Ber. d. Reinh.-Tüxen-Ges. 21, 174-195. Hannover 2009

A geobotanical analysis of forest patches on sacred sites in Northern Morocco

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Abstract

The sacred sites of different cultures and religions have been attracting the attention of nature conservationalists for quite a while now, because biotic as well as abiotic (e.g. springs) elements are frequently protected by the local population and often forest patches are being preserved. While numerous studies on flora and vegetation of such sites are available from Southeast Asia and sub-Saharan Africa, little is known from Muslim societies, and even less from those in North Africa. In a project sponsored by the DFG we hence investigate the vegetation of Muslim sacred sites and graveyards in rural regions of Northwest Morocco and compare the results with data from sacred sites in other parts of the world. On several spatial scales (landscape, ecoregion, sacred site) we study different aspects of sacred sites, like their frequency, size, geographical position, biotopes, vegetation and flora. In this publication we present first results of our project with emphasis on sacred sites´ forested patches, also called sacred groves or holy forests.

Sacred sites are common elements of the northern Moroccan cultural landscape. On average 100 km^2 hold 26 sacred sites. Of 73 sacred sites investigated in 2008 61 possess sanctified and conserved vegetation around the saint's tomb. Sacred sites are rather small (on average 0.7 ha), but 64% have a forested patch of at least 500 m^2.

The vegetation of the sacred groves can be assigned to three main forest communities characterised and dominated by different tree species: *Quercus coccifera*, *Quercus suber* and *Olea europaea* var. *sylvestris*. Their dominance is mainly dependent on the prevailing substrate. Obviously only a fraction of these forest patches are near-natural. Numerous sacred sites and graveyards are grazed. The three main forest types are phytosociologically classified and subdivided into eight subtypes, which are primarily distinct based on a different intensity of human impact. Grazing changes the vegetation structure (reduces the number of strata), but also the floristic composition: Stenoecious perennial forest floor species are replaced by euryoecious annuals. Hence the processes of therophytization and ruderalisation also occur on such sites, which underlie certain religious taboos. Constant overgrazing results in an overaging of the tree layer ("fossilisation") and ends up – in spite of the usage taboo of the tree layer – with the disappearance of the sacred grove, due to missing regeneration of woody plants. Nevertheless, very well preserved holy forests also exist. They have a high conservation value, because a) they are rare examples of intact mediterranean sclerophyllous forests, b) they represent close-to-climax vegetation and c) they are aesthetic elements in otherwise intensively used cultural landscapes.

1. Introduction

In recent years, conservationists all over the world have become more and more interested in forest patches, which are considered by local societies as "sacred" and are therefore protected from logging and deforestation. A symposium (SCHAAF & LEE 2006), organized by UNESCO, IUCN and other international organisations was dedicated to this topic and resulted in the Yamato-declaration, formulating guidelines on the conservation management of sacred natural sites. Profound studies about the ecology, biodiversity and conservation status of such sites however are unevenly distributed around the world. The synoptic volume of RAMAKRISHNAN et al. (1998) (see first of all the contributions by HUGHES & CHANDRAN and HAY-EDIE & HADLEY therein) documents, that holy forests have been intensively analysed in India (e.g. GADGIL & VARTAK 1976, RAMAKRISHNAN 1996, RAMANUJAM & KADAMBAN 2001, ALEMMEREN JAMIR & PANDAY 2003, RAMANUJAM & PRAVEEN KUMAR CYRIL 2003, UPADHAYA et al. 2003, MISHRA et al. 2004), and to a lesser extent in China (LIU et al. 2002, ANDERSON et al. 2005), Indonesia (WADLEY & COLFER 2004) and Japan (ITOW 1991 for example).

In Africa, sacred grove studies are restricted to the sub-Saharan parts of the continent and concentrate on West and East Africa (see Fig. 1 in SHERIDAN 2008 for a synopsis). Invento-

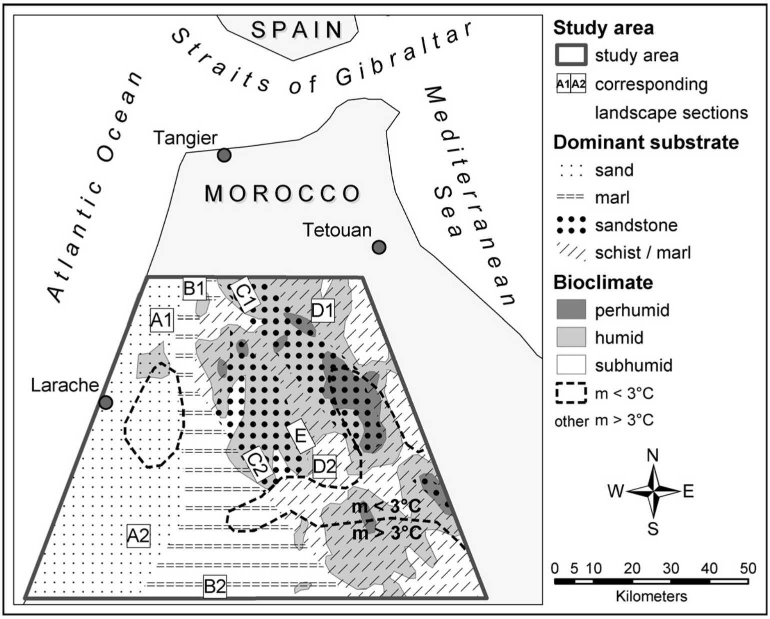

Fig. 1: The study area: delimitation, bedrock strata, climatic differentiation (hygric types; m = mean minimum temperature of the coldest month) and location of the selected landscape sections.

ries of the flora and an analysis of the vegetation and stand structure are for example presented by GUINKO (1985) and NEUMANN & MÜLLER-HAUDE (1999) from Burkina Faso, by TCHAMIÈ (2000) and KOKOU & KOKUTSE (2006) from Togo, by CAMPBELL (2005) from Ghana, by MGUMIA & OBA (2003) from Tansania, and by a number of studies in the afromontane zone of Ethiopia (AERTS et al. 2006, ALEMAYEHU WASSIE et al. 2005, ALEMAYEHU WASSIE & DEMEL TEKETAY 2006, BONGERS et al. 2006).

Geobotanical investigations about sacred groves in Muslim societies in general and in Africa in particular are rare. The contribution by MWIHOMEKE et al. (1998), dealing with groves sanctified by a Muslim society in Tanzania, is an exception. Among the dozens of regional case studies all over the world, summarized by SCHAAF & LEE (2006), only a single one deals with sacred sites in a Muslim society in Kyrgyzstan (AITPAEVA 2006). LISSOVSKY (2004) and DAFNI (2007) report about sacred trees in Palestine, which are admired and protected by different religious groups. From the viewpoint of vegetation ecology however, both studies are very cursory.

