Desiccated plant macrofossils from the medieval castle of Marmorera, Switzerland, with a note on the identification of leaves of Cyperaceae

Örni Akeret and Marlu Kühn

During restoration work at the medieval castle of Marmorera, Graubünden canton, Switzerland, numerous desiccated plant remains were found — in a rock crevice that was protected from precipitation by a massive rock shelter. The identification of the remains showed that the majority could not have grown at the castle, but must have been transported to the site. Many of the plants came from warmer climates and were imported from lower lying regions, indicating the position of the castle at an important transalpine route. Among the finds was a lump of grass-like leaves for which for a method of preparation and identification was developed. The leaves turned out to be of *Carex* species that grow in wet habitats which were probably used as litter or as bedding material.

Keywords: Archaeobotany, desiccated plant macrofossils, Cyperaceae, medieval, Switzerland, Alps

Introduction

During archaeological excavations at the ruins of the medieval castle of Marmorera, Switzerland, numerous plant remains were discovered, most of them were preserved in a desiccated state. This kind of preservation is mainly known from arid regions (e.g. van der Veen 1995; Fahmy 2005), whereas in Europe it occurs only under exceptional conditions. In existing buildings of medieval or post-medieval dates, desiccated plant remains may survive in wattle and daub walls (e.g. Fischer and Rösch 1999), in blind floors (e.g. Oeggl 1998; Ernst and Jacomet 2006), in thatch (e.g. Letts 1999), or in other parts of buildings (Willerding 1996). Unlike the examples listed above, the finds from Marmorera came from outside a building and were protected from water by a large rock shelter. This situation is so far only paralleled by one other site: Malvaglia/Casa dei Pagani, southern Switzerland, another castle built under a rock shelter (thirteenth/fourteenth century) (Schoch 1986).

A notable find amongst the remains was a desiccated lump of grass-like leaves. Due to the limited space at the castle site it was likely that this material, like most other plant remains, had been transported to the castle. To find out for what purpose this might have been done identification of the leaves was essential. This has rarely been done before and is one of the foci of the present paper.

The site

The ruins of the castle of Marmorera are located at N 46°30'/E 9°37', at *c.* 1780 m asl, in the valley of the river Gelgia (Figs. 1, 2). To the south the valley leads to two passes: Julierpass/Pass dal Güglia at 2284 m asl, and Pass da Sett at 2310 m asl. Both have been used at least since the Roman period (e.g. Rageth 2005). The castle therefore controlled the traffic of an important transalpine route. The former village of Marmorera was situated at the bottom of the valley at 1634 m asl, but has been under the waters of an artificial lake since 1954.

In 1893 a substantial part of the castle still existed (Janosa 1992). Since then most structures have

Örni Akeret (corresponding author) and Marlu Kühn, Institut für Prähistorische und Naturwissenschaftliche Archäologie IPNA, Universität Basel, Spalenring 145, CH-4055 Basel, Switzerland; e-mail: oerni.akeret@unibas.ch
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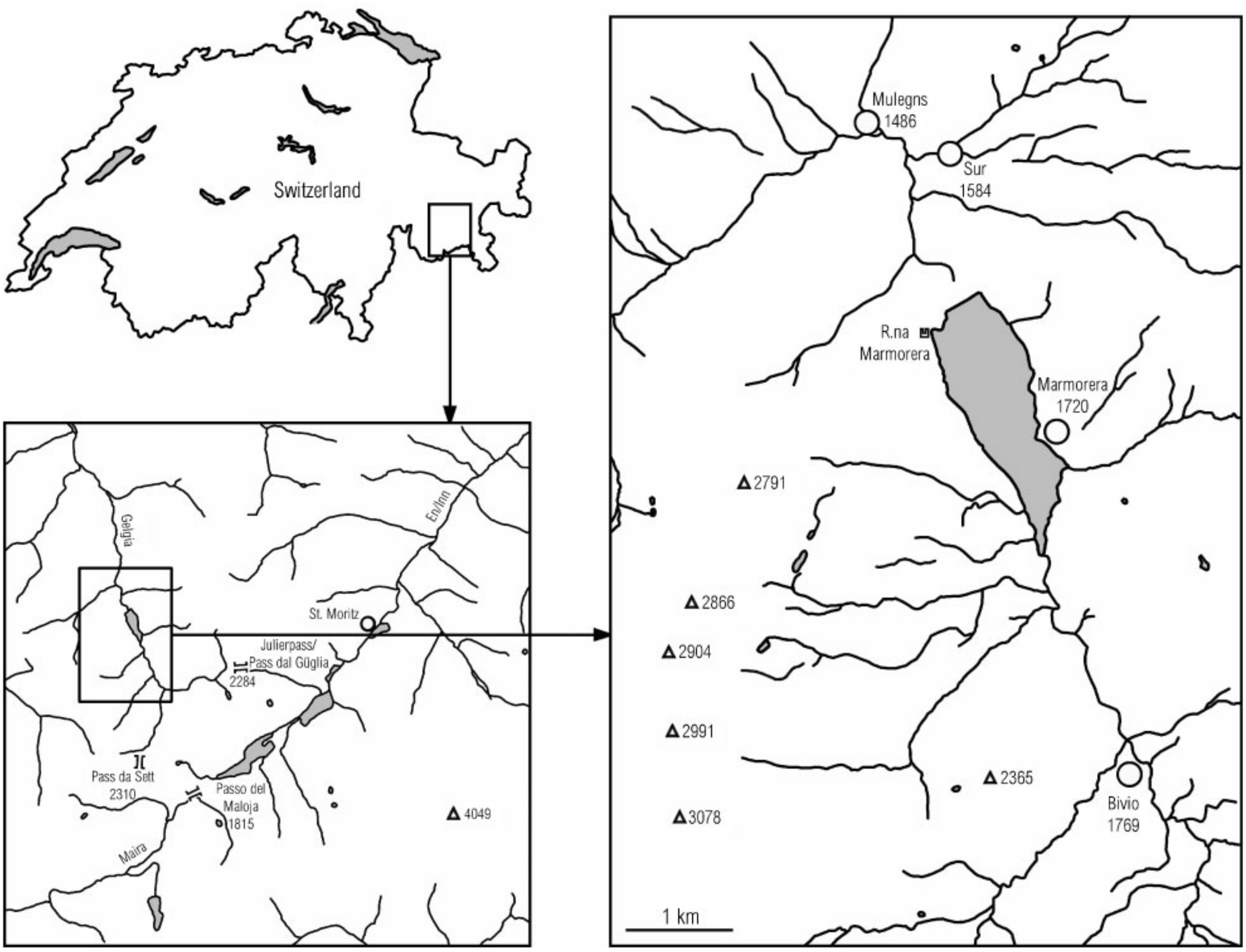

