

Wetland belts and wet to dry grassland areas on dunes at lake shores

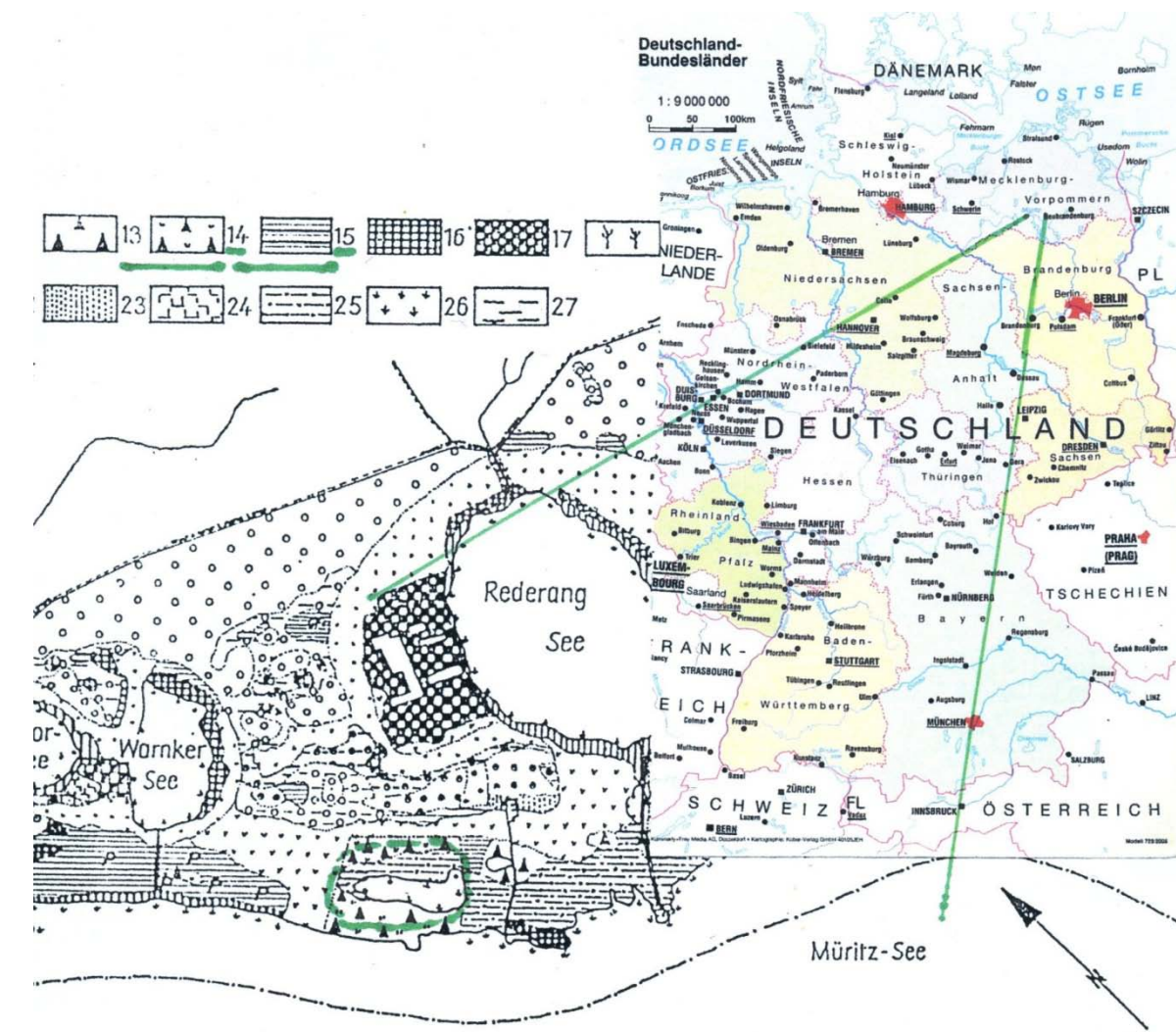
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Growth and species combinations of aquatic and terrestrial plant communities vary depending on altitude and elevation/depression landforms (or sea/lake bottom ground). This is valid for submerged plant belts and wet to dry terrestrial plant community belts. The plant growth below the lake water level depends mainly on water deepness above lake ground. Main basics for terrestrial plant belts are floods during springtime and increasingly deeper groundwater level. The submerged flora belts follow water deepness along the depressions and elevations of the lake bottom. The terrestrial plant community belts follow the surface depressions and elevations (strata in the direction of slope curves, the orthogonal trajectories of contour lines). These strata do not occur parallel of contour lines. They mediate between ridge lines of elevations and depth lines of complementary depressions – due to the effect of rising mass. This kind of spatial ecological order may be resilient against – moderate – permanent change of lake water level (decrease or increase of water level artificially by water constructions or by climate change). The aquatic and terrestrial plant belts will then be moved, and redeveloped in deeper or higher positions parallel to the new shore line. These processes will need a certain time of decades if no other disturbing processes exist. Also the site conditions will be changed into new balance, like soil stratification into oxidation and reduction horizons. An example shows species-rich wetland areas at Müritz lake shore, the largest German inland lake, near to a lagoon. Ecology, hydrology, pedology and management practices are shortly described including covered ground area by plant species (after Braun-Blanquet) in table and diagram. It was a nature reserve, and is now part of the larger National Park Müritz. The areas harbor a large variety of wetland-specific plant species, on lower sites flooded in springtime, and also terrestrial species of the juniper heath (with bushes of *Juniperus communis*). The areas contribute substantially to the species diversity of the landscape.

