....	.1 ... 11..1231.1.	..1 ....533355.225 4545545 3433.
Teucrium chamaedrys	....	....	.. ..1.2..	... ...1..22213... 5445514 55.15
Festuca ovina s.l.	....	21.. .....1.	.. ..34315..	.22 .1535.54545544 5555554 ...24
Hippocrepis comosa	....	....1..	.1 ... 1.....4....	2.1 25322455425454 3445555 35221
38:				
Anacamptis pyramidalis	....	....	.. ..	2.. ..2...4413.... 124533. 2....
Potentilla neumanniana	....	....	.. ..	... .5.1223.... 1245552 1....
Anthericum ramosum	....	....	.. ..	... .2....3...1... 24453.3 2....
Viola hirta	....	....	.. ... 1...1.11...	222 ...12.2222321. 3235251 322..
Bupleurum falcatum	....	....	.. ..	... .2..... 243533. .....
Hypericum perforatum	....	....	.. ... 221..21322.	2.. .....12.2.23. 2.3525. ...12
Aster amellus	....	....	.. ..	... .2.13.... 1.2434. 22...
Vincetoxicum hirundinaria	....	12.1	.. ... .3..12.3...	... .12..1... 123543. .....
Euphorbia verrucosa	....	....	.. ..	... ..1...3322.... 2.25... .....
Sedum sexangulare	....	....	.. ... .11..11....	... .2..222...2 1..5.1. 2.421
Trifolium ochroleucon	....	....	.. ..	... .21.... 1.344.. .....
Arenaria serpyllifolia s.l.	....	....	.. ..1..1....	... .1.....3..... .4.52.. ...11
Chamaespartium sagittale	....	....	.. ..	... . .2.551. .....
Echium vulgare	....	....	.. ... 22..1..3...	... .1..... 1.254.. ...12
Polygala amarella	....	....	.1	2.. .....311... 3225... .....
Trifolium medium	....	....	.. ..	5.1 ..1.2.2223.... 2..4.31 ...11
Coronilla varia	....	....	.. ..	... .1....2..... ...5.1. ..2.4
Agrimonia eupatoria	....	....	.. ..12..	... .23.1.... .2.42.1 .....
Stachys recta s.l.	....	....	.. ..	... .423. 12.22
Veronica teucrium	....	....	.. ..	... .41.... 1.34... .....
Ophrys fuciflora	....	....	.. ..	... . .23421. .....
Acinos arvensis	....	.1..	.. ..	... . .2.54.. .....
Platanthera chlorantha	....	....	.. ..	... .1... ..25.3. .....
Gentiana verna	....	....	.. ..	... ...2.....4... ...5... .....
Orchis morio	....	....	.. ..	... .2.....21. ..2422. 1....
Gentianella germanica s.l.	....	....	.. ..	... .1.2... ...5... .....
Himantoglossum hircinum	....	....	.. ..	... .12..... ...4... .....
Ophrys insectifera	....	....	.. ..	... .1... ..24... .....
Aquilegia vulgaris	....	.... 2.....	.. ..	22. .....21.... ...5... .....
IX: Indicators of low to moderate nutrient availability and dry to moist soils (+ indicators of alkaline soils):				
39:				
Polygonatum odoratum	....	....	.. 21.	... .12..... 1..... .....
Cornus sanguinea	....	....	.. ..	... 11....12..... 1....2. 1
Orchis militaris	....	....	.. ..	... .13..... .....2. .....
40:				
Acer pseudoplatanus	....	....	.. ..1...1.	.2. .....41.... 1..... .....
Senecio erucifolius	....	....	.. ..	2.. .....2.34.... ....
41:				
Pimpinella nigra	....	....	.. ..	... .2..... 11
Hieracium auricula	....	....	.. ..	... .5..11.... ....
Lotus delortii	....	...3	.. ..	... 33...5..... ....