One might think, the reason for the rarity of sacred grove studies in Muslim societies is that orthodox Islam does not allow any veneration of saints and that consequently sacred groves do not exist there. However, the religious practises are different. In the Maghreb countries in Northwest Africa (Morocco, Algeria, and Tunisia) for example, the surroundings of tombs where Muslim saints are buried and cemeteries of local Muslim communities are considered to be holy forests ("bois sacrés", "forêts maraboutiques") and thus protected from clearing for religious reasons. The cultural and spiritual importance of those places is well-known (LANG 1992). Within the holy territory, trees became protected without being the actual object of protection, because such sites are relevant for the identity of tribal groups, for genealogy and myths (BOURQUIA 1990). A similar situation can be observed in Central Asia. Sacred sites in Kyrgyzstan play an important role for the ethnic identity (AITPAEVA 2006). They date back to pre-islamic period and are meeting points of nomadic groups.

Especially in Morocco, the appreciation of the spiritual authority of patron saints is a common and vivid phenomenon. Initially, faithful people assembled around the living saints. Those religious brotherhoods around saints, which are called "*Marabout*", played an important political, economic and social role since the beginning of the 15th century, especially in the fight against the Spanish and Portuguese forces, occupying the Atlantic coastal areas of Morocco. Today, the authority of saints and the Marabout movement are still alive (GELLNER 1969, LANG 1992). They are expressed in collective pilgrimages, the "*moussem*", to the saints' tombs (Arab "qabre" or "koubba", French "cupola", English "dome"), the latter often situated in the shades of trees. An impression about the enormous number of sacred sites, which are the destiny of pilgrimage activities, can be gained from studies about the inner Moroccan tourism (BERRIANE 1992, see also Fig. 1 in DEIL et al. 2005).

Studies from Maghreb countries, which deal with the nature of sacred sites and which investigate the flora and vegetation of burial grounds, their habitat diversity and the conservation value of holy places, are extremely rare. QUÉZEL & BARBERO (1990) and BENABID (1991) make general statements about the nature conservation value of the Marabout forests in Morocco and they mention that sacred groves might document formerly widely distributed original woodland types. Further data have been sampled in the context of vegetation studies of forests in general (BARBERO et al. 1981, DEIL 1984, BENABID 1984, FENNANE 1988, AJBILOU et al. 2003, 2006), where a considerable number of the sample plots have been located in sacred groves.

A few preliminary observations, dedicated explicitly to sacred groves, are available from the Tangier Peninsula, the Northwestern part of Morocco. In a pilot study to our project, the plant cover of two Marabout-sites was studied and the vegetation mosaic was mapped (DEIL 2003, DEIL et al. 2005, 2008). First and very preliminary results of the current investigations of our group are documented in JÄCKLE & FROSCH (2008) and in the unpublished master study of FATEH (2008).

Some observations about number, size, and localities of sacred sites are available for the Province of Tetouan and for the communal area of Boukorra (DEMDAM et al. 2008, TAÏQUI et al. 2005). The data are based on topographic maps and a preliminary ground check. However, a detailed inventory of the flora and vegetation of sacred sites in Morocco is missing in these studies.

Our Marabout-project started in 2007. Spatially we focus on rural areas on the Tangier Peninsula in NW Morocco. In a long term, the research should give answer to the following questions:

1. How many sacred sites exist? Where are they located? What is their size?
2. What is their cultural context (saints' tomb, cemetery, both functions)? Are they destination of pilgrimage activities? How is the saint named?
3. Do the sacred sites shelter forests? What percentage of the site does the forested area have? Which other habitats occur on sacred sites? Are these groves virgin forests or are they subjected to pasturing and other human impacts (beyond burial activities!)? How strong is this impact? Which vegetation patterns are created by the traditional land use?
4. Is the present land use sustainable and does it guarantee the long-term persistence of the forest? The pilot studies showed that the tree layer is sometimes very over-aged and that pasturing can be strong and unsustainable.
5. Which plant species and plant communities occur on such burial grounds? Do sacred sites shelter rare plant species?
6. Does the floristic composition of the holy forests reflect the abiotic differentiation of the study area? Do holy forests represent the potential natural vegetation?

A first starting hypothesis is that the vegetation of sacred sites is closer to the climax vegetation than the surrounding landscape. A second hypothesis is that the floristic composition of the sacred groves will mirror the abiotic patterns of the study area. A third hypothesis is that disturbance by men and his livestock will increase the overall phytodiversity by an increase of ruderals which overcompensates the reduction of stenoecious forest taxa. In accordance with the "therophytization" model of the degradation of Mediterranean forests, proposed by BARBERO et al. (1990), we expect a shift from perennial herbaceous species to annuals. The opening of the forest canopy by browsing and the nitrification of the forest soil should result in a floristic trivialization of the forest floor vegetation.

This contribution presents data based upon the field campaign in spring 2008. We will give first and preliminary answers to some of the questions, for example from question-groups 1, 3 and 6. The thematic focus will be the forested parts of sacred sites. Finally, the situation on sacred sites in Morocco will be compared with other parts of the world.

2. Study area

The study area (Fig. 1) is situated on the Tangier Peninsula in Northern Morocco. It stretches from the Atlantic coast north and south of Larache up to the Outer Rif Ranges (= Prérif), excluding the highest calcareous mountain ridge of the Western Rif Mountains, the "Dorsale Calcaire" SSE of Tetouan. The altitude increases from sea-level at the Atlantic coast to about 1700 m on the highest peaks in the eastern part of the study area. This altitudinal change is linked with a gradient of increasing precipitation, from a sub-humid bioclimate in the lowlands to per-humid conditions on the mountain ridges (BENABID 1984). The geology is very diverse with predominating Pliocene and Quaternary sands along the western littoral parts, Flysch and Oligocene sandstone ridges in the East, and a hilly area, dominated by marls, in between. According to EMBERGER (1939) and BENABID (1984), the potential natural vegetation of the study area is forest throughout. However, the actual vegetation is very different from the potential natural vegetation due to the land-use pressure. In the lowlands, most of the forests have been cleared for agriculture. In mid and high altitudes, forests are still quite common, but subjected to pasturing and timber exploitation.

3. Methods

3.1 Sampling design

For a comprehensive overview of the sacred sites in Northern Morocco and their vegetation cover, data of different quality and quantity have been sampled in four spatial scales (Fig. 2):

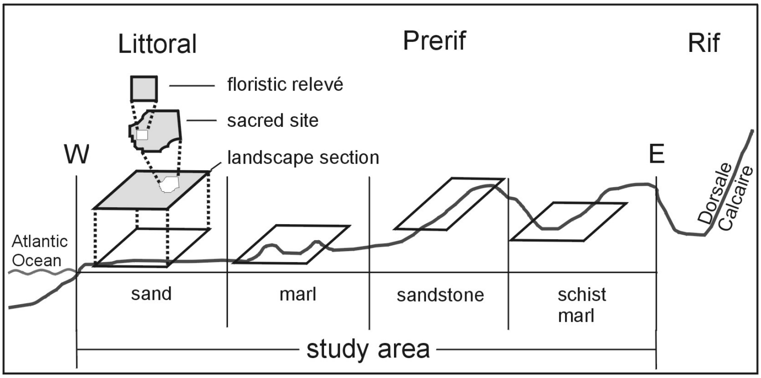

Fig. 2: Schematic profile of the study area, illustrating the sampling design with the hierarchy of 4 spatial scales: study area, landscape section, sacred site and sample plot for floristic relevés.