Figure 1 Map showing the location of the castle of Marmorera

collapsed and the only surviving building is the chapel which was restored in 1987 and 1988, when archaeological excavations were carried out. The castle was built at around AD 1100, as indicated by dendrochronology and was still occupied in AD 1550. It is unknown when it was abandoned, but in AD 1672 it was reported as being a ruin.

The castle was built under a massive rock shelter. This location is the reason why parts of the archaeological site have been protected from precipitation, and why organic remains like textiles, leather or wooden artefacts and even a piece of parchment, mentioning a trade of pepper, survived, This document proves that the spice was used by the habitants of the castle, even though it could not be detected archaeobotanically.

All of the material investigated originates from a crevice to the west of the surviving chapel that had been used as a rubbish dump (Fig. 3). The filling of the crevice can be divided in two phases, separated by a layer of burnt material, dating from the fourteenth century.

Methods

Two types of samples had been taken at the excavation: 13 bulk sediment samples, and 17 single hand-collected finds. The latter did not have to be processed before analysis. The bulk samples were first inspected for plant remains with the naked eye. The remaining sediment was then wet sieved using mesh sizes of 8, 4, 2, 1, 0·5 and 0·25 mm. Water had an adverse effect on the desiccated plant remains, because these remains are brittle and easily deform or disintegrate when soaked in water. This procedure was chosen due to lack of experience with this kind of material in the late 1980s and should not be applied in future studies. Nomenclature for plant species follows Aeschimann and Heitz (1996).

A method for the preparation and identification was developed. The identification was based on leaf cross sections, because these have proved to be useful for the recognition of the representatives of the grass family (Poaceae), notably species of the genus *Festuca* (e.g. Markgraf-Dannenberg 1980), of rush (*Juncus*) (e.g. Stace 1997), but also for studying systematic

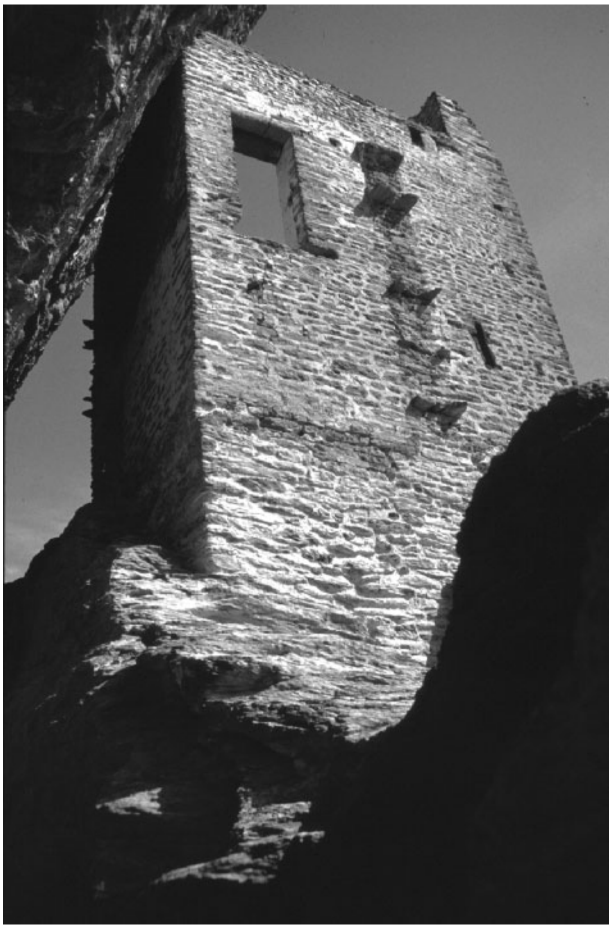

Figure 2 The chapel is the only remaining building of the former castle. All plant finds originate from a crevice to the left of the chapel, and were protected from precipitation by the sheltering rock

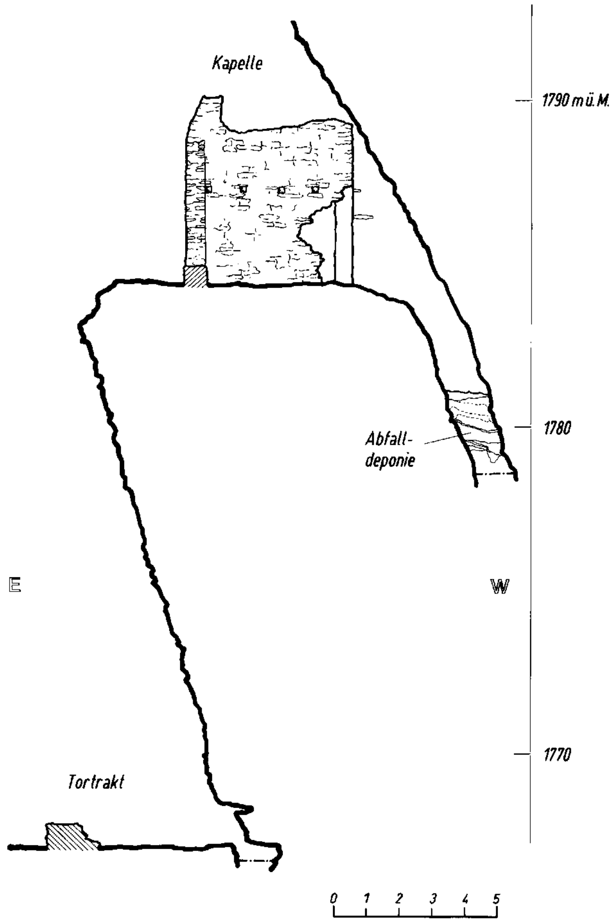

Figure 3 Profile showing the chapel and the rubbish dump (=Abfalldeponie) in a rock crevice from where the desiccated plant finds were retrieved

relationships of taxa of the sedge family (Cyperaceae) (Spinner 1903; Pfeiffer 1927). Cross sections allow study of various plant tissues. Previous work on the identification of archaeological finds of grass leaves was based on the examination of the epidermis (Acs *et al.* 2005).