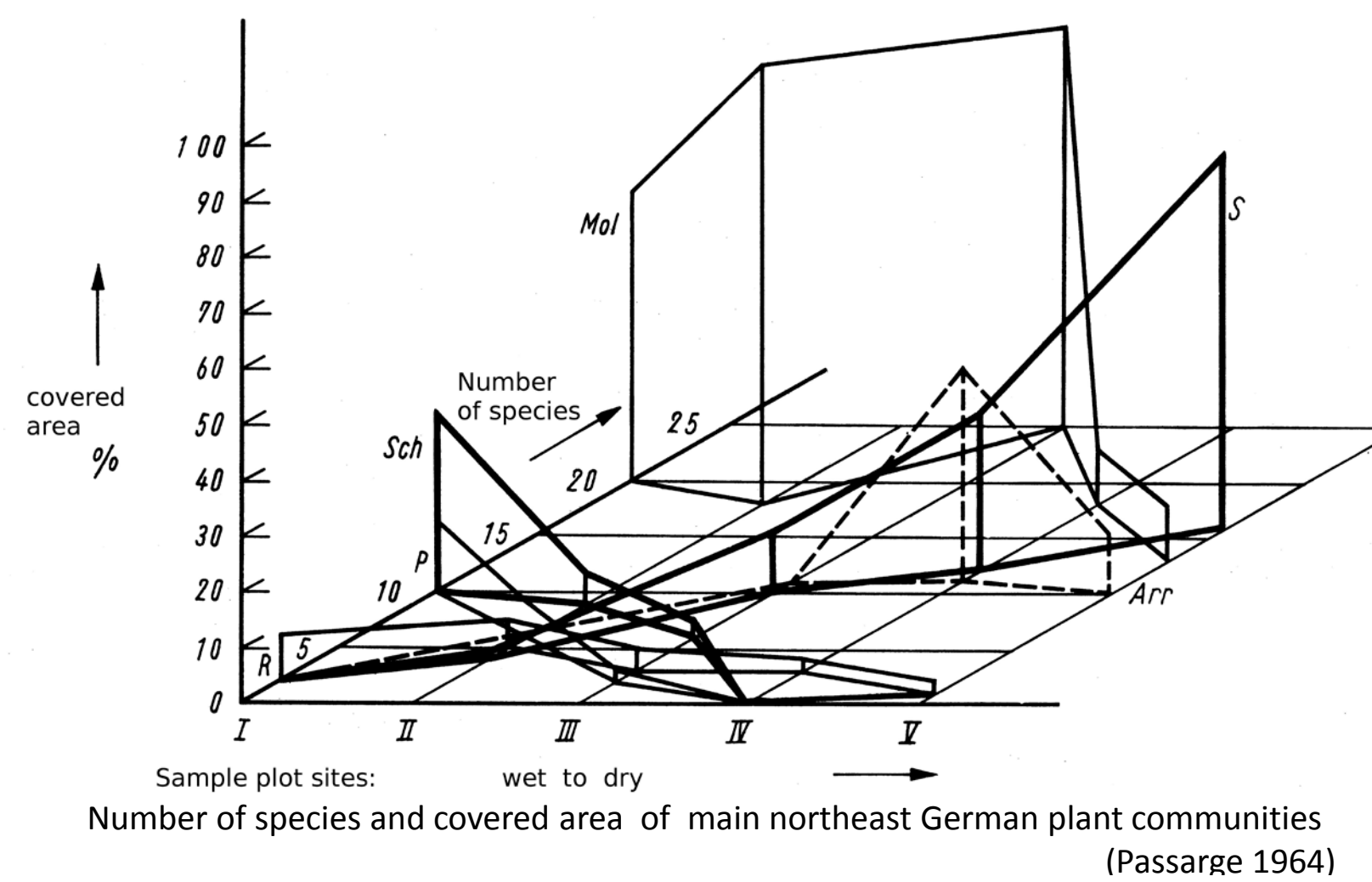
Protection and sustainable management was done with Scandinavian Fjäll-cattle at pasture, since 1969, recently also with Gotland sheep and Shetland ponies introduced into the herd. Some common pasture grasses and herbs (mostly ruderal and ubiquitous species), not have been found within the sample plots by author in 1977, now occur in nearly comparable sample plots (research work and dissertation (Kühner 2004) from the Oldenburg University). It is difficult to compare the results of 5 investigation plots 6th July 1977 (40 – 120 m² each) (Thomas 1979) with those of 11 plots before 2004 (1.5 x 1.5 m² or 2 x 2 m²) from Kühner (2004) near to the 5 plots 1977. It may indicate an intensified use of the areas and enrichment with fertilizers (eutrophication). (And could endanger some rare species in future?)