1. Number and topographical position of sacred sites in the different ecoregions and cultural landscapes in the study area were extracted from the topographic maps 1:50.000 (Ministère de l'Agriculture 1965-2002) of the study area in a first step. All signatures indicating "Marabout", "Koubba" (both saint tombs) and "Cimetière" (cemetery) were registered and topographically digitized. "Mosques" have been excluded. The following maps were analysed (name and year of publication; pp = only those parts belonging to the study area): Arba Ayacha/1965, Arbaoua/2002, Asilah/1965, Bab Taza/1970pp, Beni Ahmed/1974pp, Chaouene/1970pp, El Ksar el Kebir/1965, Lalla Mimouna/2000, Larache/~1965, Moulay bou Salham/1974, Ouezzane/1974, Souk el Kolla/1972, Souk Khemis des Beni Arouss/1966, Souk Larbaa Beni Hessane/1970pp and Zoumi/1970.

2. To analyse the vegetation and the conservation status of the sites, a more detailed scale is used. Landscape sections of 36 km^2 were chosen and all sacred sites were investigated in the field. To obtain representative data for the different ecoregions from a small number of landscape sections, the following pre-stratified random sampling procedure was applied: A) Based upon the geological map 1:500.000 of Northern Morocco (Ministère de l'Énergie et des Mines 1980), four strata with different dominating geological bedrock material were separated (see Fig. 1 and 2). B) To keep the thermal conditions relatively constant, areas with mean minimum temperature of the coldest month < 3°C were excluded (based upon the bioclimatic map of BRIGNON & SAUVAGE 1962). In the remaining area, as many landscape sections as possible were placed within each of the four geological strata. Sections containing fewer than four sacred sites were excluded. From the remaining sections two corresponding landscape sections per stratum were chosen randomly. To avoid spatial autocorrelation, a minimal distance of 20 km between the corresponding sections of a stratum was a further precondition. Finally we checked whether corresponding sections were situated within the same bioclimate according to the map in BENABID (1984). For D1 and D2, a slightly differing bioclimate was accepted because a first field survey proved a similar forest vegetation of both sections. Section E has no corresponding part. It was explicitly located in the transition zone from sandstone to schist bedrock. The locations of the studied landscape sections are given in Fig. 1.

3. Within the landscape sections all sacred sites with a spatial extension have been mapped (sacred sites consisting only of a saint's tomb, without a surrounding vegetated holy area, are not further considered here). The following parameters have been noted: Locality, size, vegetation types classified according to vegetation structure (stratification, life forms per layer), and dominating species in each layer. Based upon these parameters, habitat types were defined and their relative abundance per sacred site was mapped. The number of sacred sites per landscape section investigated until now is documented in Tab. 1.

Tab. 1: Number of sacred sites per landscape section and number of phytosociological relevés on the sacred sites

landscape section	SaS in topographic maps [n]	SaS total [n]	SaS analyzed [n]	phytosociological relevés [n]	relevés from forest* plots [n]
A1	9	16	13	36	17
A2	6	4	4	8	1
B1	9	9+	0	0	0
B2	13	13	9	12	1
C1	8	10+	9	20	12
C2	8	10	6	10	5
D1	26	27+	8	27	18
D2	8	8+	1	2	0
E	14	21+	11	29	12
Σ	**101**	**118+**	**61**	**144**	**66**

SaS = sacred site
"+" after "SaS total" indicates that the total number is not yet finally recorded in this landscape section
*defined as woody vegetation with a canopy cover of more than 10 % and a canopy height of at least 5 m

This publication is focused on the parts of sacred sites with woody vegetation. The following tree cover categories are used: A) sacred sites without trees, B) with isolated trees, C) with a group of trees covering ≤ 500m², D) with forest or forest fragment > 500 m² (Definition of tree: woody specimen ≥ 5 m; definition of forest: woody vegetation with a canopy cover ≥ 10% and canopy height ≥ 5 m).

4. To analyse the vegetation and flora of the sacred sites in detail, one to several phytosociological relevés were sampled per sacred site. The selected plots were homogenous according to vegetation structure and correspond to the habitat types of spatial scale 3 (see above). Data sampling (cover-abundance scale) and data analysis (classification according to floristic similarity) follow the methods of BRAUN-BLANQUET (1964). In total 144 relevés were taken thus far on the sacred sites investigated until now (see Tab. 1). Because we are focusing upon the forested part of the sacred sites, a subset of 66 relevés is presented here. To gain a more representative data set for one of the studied forest types, several relevés which did not fit the definition of "forest" (see above) were nevertheless included.

In the floristic assessment three tree layers (t1 >15 m, t2 5-15 m, t3 2-5 m), two shrub layers (s1 0.5-2 m, s2 <0.5 m), a sapling layer (tree species ≤ 0.5 m), a seedling layer, an epiphytic layer, and an herbaceous layer were distinguished. The structural and floristic data are presented here in a constancy table (see Tab. 2). For this synoptic table, layers were partly merged in the following way: t1 and t2 to t1, s1 and s2 to one shrub layer, and sapling and seedling layer to a juvenile layer. The definition of "tree" differs from the approach used on spatial scale 3 (see above): it includes all phanerophytes in the tree layers and shrub layer in the mentioned height classes.

Accompanying site parameters like bedrock, pH, and content of $CaCO_3$ were noted or measured. Taking soil samples is a delicate task on sacred sites. We therefore sampled only one per cemetery and only from the upper soil layer (1-10 cm).

3.2 Data analysis

The floristic data set was sorted manually according to floristic similarity. A detrended correspondence analysis (DCA) was performed using the program CANOCO for Windows 4.5 (TER BRAAK & ŠMILAUER 2002). All the 66 vegetation relevés have been included in this analysis. Plant species with a frequency < 4 were excluded, except for a small number of character species. Cover-abundance values were transformed from the Braun-Blanquet-scale (r, +, 1-5) to a numerical scale (1-7).

Botanical nomenclature follows VALDÉS et al. (2002). Plant communities are named according to BENABID (1984) for Moroccan forest associations and according to RIVAS-MARTÍNEZ et al. (2002) for more widespread and higher syntaxa.

4. Results

4.1 Number, size and use of sacred sites

According to the topographic maps, 1420 sacred sites exist in the whole study area, 101 of which were within the nine chosen landscape sections. The ground check of 54 of these sites in 2008 gave the following results: Five locations could not be confirmed (either erroneously recorded in the map or area meanwhile transformed into agricultural land). 24 sacred sites were found that have not been indicated on the maps. A scaling up of these data (35% more sites existing than recorded on the maps) lets us estimate an overall number of about 1920 sacred sites in the study area (on average 26 sites per 100 km^2).

The distribution of the sacred sites within the study area is not homogeneous. Sacred sites are rare on the top of the sandstone ridges and in the alluvial plains whereas in the transition zone between sandstone ridges and underlying schist or marl they are particularly abundant. The high number of 21 sacred sites in section E (a transition zone between sandstone and schist) compared with only 10 sacred sites per sections C1 and C2 (on sandstone ridges) confirms this observation (see Tab. 1). Also within one stratum, the number of sacred sites is quite variable: In section A1 for example 16 sites exist, in section A2 only 4 sites.

Of the 73 sacred sites visited 12 consist only of a saint's tomb or a tomb with a single tree and have no surrounding sacred vegetation. They are not further considered here.