The examination of the grass-like leaves turned out to be laborious. The major part of the material stuck together and crumbled immediately at the attempt to isolate single leaves. However, some of the outer leaves could be separated. It was not possible to produce cross sections of the dry leaves, because they were too brittle. For this reason they had to be embedded in a medium. Paraffin wax was tested, but proved to be unsuitable, because it did not penetrate into the plant tissue. Synthetic resin (Kulzer Technovit 7100, based on glycol methacrylate) produced better results. The single leaves were cut in pieces of *c.* 2 mm length and laid in distilled water, until they sank after two or three days. They were then dehydrated in an ascending sequence of ethanol. The pieces prepared in this way were mounted in the resin following the instructions provided. The stabilised tissue could subsequently be cut using a rotary microtome.

In 1992 the region of Marmorera was visited several times to survey the vegetation and to collect reference material. For comparison with the archaeological finds, cross sections of modern leaves were fabricated. All different types of grass-like leaves were sampled, but emphasis was placed on Cyperaceae, as the leaves from the excavation turned out to be mainly of this family (see below). All species of the sedge family that occur in the surroundings of the castle according to personal field observations and to literature (Welten and Sutter 1982) were sampled. The modern material could be cut directly, without being embedded in resin.

The main part of the work was carried out between 1988 and 1993, with modifications added in later years. The plant finds from the excavation as well as the reference material are stored at the Institut für Prähistorische und Naturwissenschaftliche

Archäologie IPNA, Universität Basel, Spalenring 145, CH-4055 Basel, Switzerland.

Results

The plant finds are presented in Table 1. A total of *c.* 18,000 macrofossils were counted, but it has to be noted that the number of 13,000 *Rubus idaeus* fruit stones from one single find were based on estimation. The remains were of 119 taxa. The overwhelming majority of the finds were preserved in desiccated state, only 38 items (of nine taxa) were charred.

The dry conditions enabled the preservation of a range of plant organs other than seeds or fruits that usually do not survive in the archaeological record, like leaves or various parts of the flower and the inflorescence. These included nodes of *Equisetum palustre/variegatum*, needles of a range of conifers (*Juniperus communis*, *J. sabina*, *Larix decidua*, *Picea abies*, and *Pinus cembra*), calyces of *Globularia nudicaulis* and *Thymus serpyllum*. The variety of parts of the inflorescence of representatives of the grass family (Poaceae) like spikelets, florets or glumes was remarkable. These permitted the identification of the following taxa: *Agrostis capillaris/stolonifera*, *Briza media*, *Calamagrostis varia*, *Festuca*, *Glyceria notata*, *cf. Molinia*, *Panicum miliaceum*, *Poa alpina*, *P. nemoralis*, *P. pratensis* aggr., *P. violacea* and *Trisetum flavescens*. Some *Carex* fruits were still enclosed in the utricle and could therefore be recognised: *C. davalliana*, *C. nigra* and *C. rostrata*. The latter species was even represented by an entire spike, consisting of more than 20 utricles. Without utricles, the identification of sedge fruits is rarely possible. One sample contained three pieces of birch (*Betula pendula* or *pubescens*) bark. The largest piece measured 5·5 x 5·5 cm, the fragments presumably belonged together originally. They were found loose, thus without wood.

Eleven out of twelve of the leaves were identified as being representatives of the sedge family (Cyperaceae). Their leaves can be differentiated from those of the Poaceae by a well developed aerenchyma (Pfeiffer 1927; Hegi 1980). This is a tissue with large intercellular cavities. Aerenchyma compartments run longitudinally between sclerenchyma ribs and are surrounded by green parenchyma. In certain species the epidermis of the lower surface (sometimes also the upper surface) shows papillae. For a schematic leaf cross section see Fig. 4. At first sight, Cyperaceae leaves all look very similar. A detailed study however reveals that the internal tissues are arranged in different ways depending on the species. Their taxonomical value has been recognised for a long time (Spinner 1903; Pfeiffer 1927). As a basis for this identification, the characteristics of all species occurring in the region were compiled (Table 2).

According to the criteria in Table 2 the desiccated *Carex*-leaves belong to three species: *C. rostrata* (n=6), *C. nigra* (1) and *C. cf. davalliana* (2). In the case of the last taxon, *C. microglochin* cannot be excluded, as the characteristics of the leaf cross sections of both species are identical. But the latter is very rare in the vicinity of the castle of Marmorera and it is therefore unlikely that the archaeological material should belong to that species (Fig. 5).

One of the leaves was identified as a representative of the grass family (Poaceae). The cross section shows a leaf that is narrow and folded longitudinally. Grass species with such leaves in the surroundings of Marmorera are: *Agrostis rupestris*, *Avenella flexuosa*, *Nardus stricta* and several species of *Festuca*. In *Agrostis*, the sclerenchyma is only slightly developed; in *Avenella* it forms a continuous ring under the epidermis. In *Nardus* it is very strong and partially traverses from the lower to the upper surface. Among the *Festuca*-species with narrow and folded leaves, two can be excluded: *F. trachyphylla* (sclerenchyma forms a continuous ring) and *F. quadriflora* (upper surface much reduced, cross section regularly hexagonal. The remaining possible taxa are *F. halleri* aggr., *F. rubra* aggr. and *F. violacea* aggr.