Long term ecological studies, related to wetland and adjacent areas should be done to protect the biodiversity e.g. under use of cattle. The variation of plant communities I to V depends on (little) altitude differences, average groundwater level and seasonal changes (up to flooding times), variation in soil stratification with different characteristics in physics and chemistry of oxidation and reduction horizons. On drier plots III and IV are also little "hills" made by ants with some plant species marked by a "Λ" behind symbol of area coverage (after Braun-Blanquet) in the table. It makes no sense to analyze a lot of plant community plots spread all over the whole area, using which kinds of statistical methods also ever - in case of not paying attention to before mentioned differentiation in landform and hydrological strata (strata in the original physical spatial sense)?



Excerpt map (Jeschke 1962): East shores of Müritz lake, Lagoon „Spukloch“

- 13 Juniper pioneer forest stages (*Juniperus communis*)
- 14 like 13, combined with poor grassland
- 15 more or less groundwater influenced sandy sites



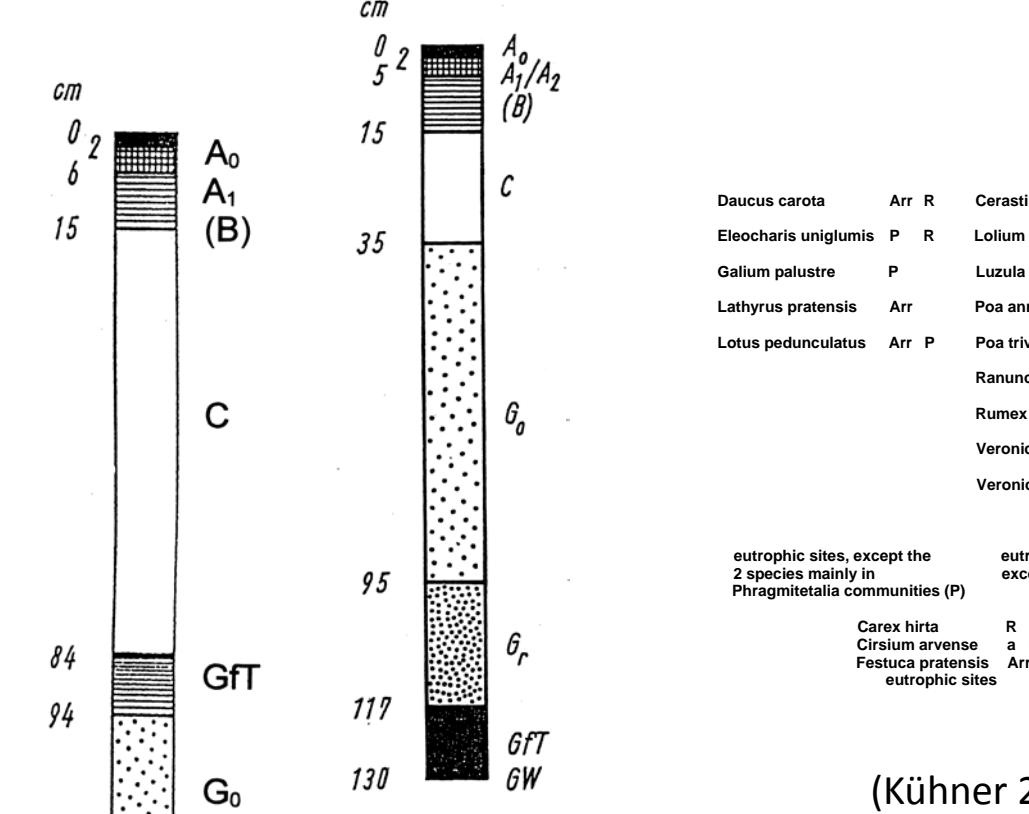
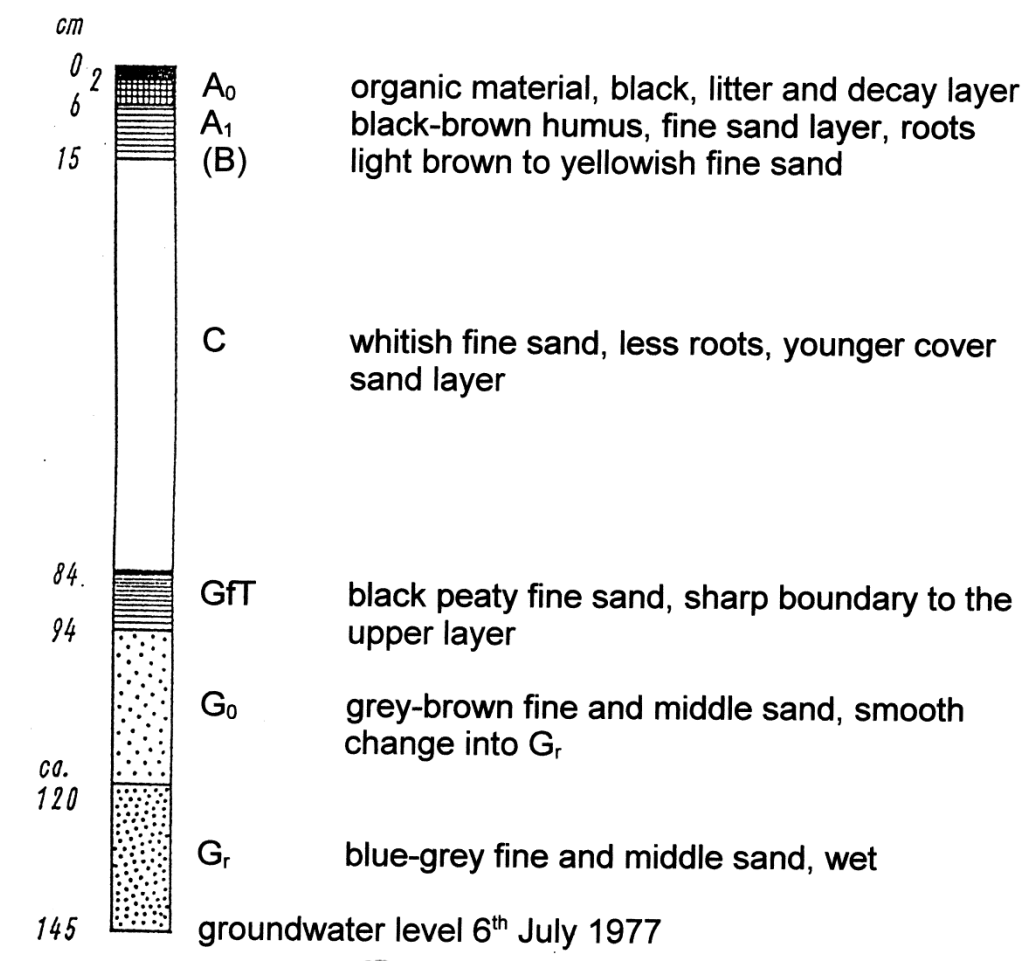
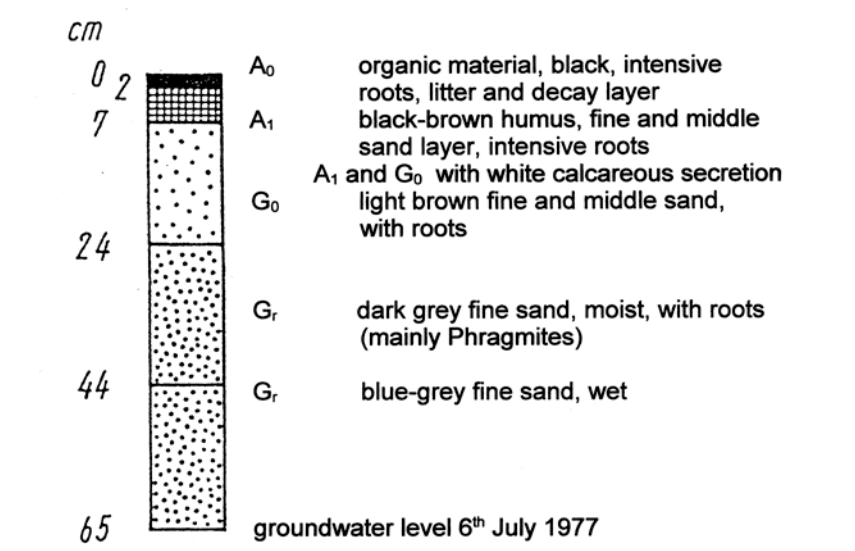
Soil and groundwater level of sample sites