Most (=75%) of the 61 sacred sites with a spatial extension studied until now consist of a sacred tomb, surrounded by a cemetery. People want to be buried near a sacred tomb to profit from the "baraka", the spiritual blessing of all objects in spatial context to the Marabout (LANG 1992). 10 % of the sacred sites are only saint's tombs (not surrounded by a cemetery) and 15 % are only cemeteries.

Their size varies between 85 m^2 and 5 hectares with an average of 0.7 ha per site (calculated on the basis of the hitherto analysed 27 of the recorded 61 sites). Their surface is usually covered by a mosaic of several habitats.

For the 61 sites with spatial extension from all the landscape sections analysed until now, the vegetation around the tombs was mapped according to tree-cover categories: 64 % of the sites harbour forests or forest fragments of at least 500 m^2 size, often beside other non-forest habitats. 7 % shelter only a smaller group of trees and 21 % have just a single isolated tree and are elsewhere covered by shrubs and/or herbaceous plants. 8 % are without any trees. Considering only sites with forests or forest fragments, the forested part of the site varies widely between 8 % and 100 %. Most of the forest patches are small, with a mean size of 0.5 ha. Sometimes these stands are coppice forests. This type of forest dominates for example in section A1.

4.2 Tree cover categories of sacred sites in different ecoregions

Seven landscape sections were studied for the proportion of sacred sites in the four tree cover categories. The variability of this parameter is documented in Fig. 3. Some relationships between altitude, substrate and the proportion of forested sites per landscape section can be

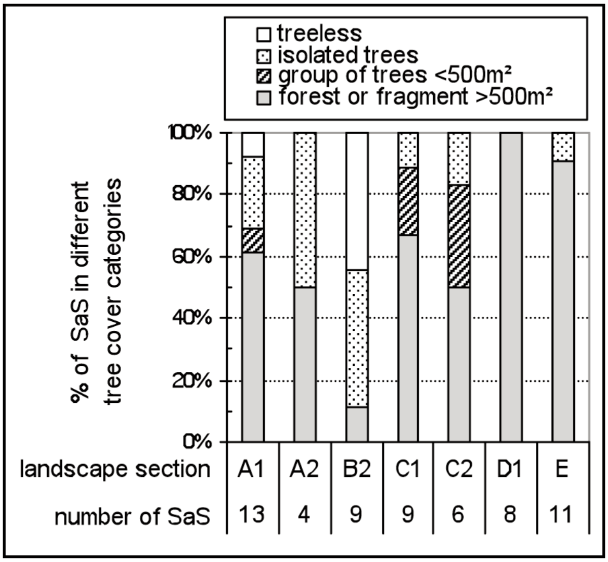

Fig. 3: Tree-cover categories of sacred sites (= SaS) per landscape section

observed. In section B2, a lowland area (mean altitude of 189 m, marl as prevailing substrate), the sacred sites are embedded in intensively cultivated agricultural land. Here the proportion of sites with a forest cover over 500 m^2 is much lower (11 %) than in the mean of all sacred sites studied (64 %). In sections A1 & A2, also situated at low altitudes (~ 110 m) but with sand as the dominant substrate and in the mountainous sections C1 & C2 (~ 500 m mean altitude, mainly on sandstone), it is close to the mean. In the landscape sections D1 & E, on medium altitudes (357 m and 391 m mean altitude) but with high altitudinal differences, the proportions of forested sites are higher (100 % and 71 % respectively) than on average.

No relationship between forest cover and character of the site (saint's tomb, cemetery, or both functions) was found.

4.3 Forest plant communities on sacred sites: Structure and environmental conditions

The classification of the phytosociological data collected on the sacred sites results in a first step in three forest types, dominated by the tree species *Quercus coccifera*, *Quercus suber*, and *Olea europaea* var. *sylvestris* respectively (Tab. 2). This classification according to floristic similarity, which is strongly supported by a DCA (Fig. 4 a, see also chapter 4.3.4) reflects the substrate preference of the main tree species: Kermes Oak (*Quercus coccifera*) prefers basic schist, Cork Oak (*Quercus suber*) is restricted to sandstone and other acid substrates, and Wild Olive (*Olea europaea* var. *sylvestris*) dominates on marl and argil, and in our study area also on slightly acidic littoral sands (Fig. 4 b) (remarks on habitat preferences of species refer to our data set, the study area northern Morocco and the habitat forest). The synoptic table (Tab. 2) shows, that within the three main forest types (1 to 3) several subtypes (1.1., 1.2., 2.1. etc.) can be distinguished. Apart from soil, further differentiating environmen-

Tab. 2: Forest plant communities on sacred sites in Northern Morocco

main forest types	**Quercus coccifera groves**		**Quercus suber groves**				**Olea europaea groves**	
subtypes	**1.1**	**1.2**	**2.1**	**2.2**	**2.3**	**2.4**	**3.1**	**3.2**
number of relevés	9	8	3	8	8	10	13	7
mean species number	23	12	26	19	30	31	23	29
tree layer 1 (> 5m)								
Quercus coccifera	**V**	**V**	.	.	.	.	.	.
Phillyrea latifolia	**III**	**II**	.	I	.	.	.	.
Pistacia lentiscus	**III**	**I**	.	.	.	.	.	.
Quercus suber	III	II	**V**	**V**	**V**	**V**	.	.
Olea europaea var. *sylvestris*	.	.	.	.	.	I	**III**	**III**
tree layer 2 (2-5m)								
Quercus coccifera	I	III	.	II	.	.	.	.
Phillyrea latifolia	I	IV	.	I	.	.	.	.
Arbutus unedo	.	II	IV	I	.	.	.	.
Pistacia lentiscus	I	II	.	.	.	.	.	.
Erica arborea	.	II	.	II	.	.	.	.
Olea europaea var. *sylvestris*	.	.	.	.	.	.	**III**	**III**
juveniles of tree species ** (≤ 0.5m)								
Quercus coccifera	**V**	**V**	.	II	.	I	.	.
Phillyrea latifolia	**IV**	**III**	II	II	II	II	.	.
Quercus suber	II	I	**V**	**V**	**V**	**III**	.	.
shrub layer (< 2m)								
Smilax aspera	**V**	**V**	II	II	III	I	II	I
Rubia peregrina	**V**	**IV**	II	II	II	I	II	.
Pistacia lentiscus	**IV**	**V**	IV	I	III	I	I	.
Phillyrea latifolia	**II**	**V**	IV	I	.	.	.	.
Quercus coccifera	**I**	**III**	.	I	.	.	.	.
Clematis cirrhosa	**III**	**III**	.	.	II	.	I	I
Rosa sempervirens	**III**	**II**	.	.	.	.	.	I
Hedera helix s.l.	**IV**	.	.	.	I	.	.	.
Lonicera periclymenum	**II**	.	.	.	.	.	.	.
Viburnum tinus	II	II	**V**	II	.	.	.	.
Myrtus communis	I	II	**V**	II	I	.	.	.
Phillyrea angustifolia	.	.	**IV**	.	II	I	.	.
Erica arborea	I	II	**V**	**V**	II	I	.	.
Cistus salviifolius	.	.	.	IV	II	II	I	I
Rubus ulmifolius	II	.	.	II	II	I	II	I
Cistus crispus	.	.	.	I	**II**	**III**	I	I
Olea europaea var. *sylvestris*	.	I	.	.	.	.	**II**	**II**
Chamaerops humilis	.	I	II	.	.	.	**II**	**III**
Calicotome villosa	I	.	.	I	I	I	**II**	**I**
Daphne gnidium	.	.	.	.	.	.	**II**	**II**
Asparagus aphyllus	.	.	.	.	.	.	**IV**	**III**
epiphyte layer								
Umbilicus rupestris	.	.	**V**	**IV**	**II**	**II**	I	.
Polypodium cambricum	.	.	.	**II**	**II**	**II**	.	.
Davallia canariensis	.	.	**V**	.	.	.	.	.
Moehringia pentandra	.	.	**IV**	.	.	.	.	.
Geranium purpureum	.	.	**II**	.	.	.	.	.
herbaceous layer*								
Ruscus hypophyllum	**V**	**II**	**IV**	II	I	I	II	I
Tamus communis	**V**	**IV**	**IV**	I	II	II	II	I
Asplenium onopteris	**IV**	**III**	**V**	II	I	I	.	.
Polypodium cambricum	**II**	**III**	**V**	I	I	.	.	.
Cephalanthera longifolia	**V**	I	.	.	.	.	.	.
Galium scabrum	**IV**	.	.	III	II	II	.	.
Luzula forsteri	**II**	.	II	III	I	.	.	.
Brachypodium sylvaticum	**III**	I	.	I	I	.	.	.