Discussion

Among the plants identified from the archaeological deposits, some might have grown next to the castle. During four visits in July and August 1992, the following were found to grow in the immediate vicinity of the ruins: *Achillea millefolium*, *Alchemilla conjuncta* aggr., *Alchemilla fissa* aggr., *Arabis alpina*, *Carduus defloratus* ssp. *tridentinus*, *Carum carvi*, *Descurainia sophia*, *Fragaria vesca*, *Galeopsis tetrahit*, *Juniperus sabina*, *Myosotis sylvatica*, *Phyteuma scheuchzeri*, *Poa alpina*, *Poa nemoralis*, *Poa pratensis* s.str., *Potentilla aurea*, *Rubus idaeus*, *Sambucus racemosa*, *Senecio ovatus*, *Stellaria media*, *Thymus pulegioides*, *Trisetum flavescens*, *Urtica dioica*, *Valeriana officinalis* and *Viola biflora*. The more or less flat plateau around the ruins is now covered with grassy vegetation. This place was certainly less overgrown with plants during the time when the castle was inhabited, because it was occupied by buildings and intense trampling took place. Probably only species that grow in rocks and ruderals grew there at that time. *Juniperus sabina*, of which a short

Table 1 Plant finds from the castle of Marmorera

			Phase	Early Phase		Late Phase	
			Sample Type	Bulk samples	Single Finds	Bulk samples	Single Finds
			Number of samples/finds	5	9	8	8
Taxon	**Parts recorded**	**Preservation**	**Total**				
Agrostemma githago L.	seed	desiccated	2	.	.	2	.
Agrostis capillaris L./*stolonifera* L.	spikelet	desiccated	2	.	.	2	.
Alchemilla	achene	desiccated	72	2	.	70	.
Alnus viridis (Chaix) DC.	achene	desiccated	4	.	.	4	.
Apiaceae	mericarp	desiccated	9	.	.	9	.
Arabis alpina L. s.str.	seed	desiccated	1	.	.	1	.
Asteraceae	achene	desiccated	2	.	.	2	.
Asteraceae	pappus	desiccated	1	.	.	1	.
Atriplex	seed	desiccated	11	.	.	11	.
cf. *Avena*	lemma	desiccated	1	.	.	1	.
Betula pendula Roth/*pubescens* Ehrh.	bark	desiccated	3	.	.	.	3
Brassica	seed	desiccated	22	1	.	21	.
Brassicaceae	seed	desiccated	2	.	.	2	.
Briza media L.	floret	desiccated	3	.	.	3	.
Bryophyta	stem	desiccated	113	30	.	83	.
Calamagrostis varia (Schrad.) Host	floret	desiccated	1	.	.	1	.
Campanula	seed	desiccated	4	.	.	4	.
Cannabis sativa L.	achene	desiccated	9	.	.	9	.
Carduus	achene	desiccated	3	.	.	3	.
Carduus/Cirsium	achene	desiccated	1	.	.	1	.
Carex	nut	charred	3	3	.	.	.
Carex	nut	desiccated	322	16	.	306	.
Carex	leaf	desiccated	2	.	.	2	.
Carex	utricle	desiccated	22	.	.	22	.
Carex davalliana Sm.	utricle	desiccated	2	.	.	2	.
Carex cf. *davalliana* Sm.	leaf	desiccated	2	.	.	2	.
Carex nigra (L.) Reichard	leaf	desiccated	1	.	.	1	.
Carex nigra (L.) Reichard	utricle	desiccated	2	.	.	2	.
Carex rostrata Stokes	leaf	desiccated	6	2	.	4	.
Carex rostrata Stokes	utricle	desiccated	158	90	.	68	.
Carum carvi L.	mericarp	desiccated	7	.	.	7	.
Caryophyllaceae	seed	desiccated	5	.	.	5	.
Castanea sativa Mill.	achene	desiccated	2	.	.	1	1
Centaurea nervosa Willd./*rhaetica* Moritzi	achene	desiccated	1	.	.	1	.
Cerastium fontanum Baumg. s.l.	seed	desiccated	2	.	.	2	.
Chaerophyllum hirsutum L.	mericarp	desiccated	1	.	.	1	.
Chenopodiaceae	seed	desiccated	13	.	.	13	.
Chenopodium album L.	seed	desiccated	84	2	.	82	.
Corylus avellana L.	nut shell	charred	1	.	1	.	.