	I	II	III	IV	V
Fine and middle sand above loamy sand	(X)	X	X		
Middle and fine sand	(X)			X	X
Flooded in springtime	X	X			
Maximum temporary groundwater level during vegetation period [cm]	7	8	25	84?	35
Average groundwater level [cm]	24	65	90	120	95
Groundwater level on 6th July 1977 (extremely low precipitation during 2 months before and dry year 1976!) [cm]	65	115	115	145	130

Jeschke, L. 1962: Karte Biotopgliederung des NSG „Ostufer der Müritz“. In: Jeschke, L.; Klafs, G.; Schmidt, H.; Starke, W.: Ostufer der Müritz. In: Weinitschke, H. (Ed.): Handbuch der Naturschutzgebiete der DDR, Urania-Verlag Leipzig Jena Berlin. Bd. 1 Bezirke Rostock, Schwerin und Neubrandenburg, 2. Aufl. 1980
 Kühner, A. 2004: Habitat models for plant functional groups with respect to soil parameters and management. Diss. Univ. Oldenburg
 Passarge, H. 1964: Pflanzengesellschaften des nordostdeutschen Flachlandes I. Pflanzensoziologie, Bd. 13. Jena
 Thomas, S. 1979: Pflanzensoziologisch-ökologische Analyse der Vegetation beweideter Strandwälle im Naturschutzgebiet "Ostufer der Müritz". Archiv Naturschutz u. Landschaftsforschung 19 (1979), 3, 217-229