Contin. Tab. 2

main forest types	**Quercus coccifera groves**		**Quercus suber groves**				**Olea europaea groves**	
subtypes	**1.1**	**1.2**	**2.1**	**2.2**	**2.3**	**2.4**	**3.1**	**3.2**
number of relevés	9	8	3	8	8	10	13	7
mean species number	23	12	26	19	30	31	23	29
Ruscus aculeatus	**III**	.	.	I	.	.	.	.
Vinca difformis	**III**	.	.	.	.	.	I	.
Melica arrecta	**II**	.	II	I	.	.	.	.
Arum italicum	**II**	.	.	.	.	.	.	I
Oenanthe pimpinelloides	**II**	.	.	I	I	.	.	.
Allium triquetrum	**II**	.	.	.	.	.	.	.
Carex distachya	I	I	**IV**	**IV**	**IV**	**II**	I	I
Umbilicus rupestris	II	.	**V**	**IV**	**II**	**III**	.	.
Moehringia pentandra	III	.	**V**	**III**	**II**	**I**	.	.
Scilla monophyllos	.	.	**V**	**III**	**II**	**I**	.	.
Veronica cymbalaria	II	I	**II**	**III**	**II**	**III**	.	.
Ornithogalum algeriense	.	.	**.**	**II**	**II**	**II**	.	.
Ranunculus ficaria	.	.	**.**	**I**	**II**	**II**	.	.
Teucrium pseudo-scorodonia	.	.	**V**	.	.	.	.	.
Asplenium obovatum ssp. *lanceolatum*	.	.	**IV**	.	II	I	I	.
Crepis tingitana	.	.	**IV**	I	.	.	.	.
Centranthus calcitrapae	.	.	**V**	.	II	I	.	.
Hypochaeris radicata	.	.	.	.	**III**	**III**	I	.
Galium murale	.	.	.	.	**II**	**III**	I	II
Trifolium subterraneum	.	.	.	.	**II**	**III**	I	I
Bromus madritensis	.	.	.	.	**II**	**III**	I	III
Rumex pulcher s.l.	.	.	.	I	II	**IV**	.	III
Ranunculus muricatus	.	.	.	I	.	**IV**	I	I
Silene gallica	.	.	.	.	I	**IV**	I	I
Sisymbrium officinale	.	.	.	.	.	**III**	I	III
Ranunculus parviflorus	.	.	.	I	I	**II**	I	.
Tolpis barbata	.	.	.	.	I	I	**III**	**IV**
Medicago polymorpha	.	.	.	.	.	I	**II**	**III**
Hedypnois rhagadioloides	.	.	.	.	.	.	**II**	**III**
Achyranthes sicula	.	.	.	.	.	.	**I**	**II**
Eryngium tricuspidatum	I	.	.	II	.	I	**IV**	**III**
Brachypodium distachyon	I	.	.	.	III	I	**IV**	II
Gaudinia fragilis	.	.	.	.	.	.	**III**	I
Dactylis glomerata ssp. *hispanica*	.	.	.	.	.	I	**II**	I
Hordeum murinum ssp. *leporinum*	.	.	.	.	II	II	.	**V**
Torilis nodosa	.	.	.	I	II	II	II	**V**
Trifolium isthmocarpum	.	.	.	.	.	I	I	**IV**
Carex divulsa	**III**	.	.	II	**V**	**V**	III	II
Arisarum simorrhinum	**IV**	II	.	I	**IV**	**III**	II	III
Geranium purpureum	**IV**	I	IV	II	**IV**	**III**	II	I
Aristolochia paucinervis	**III**	II	IV	II	**II**	**IV**	I	.
Stellaria media	**II**	I	II	I	**V**	**IV**	I	V
Sherardia arvensis	.	.	.	II	IV	V	II	V
Anagallis arvensis ssp. *latifolia*	.	.	.	I	II	IV	IV	V
Mercurialis annua ssp. *ambigua*	I	.	.	.	II	I	III	III
Satureja nepeta ssp. *nepeta*	.	.	.	II	II	III	II	III
Desmazeria rigida	.	.	.	.	III	III	II	III
Urospermum picroides	I	.	II	I	III	II	II	II
Ornithopus compressus	.	.	.	.	III	II	II	I
Geranium molle	.	.	.	.	II	II	II	III
Cerastium glomeratum	.	.	.	.	II	II	I	III

herbaceous layer includes chamaephytes and geophytic lianes (e.g. *Tamus communis*) < 50 cm
** seedlings and saplings of tree species ≤ 0.5 m (tree species 0.5-2m in shrub layer)
constancy classes: I 1-20% II >20-40 % III >20-40% IV >60-80% V >80-100%

tal factors are land use intensity and climatic conditions. The subtypes are arranged from left to right according to increasing land use intensity (grazing and cutting/logging).

4.3.1 *Quercus coccifera* groves (Tab. 2, col. 1.1 and 1.2)

In the present data set, sacred groves dominated by Kermes Oak are the least disturbed forests. The closed stands with an upper tree canopy, ranging from 8 to 24 m, are not influenced by grazing or logging. They are floristically distinct by having *Quercus coccifera* dominating the tree layer 2 (6-15 m) or even layer 1 (> 15 m) and the codominant trees *Phillyrea latifolia* and *Quercus suber*. Outside of sacred sites *Q. coccifera* and *Phillyrea latifolia* occur in Morocco only in a low shrubby form, due to human impact (cutting, grazing).

Kermes Oak groves are characterised by a distinctive liana layer with *Smilax aspera, Rubia peregrina* and *Clematis cirrhosa*, by *Rosa sempervirens* in the shrub layer, and by *Ruscus hypophyllum, Tamus communis, Asplenium onopteris* and *Polypodium cambricum* on the forest floor. According to the overall floristic composition, these groves can be assigned to the Rusco hypophylli-Quercetum cocciferae. This association, described by BENABID (1984) also from northern Morocco and nearly exclusively from sacred sites, belongs to the class of evergreen Mediterranean forests (Quercetea ilicis) and its west mediterranean thermophilous alliance Querco rotundifoliae-Oleion sylvestris.