f- r- a- g-

Table 1 Continued

Taxon	**Parts recorded**	**Preservation**	**Phase**	**Early Phase**		**Late Phase**	
			Sample Type	**Bulk samples**	**Single Finds**	**Bulk samples**	**Single Finds**
			Number of samples/finds	5	9	8	8
			Total				
Corylus avellana L.	nut shell	desiccated	35	.	8	11	16
Cyperaceae	achene	desiccated	1	.	.	1	.
Descurainia sophia (L.) Prantl	seed	desiccated	2	1	.	1	.
Eleocharis palustris (L.) Roem. & Schult. aggr.	nut	charred	1	1	.	.	.
Eleocharis palustris (L.) Roem. & Schult. aggr.	nut	desiccated	23	.	.	23	.
Equisetum palustre L./*variegatum* Schleich.	node	desiccated	1	.	.	1	.
Euphorbia helioscopia L.	seed	desiccated	1	1	.	.	.
Fabaceae	seed	desiccated	1	.	.	1	.
Fallopia convolvulus (L.) A. Löve	achene	desiccated	8	.	.	8	.
Festuca	floret	desiccated	8	.	.	8	.
Festuca	leaf	desiccated	1	.	.	1	.
Ficus carica L.	achene	desiccated	4	.	.	.	4
Fragaria vesca L.	achene	charred	3	2	.	1	.
Fragaria vesca L.	achene	desiccated	1368	28	1137	203	.
Galeopsis angustifolia Hoffm./*ladanum* L.	nutlet	desiccated	1	.	.	1	.
Galeopsis tetrahit L.	nutlet	desiccated	26	.	.	26	.
Galium spurium L.	nutlet	desiccated	1	.	.	1	.
Gentiana cruciata L.	seed	desiccated	3	.	.	3	.
Globularia nudicaulis L.	calyx	desiccated	10	.	.	10	.
Glyceria notata Chevall.	floret	desiccated	1	.	.	1	.
Hordeum distichon L./*vulgare* L.	grain	charred	1	.	.	1	.
Hyoscyamus niger L.	seed	desiccated	1	.	.	1	.
cf. *Juglans regia* L.	nut shell	desiccated	3	.	.	3	.
Juglans regia L.	nut shell	desiccated	39	.	7	2	30
Juncus	seed	desiccated	1	.	.	1	.
Juniperus communis L.	leaf	desiccated	3	.	.	3	.
Juniperus sabina L.	stem	desiccated	1	.	.	1	.
Lapsana communis L.	achene	desiccated	3	.	.	3	.
Larix decidua Mill.	cone	desiccated	1	.	.	.	1
Larix decidua Mill.	leaf	desiccated	91	.	.	91	.
Leontodon	achene	desiccated	3	.	.	3	.
Lepidium	seed	desiccated	1	.	.	1	.
Linum catharticum L.	seed	desiccated	1	.	.	1	.
Malus domestica Borkh.	seed	desiccated	1	.	.	1	.
cf. *Molinia*	floret	desiccated	1	.	.	1	.
Myosotis	nutlet	desiccated	10	.	.	10	.
Panicum miliaceum L.	floret	desiccated	2	.	.	2	.
Petroselinum crispum (Mill.) A. W. Hill	mericarp	desiccated	5	.	.	5	.
Phyteuma betonicifolium Vill./*scheuchzeri* All.	seed	desiccated	1	.	.	1	.

Table 1 Continued

			Phase	Early Phase		Late Phase	
			Sample Type	Bulk samples	Single Finds	Bulk samples	Single Finds
			Number of samples/finds	5	9	8	8
Taxon	**Parts recorded**	**Preservation**	**Total**				
Phyteuma orbiculare L.	seed	desiccated	5	.	.	5	.
Phyteuma	seed	desiccated	2	.	.	2	.
Picea abies (L.) H. Karst.	bud	desiccated	8	.	.	8	.
Picea abies (L.) H. Karst.	leaf	charred	25	14	.	11	.
Picea abies (L.) H. Karst.	leaf	desiccated	261	6	.	255	.
Picea abies (L.) H. Karst.	seed wing	desiccated	1	.	.	1	.
Picea abies (L.) H. Karst.	twig	desiccated	7	.	.	7	.
Pimpinella saxifraga L. aggr.	mericarp	desiccated	1	.	.	1	.
Pinus cembra L.	seed	charred	1	.	.	1	.
Pinus cembra L.	seed	desiccated	193	4	4	180	5
Pinus cembra L.	leaf	desiccated	20	.	.	20	.
Plantago	capsule	desiccated	2	.	.	2	.
Plantago	seed	desiccated	2	.	.	2	.
Poa	floret	desiccated	7	.	.	7	.
Poa alpina L.	floret	desiccated	5	.	.	5	.
Poa nemoralis L.	floret	desiccated	10	.	.	10	.
Poa pratensis L. aggr.	floret	desiccated	5	.	.	5	.
Poa violacea Bellardi	floret	desiccated	1	.	.	1	.
Poaceae	floret	desiccated	57	.	.	57	.
Polygonaceae	achene	desiccated	13	.	.	13	.
Potentilla	achene	desiccated	10	.	.	10	.
Potentilla aurea L.	achene	desiccated	1	.	.	1	.
Potentilla erecta (L.) Raeusch.	achene	desiccated	5	.	.	5	.
Prunella cf. *vulgaris* L.	fruit stone	desiccated	2	.	.	2	.
Prunus avium L./*cerasus* L.	fruit stone	desiccated	3	.	3	.	.
Prunus domestica L./*insititia* L.	fruit stone	desiccated	1	.	.	.	1
Prunus persica (L.) Batsch	fruit stone	desiccated	4	.	3	.	1
Pteridophyta	sporangium	desiccated	80	.	.	80	.
Ranunculus	achene	desiccated	80	.	.	80	.
Rhinanthus	seed	desiccated	2	.	.	2	.
Rubus idaeus L.	fruit stone	charred	2	2	.	.	.
Rubus idaeus L.	fruit stone	desiccated	14151	20	1080	13051	.
Rumex	achene	desiccated	78	.	.	78	.
Salix	bud	desiccated	1	.	.	1	.
Sambucus cf. *racemosa* L.	seed	desiccated	37	30	.	7	.
Selaginella selaginoides (L.) Schrank & Mart.	macrospore	desiccated	61	3	.	58	.
Senecio	achene	desiccated	1	.	.	1	.
Senecio hercynicus Herborg/*ovatus* (P. Gaertn. & al.) Willd.	achene	desiccated	2	.	.	2	.
Senecio viscosus L.	achene	desiccated	2	.	.	2	.