Sample plot IV: oldest strand hill, some decimeter higher altitude; gley soil on middle and fine sand

Sample plot I: gley soil on fine and middle sand flooded in springtime



Daucus carota	Arr	R	Cerastium glomeratum	R
Elyocharis unguis	P	R	Lolium perenne	R
Galium palustre	P		Luzula campestris	Arr
Lathyrus pratensis	Arr	R	Poa annua	Arr
Lotus pedunculatus	Arr	P	Poa trivialis	Arr
			Ranunculus repens	Arr
			Rumex acetosa	Arr
			Veronica arvensis	Arr
			Veronica chamaedrys	Arr

eutrophic sites, except the 2 species mainly in Phragmitetalia communities (P)
 Caneis hista R
 Cirium arvense a R
 Festuca pratensis Arr
 eutrophic sites, except Luzula campestris

(Kühner 2004)



Scandinavian Fjäll cattle



Gotland sheep



Shetland pony

Sample plot	I	II	III	IV	V	Plant comm.
Death to groundwater on 6th July 1977 [m]	0.65	1.15	1.15	1.45	1.30	
Area coverage [%]	100	90	100	80	95	
Area grazed [%]	60	80	80	20	10	
Number of species	57	58	71	59	50	
S Shrub layer						
Solva avicula L.	S	+				
S. pentandra L.	S	+				
S. cinerea L.	S	+	1	+		
Betula pubescens Ehrh.	S	+				
Fraxinus alba Mill.	H	+				
Populus avium (L.) L.	H	+				
Juniperus communis L.	S	+	2	2	2	
Picea sylvestris L.	S	+				
Betula pendula Roth	S	+				
Quercus robur L.	H	+				
Rosa canina L.	S	+				
Viburnum opulus L.	H	+				
Crataegus monogyna Jacq.	H	+				
Prunus spinosa L.	H	+				
Rhamnus cathartica L.	H	+				
Sambucus nigra L.	S	+				
H Herb layer						
Callitriche palustris L.	+					P Sch
Scutellaria galericulata L.	+					P Sch
Lycopus europaeus L.	+					P Sch
Prucedenum palustre (L.) Moench	+					P Sch
Elyocharis palustris agg.	+					P
Junco oligosperma Desf.	+					P
Scheuchzeria palustris L.	+					P
Lysimachia vulgaris L.	+					Mod P
Eupatorium cannabinum L.	+					Mod P
Elyocharis quinqueflora (Horn) D. Schwarz	1	1				Sch
Carex acutis	+					Sch
Potentilla anserina L.	2	1				Rp P
Mentha aquatica L.	1	1				P L
Cladonia monilicea (L.) Poeh	+	1				P Sch
Agrostis canina L.	+	+				Sch
Galium uliginosum L.	+	+				P Mod
Junco articulatus	1	1				Sch L
Hydrocotyle vulgaris L.	2	1	1			Sch Mod
Epipactis atrorubens (L.) Crantz	+	+				Sch
Calamagrostis stricta (Thun) Koeler	1					P
Agrostis stolonifera agg.						Rp J
Phragmites australis (Cav.) Steud.	2	1	1			P
Dactylis glomerata (L.) Steud.	+					Mod
Listera ovata (L.) R.Br.	+					
Valeriana officinalis L.	+	+				P Mod
Cirsium palustre (L.) Scop.	+	+				Mod P
Festuca rubra L.	2	1				Mod Arr
Phragmites australis L.	+	1				Sch Mod
Parnassia palustris L.	+	1				Mod Sch
Scorzonera autumnalis (L.) Moench	+	1				Mod Arr
Salix repens agg.	1	1	2			
Isula britannica L.	+					Rp Mod
Succisa pratensis Moench	+					Mod