The studied *Quercus coccifera* groves occurred in mid altitude (330 to 490 m a.s.l.) in subhumid to humid climatic conditions and on basic to slightly acid soils, originating from schist and sandstone, the prevalent bedrock material in landscape section D1. A more or less continuous litter layer covers the forest floor. Seedlings of *Quercus coccifera* and especially *Phillyrea latifolia* occur in remarkably high abundance. The less shade tolerant seedlings of *Quercus suber* are much rarer and are completely lacking in subtype 1.2.

***Cephalanthera longifolia-Galium scabrum*-subtype (Tab. 2, col. 1.1):** A first subtype of the *Quercus coccifera* groves thrives on slightly calcareous soils (pH 6.4 on average) and with a topsoil, rich in organic material. Mean tree cover is 54 % (ranging from 10 to 90 %), the shrub cover is sparse or missing. Floristically this subtype is differentiated from subtype 1.2 by the lianas *Hedera helix* s.l. and *Lonicera periclymenum* and by a large number of mesophyllous herbaceous forest species (*Cephalanthera longifolia* to *Allium triquetrum*), restricted to humid conditions and to this subtype of sacred groves. Other differentiating species in the herb layer (*Carex divulsa* to *Stellaria media*) are indicative of a thinning of the tree canopy and nutrient rich soil conditions.

Subtype with woody understorey (Tab. 2, col. 1.2): This species-poorer subtype is possibly a successional stage of subtype 1.1. It is separated from subtype 1.1 by the lack of the *Cephalanthera-Galium*-group and by a different vertical structure and cover-abundance of the strata: Mean cover of the herbaceous/chamaephyte layer is only 3 % in comparison to 17 % in subtype 1.1. On the other hand mean cover of tree (73 %) and shrub layer (24 %) is higher. Resprouting tree species, first of all *Pistacia lentiscus*, form a woody understory of 2-5 m height. Abiotic site conditions seem to deviate slightly from those of subtype 1.1: The upper soil layer is free of calcium carbonate, pH averages 5.8.

4.3.2 *Quercus suber* groves (Tab. 2, col. 2.1 to 2.4)

Cork Oak groves occur only on acidic, carbonate free bedrock material, predominantly on sandstone. The pH of the upper soil layer ranges from 4.6 to 6.0 in the different subtypes. *Quercus suber* is often the only tree species in these holy forests, and often there is only one tree layer. Mean coverage of the tree layer is relatively low (mean 52 %; ranging from 20 to 70 %), partly due to the open crown architecture of Cork Oak, partly due to grazing, which leads to overaged stands without regeneration, partly due to direct human impact (cutting of branches). Cork is harvested in most of the sacred groves, while logging is rare and only permitted for the benefit of the religious society, for example to restore the Mosque or the Marabout building. The shrub layer varies in cover (between 1 and 20 %) and floristic composition according to the subtypes. *Erica arborea* has a high constancy in subtypes 1 and 2, *Cistus crispus* in subtypes 3 and 4. The latter stands are also rich in therophytes. Crotches and bark of mature *Quercus suber* trees offer micro-habitats for epiphytic species such as *Umbilicus rupestris* and *Polypodium cambricum*. Numerous herbaceous species are common to all *Quercus suber* groves (*Carex distachya* to *Ranunculus ficaria*). They are characteristic species of the Quercetalia ilicis or transgressives of acidophilous heathland communities.

Quercus suber groves can be subdivided into four subtypes. Disturbance is the most important differentiation factor. Subtypes 2.1 and 2.2 are less disturbed by men and domestic animals: There perennial species like *Ruscus hypophyllum* or *Asplenium onopteris* are quite common, while therophytes are rare. In the subtypes 2.3 and 2.4, ruderal shade-tolerant annuals and nitrophilous perennial herbs indicate the higher anthropozoogenic impact. The latter subtypes have a lower tree canopy (47 % versus 59 %), a lower litter layer (51 compared to 83 %), more bare soil (16 versus 3 %) and a higher species richness (30/31 versus 26/19).

Subtype with *Davallia canariensis* (Tab. 2, col. 2.1): *Davallia canariensis* is an epiphytic and epilithic perennial fern, restricted to the most humid parts of the Tangier Peninsula. It characterizes the forest association Davallio-Quercetum canariensis and the rock community Davallio-Sedetum baetici (DEIL 1994). In *Quercus suber*-forests it occurs only under very humid climatic conditions, for example in a cemetery grove on the northern-western slope of Jbel Habib in 300 m altitude. This mountain is the first ridge of the Prérif Mountains, directly submitted to Atlantic air masses. Bedrock is Numidic sandstone; soil pH is 4.6, coverage of litter amounts to 90 %. *Arbutus unedo* forms a low tree layer of 2-5 m height. A pronounced and diverse shrub layer of 20 % coverage is developed, with *Erica arborea*, *Phillyrea angustifolia, P. latifolia*, *Myrtus communis*, *Viburnum tinus* and *Pistacia lentiscus*. These stands can be arranged into the Teucrio-Quercetum suberis in an undescribed variant with *Davallia*.

Beside *Davallia canariensis*, a number of forest floor species separate this subtype from other Cork Oak subtypes (*Teucrium pseudo-scorodonia*, *Asplenium obovatum* ssp. *lanceolatum*, *Crepis tingitana* a. o.). Like in the *Quercus coccifera* groves (s. a.) the forest species group of *Ruscus hypophyllum*, *Tamus communis* and *Asplenium onopteris* is present and indicates the well preserved character of the grove. Therophytes as indicators of disturbance are lacking.

Typical subtype (Tab. 2, col. 2.2): These *Quercus suber* groves are also poor in therophytic species, but the number of perennial herbaceous forest species is smaller than in 2.1, and the diagnostic epiphyte synusium is missing. Bedrock material is predominantly sandstone, mean pH is 5.0. The litter layer coverage is less than in 2.1 (74 compared to 90 %), as is the species number (average 19 versus 26 species in 2.1), however herbaceous layer cover is comparable (11 compared to 12 % in 2.1). The monospecific tree layer holds an average height of 16 m, but can reach up to 22 m. *Erica arborea* can play a role in the shrub layer. Herbaceous forest species are rarer than in 2.1.

Subtypes with therophytes (Tab. 2, col. 2.3 and 2.4): Mainly due to intensive grazing, these Cork Oak groves harbour in spring a rich therophyte synusium on the forest floor. A number of these therophytes are unspecific to pH and occur as well in *Olea europaea*-groves (e.g. *Sherardia arvensis*, *Anagallis arvensis*, *Desmazeria rigida*). Others are more common on or even restricted to acid soils (*Hypochaeris radicata* to *Bromus madritensis*). According to soil conditions, annual ruderal grasses can develop a facies under the open tree canopy: *Brachypodium distachyon* on well drained soils, *Hordeum murinum* ssp. *leporinum* under strong nitrification by the faeces of the grazing livestock. The tree layer can reach 14-18 m height, tree cover value is very variable (10 to 70 %, mean 41 %). Soil pH ranges from 4.8 to 6.0, and is on average (5.6) considerably higher than in subtypes 2.1 and 2.2.