Table 1 Continued

			Phase	Early Phase		Late Phase	
			Sample Type	**Bulk samples**	**Single Finds**	**Bulk samples**	**Single Finds**
			Number of samples/finds	**5**	**9**	**8**	**8**
Taxon	**Parts recorded**	**Preservation**	**Total**				
cf. *Silene*	seed	desiccated	2	.	.	2	.
Silene dioica (L.) Clairv.	seed	desiccated	27	.	.	27	.
Silene nutans L.	seed	desiccated	1	.	.	1	.
Silene cf. *vulgaris* (Moench) Garcke	seed	desiccated	1	.	.	1	.
Sonchus asper Hill	achene	desiccated	5	.	.	5	.
Sonchus oleraceus L.	achene	desiccated	1	.	.	1	.
cf. *Sparganium*	fruit stone	desiccated	2	.	.	2	.
Stellaria media (L.) Vill.	seed	charred	1	1	.	.	.
Stellaria media (L.) Vill.	seed	desiccated	50	3	.	47	.
Thlaspi arvense L.	seed	desiccated	19	.	.	19	.
Thymus serpyllum L. aggr.	calyx	desiccated	6	.	.	6	.
Thymus serpyllum L. aggr.	leaf	desiccated	1	.	.	1	.
cf. *Thymus*	calyx	desiccated	1	.	.	1	.
Torilis arvensis (Huds.) Link	mericarp	desiccated	1	.	.	1	.
Trisetum flavescens (L.) P. Beauv.	glume	desiccated	1	.	.	1	.
Urtica dioica L.	achene	desiccated	183	7	.	176	.
Urtica urens L.	achene	desiccated	15	.	.	15	.
Vaccinium myrtillus L.	seed	desiccated	5	.	.	5	.
Valeriana	achene	desiccated	1	.	.	1	.
Valerianella dentata (L.) Pollich	achene	desiccated	3	1	.	2	.
Viola	seed	desiccated	16	.	.	16	.
Vitis vinifera L.	seed	desiccated	3	.	.	3	.

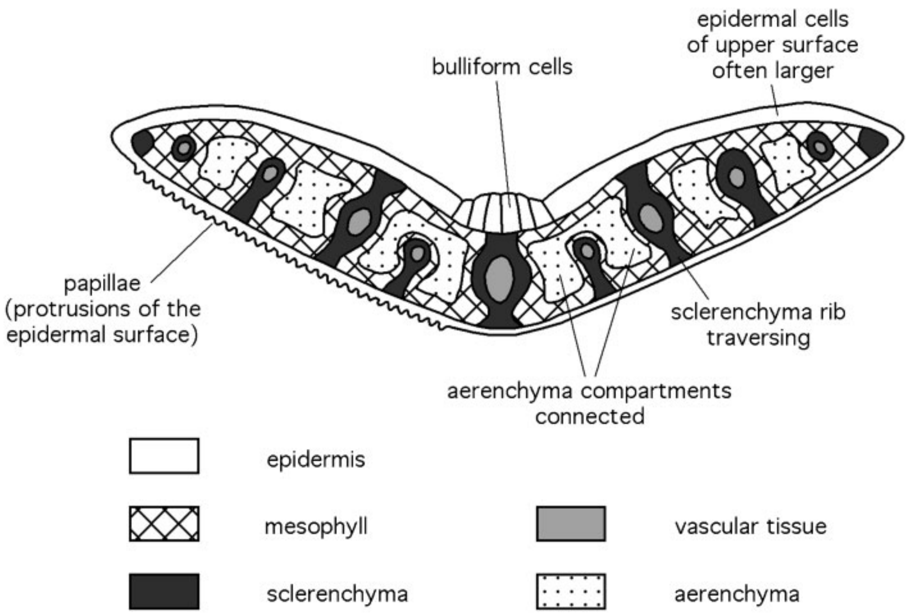

Figure 4 Schematic cross section of a Cyperaceae leaf

ment of a branch was found, still exists in the rocks around the ruin. This small and isolated population might owe its origin to a deliberate introduction during the Middle Ages. In former times it was used as an abortifacient agent and possibly escaped from cultivation and became naturalised in the dry rocks.

Some of the plant finds might have fallen down from the steep slope above the rock. As this is virtually inaccessible it is acceptable to assume that the same type of coniferous forest grew there as today. In particular remains of conifers (*Larix decidua*, *Picea abies*, and *Pinus cembra*) might come from there, although it cannot be excluded that parts of these trees were actively transported to the castle as timber or fuel.

The largest part of the plant finds must however have been actively transported to the site, either from the valley beyond the castle, or from further away. Importation from a greater distance applies for most of the cultivated plants, because at 1780 m asl only a few species can be grown for climatic reasons.

Only very few cereal remains were found at Marmorera: one charred grain of barley (*Hordeum distichon/vulgare*) and two florets of broomcorn millet (*Panicum miliaceum*). Today cereals are grown in the valley of the River Gelgia up to 1200 m asl (personal observations by the authors). In earlier centuries, cereals were cultivated to much higher altitudes, and in the canton of Graubünden, rye (*Secale cereale*) and barley were grown up to 1900 m asl, bread wheat (*Triticum aestivum*) and oat (*Avena sativa*) up to 1400 m asl (Schröter 1908). At even higher altitudes, the crop was uncertain; yet in some valleys cereals were grown for straw bedding. Among the cereals cultivated in Switzerland in the Middle Ages, broomcorn millet has the highest demands concerning temperature; it was only grown in the most low lying alpine valleys. The barley found at Marmorera might therefore have been cultivated locally, while the millet was certainly imported.

The scarcity of cereal finds represents a major difference to many other archaeobotanically investigated sites, where often considerable quantities of cereals are encountered. Cereal grains rarely seem to survive in desiccated form: in Malvaglia (Schoch 1986), where a great deal of rye (*Secale cereale*) straw and ears were preserved, not a single grain was found. Possibly they were eaten by rodents in the course of time. Despite the small number of finds, cereals probably played an important role in the nutrition of the inhabitants of the castle. They may have been brought in largely as processed grains (e.g. flour) or even as bread, although these foodstuffs can only be stored for a short period. Finds of typical agricultural weeds (e.g. *Agrostemma githago*, *Fallopia convolvulus*, *Galium spurium*) on the other hand indicate that at least some unprocessed cereals were imported, too. Some of the weed species might indicate that cereals were imported from warmer, lower lying regions, notably *Torilis arvensis* which is today only found in lower altitudes. *T. arvensis* reaches a maximum altitude of 1000 m asl in the Alps. In the canton of