Mertensia maritima L.	+	+				Arr
Hydrocotyle vulgaris L.	+					N
Molinia caerulea (L.) Moench	3	4	3			1 Mod Sch
Carex panicea L.	1	+	+			Sch Mod
C. flacca Schreb.	1	1	1	1		Sch N
C. nigra (L.) Steud.	+	+	+			Sch N
Potentilla erecta (L.) Rausch	1	1	1			Mod N
Trifolium fragiferum L.	+	+	+			Mod P
Linum catharticum L.	+	+	+			Mod Sch
Centaurea jaceo agg.	+	+	+			Mod Arr
Deschampsia cespitosa agg.	1	2	+			Mod Rp
Agrostis repens L.	+	1	+			Mod P
Ranunculus acris L.	+	+	+			Mod Sch
Vicia cracca L.	+	+	+			Mod Arr
Bischofia minor L.	+	+	+			Mod
Setium convolvulus (L.) L.	+	+	+			Mod
Phacelia vulgaris L.	+	+	+			Mod Arr
Equisetum palustre L.	+	+	+			Mod P
Sagina nodosa (L.) Fensholt	+	+	+			Rp J
Trifolium pratense L.	+	+	+			Mod Arr
Betula pubescens L.	+	+	+			Arr Mod
Taraxacum officinale auct.	+	+	+			Arr Mod
Ononis repens L.	+	+	+			S N
Brius medio L.	+	+	+			Mod Arr
Holcus lanatus L.	+	+	+			Mod Arr
Poa pratensis L.	+	+	+			Arr Mod
Dactylis glomerata (L.) DC.	1	1	1			Rp N
Trifolium repens L.	+	+	+			Mod Arr
Phragmites australis L.	+	1	+			Mod N
Crustum holosteleoides Fr.	+	+	+			Arr Rps
Carex dioca L.	+	+	+			Arr Mod
Plantago lanceolata L.	+	+	+			Arr Mod
Lotus corniculatus L.	+	1	+			N Arr
Vicia cracca L.	1	+	1			N Mod
Ranunculus bulbosus L.	+	+	+			Arr N
Agrostis capillaris L.	+	+	1	1		Sk Rp
Leontodon saxatilis Lam.	+	+	1	1		Mod J
Saxifraga tridactylota L.	+	+				Sk
Cirsium cristatum L.	+	+				Arr
Plantago media L.	+	+	+			Arr Mod
Galium verum agg.	+	+	+			Sk N
Geranium robertianum L.	+	+	+			Arr
Achillea millefolium agg.	+	+	1			Arr Mod
Arnica montana L.	+	+	+			Mod N
Rumex acetosella L.	+	+	+			N R
Knautia arvensis agg.	+	+	+			1 SN Arr
Centaurea erythraea Lam.	+	+	+			Arr
Stellaria graminea L.	+	+	+			Arr Mod
Urtica dioica L.	+	+	+			R
Carex arenaria L.	+	+	+			Sk Rp
Nardus stricta L.	+	+	+			Mod
Compositae pendula L.	+	+	+			Mod
Anthoxanthum odoratum L.	+	+	+			Sk Arr

Legend: Main occurrence of species in plant communities (after Passarge 1964)
 L Litorelletea
 Sch Scheuchzeria-Caricetea fuscae (mainly Tofieldietalia)
 P Phragmitetalia (Eu-Phragmitetalia, Magnocaricetalia)
 Mol Molinietales, Deschampsietalia caespitosae
 R Ruderal communities
 p Plantaginetea majoris
 a Artemisietea
 s Secalinetea
 S Arrhenatheretalia
 J Juncetea maritima (Armerion maritima)
 S Pioneer communities on sand, wasteland lawn, heaths
 N Nardo-Callunetea
 k Koelerio-Corynephoretea
 a Ammophiletetea
 f Festuco-Brometea
 A "Λ" behind symbol of area coverage (after Braun-Blanquet) marks species that occur (in some cases exclusively) on up to 30 cm high "hills" of ants on sample plots III and IV