Still more ruderalized than subtype 2.3 is subtype 2.4. This is indicated by character species of annual ruderal vegetations and weed communities (Stellarietea mediae) like *Rumex pulcher*, *Sisymbrium officinale*, *Silene gallica* a.o.

4.3.3 *Olea europaea* groves (Tab. 2, col. 3.1 and 3.2)

Holy forests with the Wild Olive tree (*Olea europaea* var. *sylvestris*) are restricted to low altitudes (100-200 m). Marl and slightly acidic Eocene sands are the bedrock material, pH ranges from 5.5 to 6.8. The monospecific tree stratum covers between 10 and 90 %. Either a single high layer (> 5m) of one-stemmed trees raised from seeds is developed, or a lower tree layer (2-5m) with coppice character (multi-stemmed resprouted *Olea*-individuals). The latter stands do not fit into the definition of "forest" (see methods), but have been included here because their floristic composition is similar to the higher grown stands. Both belong to a broadly defined Tamo communis-Oleetum sylvestris.

The herb layer is dominated by annual and perennial ruderals, forest herbs in a stricter sense are rare. High frequency and abundance are found for ombrophilous and nitrophilous herbs such as *Mercurialis annua* ssp. *ambigua*, *Anagallis arvensis* ssp. *latifolia*, *Hedypnois rhagadioloides* a.o. The species group *Tolpis barbata* to *Eryngium tricuspidatum* differentiates therophytized *Olea europaea*- from therophytized *Quercus suber*-groves (2.3 and 2.4). In lower multi-stemmed stands of both *Olea europaea*-subtypes patches of spiny shrubs (*Asparagus aphyllus* and *Calicotome villosa*) – transgressive species of maquis communities (Asparago albi-Rhamnion oleoides) – occur in the understorey. Subtype 3.2. differs floristically by having a high frequency and abundance of *Hordeum murinum* ssp. *leporinum* (accompanied by *Trifolium isthmocarpum* and *Torilis nodosa*), while in 3.1 *Brachypodium distachyon* is the dominating grass (see 4.3.2, subtypes 2.3 and 2.4).

4.3.4 Results of the Detrended Correspondence Analysis

The multivariate analysis (DCA) confirms the manually classified vegetation types. Fig. 4a illustrates that *Quercus coccifera*-groves (both the subtypes 1.1 and 1.2) are floristically well differentiated from *Quercus suber*- and still more from *Olea europaea*-groves. *Olea*-groves are separated from *Quercus suber*- and *Q. coccifera*-groves by the presence of several woody species (apart from *Olea europaea* e.g. by *Chamaerops humilis* and *Daphne gnidium*) and the absence or rareness of lianas, hemicryptophytic and chamaephytic forest species. They do not possess many species unique for this forest type, but a large number of euryoecious ruderals. The result is the scattered spreading of *Olea europaea*-relevés in the ordination space.

The *Quercus coccifera*-subtypes have a stronger floristic similarity among themselves than the subtypes within the *Quercus suber*- respectively the *Olea europaea*-group. The reason is that some subtypes within the Cork Oak- respectively the Wild Olive-group are only negatively differentiated (by missing species), but have no taxa restricted to the group. This holds true for example for *Quercus suber*-subtype 2.3, which is mainly separated from 2.2 by a strong abundance of common therophytes.

A close relationship can be seen between landscape sections and vegetation relevés (Fig. 4 b). Such a clear pattern underlines the strong influence of the abiotic differentiation for the floristic composition of the holy forests in the study area. Substrate and climate are the main differentiating factors for the floristic composition of the forest vegetation. Landscape section A1, located on littoral sands, is floristically characterized by *Olea europaea*-groves, while sacred sites in the Prerifean foothill area with schist (D1) are characterized by *Quercus coc-*

cifera. In the sections on sandstone (C1 and C2) *Quercus suber* dominates the groves. Vegetation subtype 2.2 (typical *Quercus suber*-groves, without differential species and poor in therophytes) has been recorded in landscape sections C1, C2, D1 and E. The transitional character of section E (from *Quercus suber*-dominated groves on sandstone to *Quercus coccifera*-dominated groves on schist, underlying shallow sandstone scree) is reflected by broad spreading of the relevés from this section in the diagram.

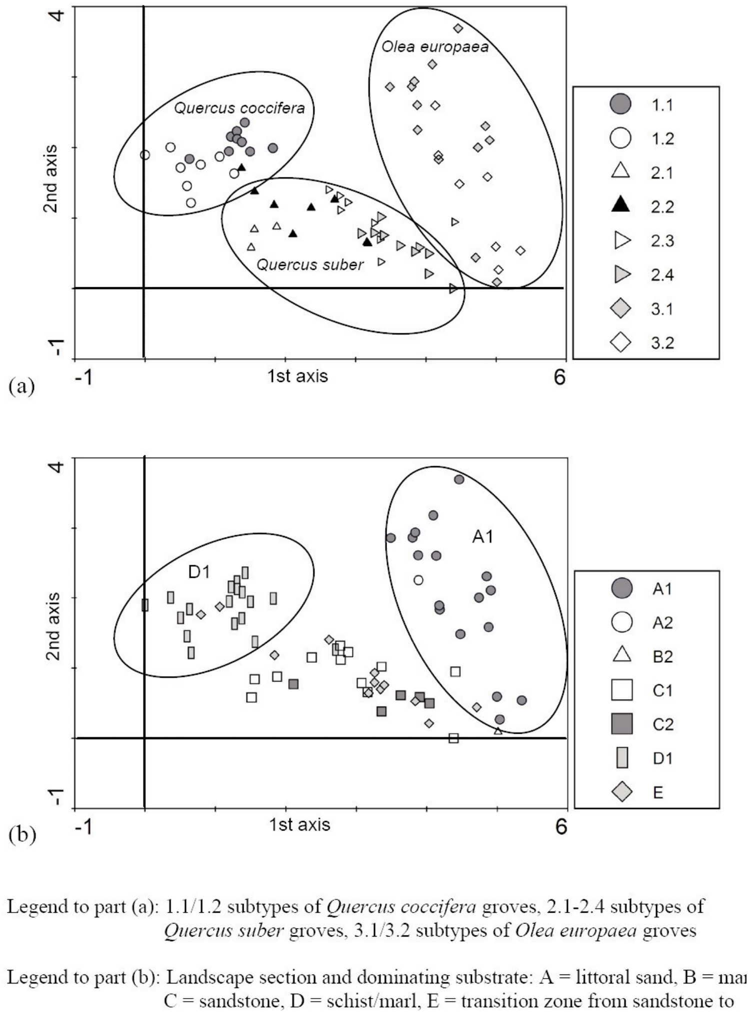

Fig. 4: Detrended correspondence analysis (DCA) showing the floristic affinity of the vegetation relevés; illustrated are vegetation types (a) and landscape sections (b) respectively

5. Discussion

Because we report here from a project which started in 2007 and is still going on, the results must be to some extent preliminary (vegetation of 61 sacred sites in 7 landscape sections analysed until now plus 12 sites without spatial extent). However the data are sufficient to answer some of the questions asked in the introduction or at least to outline some tendencies. Concerning the number, size and kind of use of the sacred sites in the study area in NW-Morocco we can state that they are very numerous (about 1920 sites in the study area = 26 sites per 100 km^2), and in reality considerably more frequent than the locations mapped as "Marabout", "Koubba" (both saint tombs) or "cemetery" on the topographic maps 1:50.000. In most cases they consist of a venerated tomb, surrounded by a cemetery, and they are small in size (average is 0.7 ha per site) even without considering the sites without spatial extension which consist only of a saint's tomb without surrounding vegetation. High density and small size of sacred sites in Morocco is also recorded by other authors. LANG (1992) estimated at least 341 sites for an area of 6.000 km^2 in the surroundings of Sidi Yahya du Gharb and Khemisset, DEMDAM et al. (2008) 308 sites for the province of Tetouan. Both numbers were taken from topographic maps 1:100.000 respectively 1:50.000. Such numbers underestimate the real number of sacred places: The coarser the map, the higher the rate of underestimation.