Table 2 Characteristics of leaves of all species of Cyperaceae occurring in the region of Marmorera

	epidermis				sclerenchyma			vascular bundles	mesophyll			aeren-chyma		
	cells of upper surface larger	papillae on upper surface	papillae on lower surface	large bulliform cells	ribs all traversing	ribs partially traversing	ribs not traversing	number	thicker on top side	equal on both sides	thicker on bottom side	compartments always separated	compartments partially connected	remarks
Blysmus compressus (L.) Link	xx	–	–	–			x	11–17			xx	x		ribs partially traversing at central vascular bundle
Carex atrata L. s. str.	x	–	x	x		x		17–23		x		x		
C. bicolor All.	xx	–	x	x		x		9–11		x		x		
C. brunnescens (Pers.) Poir.	x	x	x	x		x		13–17		x		x		
C. canescens L.	–	x	x	x		x		17–21		x		x		
C. capillaris L.	x	–	–	x		x		9–17	x			x		
C. caryophyllea Latourr.	x	–	–	xx		x		17–19	xx				x	
C. curvula All. s. str.	x	–	–	–		x		11–13			x		x	
C. davalliana Sm.	x	–	–	x			x	7–11			x		x	
C. digitata L.	x	–	–	xx		x		13–15	x				x	
C. echinata Murray	x	x/–	–	x		x		13–15		x		x		
C. ericetorum Pollich	–	–	–	x		x		15–19	x				x	
C. ferruginea Scop.	x	x/–	–	x		x		11–17		x		x/–		
C. firma Host	x	–	–	xx		x		11–13		x		x/–		
C. flacca Schreb.	x	–	x	x	x/–			19–23		x		x		
C. flava L.	xx	–	x/–	x		x		15–17		x		x		
C. foetida All.	x	–	–	x		x		9–19		x		x		
C. frigida All.	x	–	–	–		x		15–19		x		x		
C. hirta L.	x	x	x	x		x		13–17		x		x		laef hairy
C. hostiana DC.	x	–	x/–	xx	x			17–23		x		x		
C. humilis Leyss.	x	–	–	x		x		9–11		x		x		
C. lachenalii Schkuhr	x	x/–	x	xx			x	3–13		x		x		
C. lasiocarpa Ehrh.	x	–	–	x	x			13–17			x	x		ribs very high, vascular bundles close to bottom side
C. leporina L.	x	x	x/–	x		x		13–17		x		x		
C. limosa L.	x	x	x	–	x			11–13		x		x		one of the lateral vascular bundles strikingly larger
C. microglochin Wahlenb.	xx	–	–	–			x	7–9			x		x	
C. montana L.	x	x/–	–	x	x/–			9–13	x			x		
C. nigra (L.) Reichard	–	x	–	x	x			13–17		x		x		one of the lateral vascular bundles strikingly larger
C. ornithopoda Willd.	x	–	–	x		x		13–17	x			x		
C. pallescens L.	x/–	–	–	x		x		15–19	x/–			x		laef hairy
C. panicea L.	x	–	x	x		x		9–17		x		x		
C. paniculata L.	xx	x	x/–	x	x/–			17–19		x		x		
C. parviflora Host	x	–	x	x		x		15–21		x		x		

Table 2 Continued

	epidermis				sclerenchyma			vascular bundles	mesophyll			aeren-chyma		
	cells of upper surface larger	papillae on upper surface	papillae on lower surface	large bulliform cells	ribs all traversing	ribs partially traversing	ribs not traversing	number	thicker on top side	equal on both sides	thicker on bottom side	compartments always separated	compartments partially connected	remarks
C. pauciflora Lightf.	xx	–	–	x			x	5–7		x			x	
C. paupercula Michx.	x	–	x	x	x			15–19		x		x		
C. pulicaris L.	xx	–	–	–			x	5–7		x			x	
C. rostrata Stokes	–	x	–	x	x			19–21			x	x		ribs very high, vascular bundles close to bottom side
C. rupestris All.	xx	–	–	x		x		7–9		x		x		
C. sempervirens Vill.	x	–	–	x		x		11–17		x		x/–		
C. spicata Huds.	x	–	–	x		x		15–19		x		x		
C. sylvatica Huds.	x	–	–	x	x			17–23		x		x		one of the lateral vascular bundles strikingly larger
Eleocharis quinqueflora (Hartmann) O. Schwarz														lamina absent
Eleocharis uniglumis (Link) Schult.														lamina absent
Elyna myosuroides (Vill.) Fritsch	–	–	–	–			x	7–9		*		*		* leaf +/– circular, aerenchyma central
Eriophorum angustifolium Honck.	x/–	–	–	xx	x			21–27	x			x		ribs very high, vascular bundles +/– central
E. latifolium Hoppe	x	–	–	x	x			19–27	x			x		ribs very high, vascular bundles +/– central
E. scheuchzeri Hoppe	–	–	–	–			x	7–9		*		*		* leaf +/– circular, aerenchyma central
E. vaginatum L.	–	–	–	–			x	11–15		*		x		* upper surface +/– adnate
Kobresia simliciuscula (Wahlenb.) Mack.	x	–	–	–		x		13–19		x			x	
Schoenus ferrugineus L.	*	–	–	–			x	5–7		*		*		* leaf +/– circular, aerenchyma central
Trichophorum alpinum (L.) Pers.														lamina rudimentary
T. cespitosum (L.) Hartm.														lamina rudimentary