Alliance	*P.-T.*	*Arrhenatherion*	*Agrostio-Festucion*	*Mesobromion*
Number of meadow types (Appendix 1)	1234	5678 11111111112 901234567890	22 222 22223333333 12 345 67890123456	333 444444444445555 5555556 66666 789 01234567890123 4567890 12345
42:				
Medicago sativa	....	1.1. .....1.	.. ..	... 1.2.....1....5 2
Vicia sativa s.l.	....	....	.. ..	... ..2.....4 ....2.. .....
Crepis taraxacifolia	....	....	.. ..	... .3..24 ....
Thlaspi perfoliatum	....	....	.. ..	... ..2....225..15 ....
43:				
Quercus robur, Q. petraea	....	....	.. ..11....	.2. ...1..3...2... ..2... .....
Buphthalmum salicifolium	....	....	.. ..	22. ..11..53113... 2..... 3
44:				
Senecio jacobaea	....	....	.. ..	.2. ....4..... 4..2.2. .....
Prunus spinosa	....	....	.. ..	22. .....12.... 422.32. .....
45:				
Pinus silvestris	....	....	.2	..1 .1.....2..... ....2.. .....
Crataegus monogyna	....	....	.. ..	2.. ....2...11.... 1.2.2.. .....
Peucedanum cervaria	....	....	.. ..	... .2.....1. 12222.. .....
Pteridium aquilinum	....	....	.. ..1....1.	... .1.... ...24.. ..22.
Gentiana cruciata	....	....	.. ..	... .1..... .2223.. .....
Rosa canina	....	....	.. ..	... .21.... 122.3.. .....
46:				
Thesium alpinum	....	1...	1.	... .1.1..... ...2.3. .....
Geranium columbinum	....	....	.. ..	... .23. ...11
Quercus pubescens, Q. petraea	....	....	.. ..	... 23..2..... .....3. 1.3..
Inula conyza	....	....	.. ..	... .12..... ...2.4. .....
Centaurium erythraea	....	....	.. ..	2.. ..... 12...4. 32211
Anthericum liliago	....	....	.. ... 22...22....	... 13..... .....5. ..321
X: Indicators of low to moderate nutrient availability and extremely dry to dry soils:				
47:				
Vicia angustifolia	....	3	.. ..1.....	... .3.1
Hieracium sabaudum	....	....	.1	... .1..... ....2..
Veronica spicata	....	.1..	.. ... 121.....	... .3..
Thesium linophyllon	....	....	.. ..	... . 1.211
Sedum maximum	....	....	.. ... .1...1.1...	... .311
Trifolium campestre	....	....	.. ... 1.....1....	22. ....2.....1. .2..... ..31.
Calluna vulgaris	....	....	1. ... .1.....	... .33.
Dianthus carthusianorum	....	....	.. ... 2211131.2..	... .3..... .2...1. 1.4.1
48:				
Centaurea bracteata	....	....	.. ..2.3	... . 153.1
Bothriochloa ischaemum	....	....	.. ..	... .2. 352..
Thymus froelichianus	....	....	.. ..	... 1.1...4.2..... 1..... .5...
Polygala pedemontana	....	....	.. ..11412..	 45221
Geranium sanguineum	....	....	11 ... .2..	... .2.....1. ...4... 35.24
Teucrium montanum	....	....	.. ..	... . 14.5..2 45...
Chrysopogon gryllus	....	....	.. ..1.....	 55533
Carex humilis	....	....	.. ... .1.....	... .5..... .....5. 55..1
49:				
Corylus avellana	....	....	.. ..1....	... 1.....1..... ..... 2..11
Verbascum lychnitis	....	....	.. ..	... . 3.21.
Scabiosa portae	....	....	.. ..	... . 3.31.
Hypericum montanum	....	....	.. ..	... .1..... ..2.... 2222.
50:				
Phleum phleoides	....	....	.. ... .1.....	... .1..... ....1.
Astragalus glycyphyllos	....	....	.. ... 11.....	... .11
Genista germanica	....	....	.. ..	... . 1..... ...11
51:				
Fraxinus excelsior	....	....	.. ..1....	... .1..... .....1. 1
Dianthus silvester	....	....	.. ..	... .2. 1...1