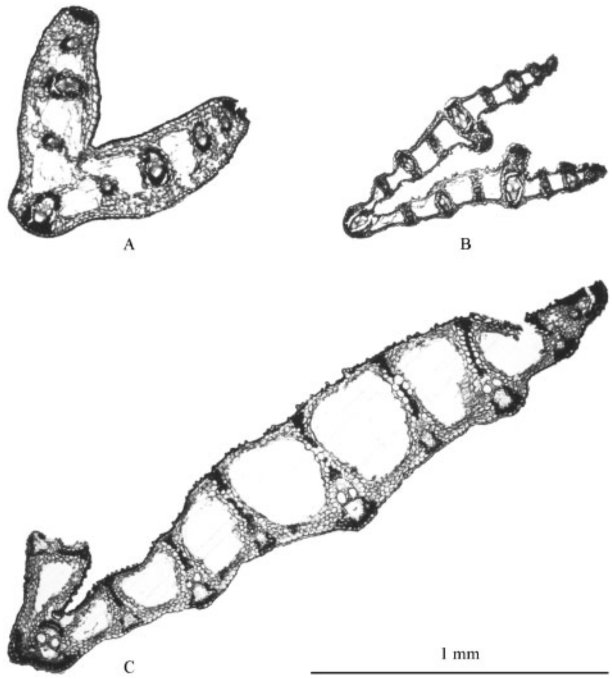

Figure 5 Leaf cross sections of desiccated *Carex* leaves from Marmorera. A: *C. cf. davalliana*. Characteristic features are: no traversing sclerenchyma ribs, only central vascular bundle connected to epidermis by sclerenchyma; aerenchyma compartments partially connected; cells of upper epidermis larger than on lower side; mesophyll thicker on lower side (*C. microglochin* has identical characteristics, but is much rarer in the region of Marmorera). B: *C. nigra*: all sclerenchyma ribs traversing; one of the lateral vascular bundles on each side conspicuously larger than all others; papillae on upper epidermis. C: *C. rostrata*. All sclerenchyma ribs traversing; mesophyll thicker on lower side; papillae on upper epidermis (only one half of a leaf is preserved). Compare also Fig. 4 and Table 2 for further explanations

Graubünden it is only found in the Valle Mesolcina, a valley in the southern part of the Alps (Hegi 1925).

Gardening was and is practised up to c. 2000 m asl in the Alps, the parsley seeds (*Petroselinum crispum*) could originate from local cultivation. Pulses are totally absent from the sediment excavated at Marmorera. Remains of a range of fruits and nuts were found: sweet chestnut (*Castanea sativa*), fig (*Ficus carica*), walnut (*Juglans regia*), apple (*Malus domestica*), cherry (*Prunus avium/cerasus*), plum (*Prunus domestica/insititia*), peach (*Prunus persica*), and grape (*Vitis vinifera*). All these species cannot have grown at Marmorera for climatic reasons and were certainly imported. The hardiest among them are cherry and apple which are grown in the lower parts of the valley of the river Gelgia. Sweet chestnut, fig and peach have the highest demands concerning temperature and were brought from a larger distance.

Hemp (*Cannabis sativa*) may have been grown locally. In the valley of Avers, adjacent to the west, this plant was formerly cultivated at up to 1720 m asl (Schröter 1908). On the excavation site hemp ropes were found, and nine achenes were extracted from the sediment samples.

Collected wild fruits and nuts complemented the diet of the inhabitants of the castle of Marmorera. Remains of the following species were found, all of which could be found in the close vicinity: *Corylus avellana*, *Fragaria vesca*, *Pinus cembra*, *Rubus idaeus*, *Sambucus* cf. *racemosa*, and *Vaccinium myrtillus*. The Alpine stone pine (*Pinus cembra*) has similar and also edible seeds like the Italian stone pine (*P. pinea*), even though smaller. Archaeological finds of *Pinus cembra* seeds are very rare so far (e.g. Oeggl 1998), even though the nutritive and tasty seeds were without doubt frequently collected. The lack of finds is certainly due to the scarcity of archaeobotanical work in the Alps. In prehistoric times, these seeds were even exported, as shown by finds in Arbon (Hosch and Jacomet 2004) and in Yverdon (Schlichtherle 1985), two Neolithic lake shore settlements situated well outside the Alps. These finds underline the appreciation of stone pine seeds in former times.

The lump of grass-like leaves was mainly composed of *Carex rostrata*, *C. nigra* and *C. cf. davalliana*, as mentioned above. These three sedges grow frequently in wet places like fens, marshes or lake-margins. They cannot have grown near the castle, where only plants preferring dry rocky places can exist, and were certainly transported to the site. Before the construction of the artificial lake in the year 1954, fens and wet meadows were probably encountered in the bottom of the valley between the castle and the former village of Marmorera. Old maps show the river Gelgia branching out at this location. Other similar wet habitats still exist within few kilometres. The first idea when finding the 'grass' leaves was that they were brought to the place to serve as animal fodder. *Carex* species (with the exception of *C. vulpina*), however, have little nutritional value. Only young and relatively tender leaves are eaten by livestock. Some sedges may even be harmful to cattle, causing allotriophagy (licking sickness) and subsequently osteoporosis (Hegi 1939). In the present case however, the leaves were certainly not young, as the sample contained also utricles and even an entire spike. For this reason the material had obviously been harvested in summer or later. On the other hand, sedges are highly valued as litter for domestic animals. According to (Hegi 1939), *C. rostrata* and *C. nigra* provide an excellent litter; *C. davalliana* is less suitable for this purpose, but as it occurs in similar habitats as the previous species it is very likely that it was harvested together with them. In view of the limited space in and around the castle it is very doubtful if animals were kept there. It cannot be ruled out that a few goats were present temporarily, for example during a siege. Otherwise it seems more plausible that animals were kept in stables in the valley beneath the castle, from where their products could be transported within a few minutes. As an utilisation of the leaves for animal fodder or bedding seems rather unlikely, another usage for the *Carex* leaves found at Marmorera should be considered; until recently the leaves of sedges (notably *C. brizoides*) were collected for stuffing mattresses, pillows and alike (Hegi 1939).

Conclusions

In desiccated material, many plant parts can be found that otherwise would not be preserved, like the grass-like leaves found at the castle of Marmorera. The present study demonstrates that the identification of such material is possible. Increasingly, existing buildings are the subject of archaeobotanical investigations and therefore more finds of desiccated plant remains can be expected in the future. Identification of vegetative plant material can bring additional information about the environment, because it allows the identification of a wider range of species, and can increase our understanding about useful plants, because it is often just the more delicate parts that are useful to humans.

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