The sacred sites profit from a certain protection status for plants and animals living there. We can sometimes even report a total absence of any human impact except for burial activities. However it is not yet clear if this protection status derives from the "Baraka" of the Marabout or from the utilization as cemetery. In general, sacred sites around Marabouts and burial grounds are closer to climax vegetation and are less degraded than the "normal landscape". We also observed however a broad variability of anthropozoogenic impacts on such sites, ranging from total protection via grazing under a protected tree stratum to coppicing or logging or even exploitation of the tree layer (in the latter case this is done for a social benefit like restoration of the Mosque). Often the human impact results in a fine-grained mosaic of different habitats, where forests constitute only one element among others, and only 53 % of the 73 studied sites shelter a forest patch at all. The mean size of the forest patches is therefore still smaller (0.5 ha on average per site) than the total size of the sacred sites. We can state a tendency to less conserved sacred sites in lowland areas, where they are embedded into an intensely used agricultural landscape. The contrast of hemeroby between sacred sites and the surrounding landscape has still to be studied. Preliminary results are given in JÄCKLE & FROSCH (2008).

Sacred site density differs according to substrate, altitude and relief. In our study area it is higher in mid altitude and in transition zones between two geological units and low in alluvial plains and on mountain ridges. Even within the same ecoregion, spatial pattern and density are very variable. An uneven distribution is also recorded from the province of Tetouan, with a mean density of 0.2 per km^2 in the lowlands, and 0.35 in the Rif ranges (DEMDAM et al. 2008).

Clustering respectively dispersion in relation to relief features has to be analyzed in the future. A number of questions remain open for the moment: 1) Is site density correlated with population density? Is the respect vis-à-vis sacred sites different among the tribes settling in the study area? Is the conservation status better when the saints' tomb is venerated beyond the local level? What are the effects of pilgrimage activities?

Both starting hypotheses, 1) that sacred sites shelter remnants of primitive forest vegetation, and 2) that the potential natural vegetation in the study area differs according to substrate and climatic conditions, could be confirmed. As stated earlier by QUÉZEL & BARBERO (1990) and by BENABID (1991), nowadays sacred sites quite often shelter in the intensely cultivated landscapes of Morocco the only remnants of earlier widespread forest types.

Thus far 66 phytosociological relevés, sampled in holy forests, were classified according to floristic similarity. This resulted on a first level in three clusters, dominated by *Olea* *europaea* var. *sylvestris*, *Quercus suber* and *Qu. coccifera* respectively, in a second step in 8 subtypes. This classification is supported by the DCA-analysis. The three main types of sacred groves can be attributed to the following plant associations: Tamo communis-Oleetum sylvestris, Myrto communis-Quercetum suberis and Rusco hypophylli-Quercetum cocciferae (see BARBERO et al. 1981, BENABID 1984, and BENZLER et al. 1998 for more details). They belong to the Querco rotundifoliae-Oleion sylvestris (Quercetalia ilicis, Quercetea ilicis), an alliance of Westmediterranean sclerophyllous forests which constitute the prevailing climax vegetation in subhumid to humid thermomediterranean regions of NW Morocco and SW Spain (RIVAS-MARTÍNEZ et al. 2002). The spatial pattern with Wild Olive-groves in the littoral parts over base rich sands and on marl, Cork Oak-groves in mid altitude over acid sandstone, and Kermes Oak-groves on schist as bedrock reflects the catenal sequence of substrates from the Atlantic coast to the outer Rif ranges. It is in accordance with the large scale vegetation pattern in Northwestern Morocco and the bioclimatic niches of the dominating tree species (see for example SAUVAGE 1961, ACHHAL et al. 1980, BENABID 1984).

Due to the strong anthropogenic impact on vegetation and soil over millennia, well preserved stands of Querco-Oleion sylvestris-associations do occur in northern Morocco as well as in other parts of their potential distribution area exclusively in small relic stands (BENABID 1984). Some of the sacred sites' groves described here – the *Quercus coccifera*-groves and parts of the *Quercus suber*-groves – represent good examples of these forest associations, with several characteristic species of the alliance according to RIVAS-MARTÍNEZ et al. (2002) and QUÉZEL & MÉDAIL (2003), such as *Ruscus hypophyllum, Rubia peregrina, Clematis cirrhosa* or *Smilax aspera*.

A characteristic feature of intact holy forests (e.g. *Quercus coccifera*-groves) is that species which are commonly found in a shrubby form occur as trees (AJBILOU et al. 2006). This could be observed for example for *Quercus coccifera* itself, but also for *Phillyrea latifolia*, *Arbutus unedo* and *Pistacia lentiscus* (and more rarely for *Chamaerops humilis*). These woody taxa are considered as character species of the evergreen Mediterranean maquis order Pistacio lentisci-Rhamnetalia alaterni. But in undisturbed situations at least *P. latifolia* is able to compete with Kermes Oak and can be co-dominant in the higher tree layer while the others profit from gaps in the canopy.

The occurrence of the Pistacio-Rhamnetalia-species as shrubs under an Oak tree layer can indicate degradation by opening of the forest canopy as well as progressive succession after a reduced human impact. With our data set we cannot distinguish between both processes. The same holds true for *Calicotome villosa, Daphne gnidium* and *Asparagus aphyllus* in *Olea*-groves. The successional role of the light-demanding *Cistus salviifolius* and *Cistus crispus* in *Quercus suber*-groves is clearer. Both species are transgressives of acidophilous rockrose communities (Cisto-Lavanduletea), indicating disturbance by fire.

An important result of our investigations is the observation that in most cases these holy forests are not virgin forests, but subjected to human impact of different intensity. Two processes have been described for the anthropo-zoogenous transformation of Mediterranean forests, "therophytization" and "fossilization". BARBERO et al. (1990) introduced the term "forest therophytization", a form of degradation due to overgrazing. While the tree cover is still intact, the permanently high grazing pressure results in the disappearance of the shrub layer and a complete floristic modification of the forest floor. Perennial forest species are replaced by annuals. This process obviously took place in *Quercus suber*-groves of the subtypes 2.3 and 2.4 and in most of the *Olea europaea*-groves. The therophytization is indicated by the high frequency and abundance of species like *Sherardia arvensis*, *Anagallis arvensis* and *Mercurialis annua* ssp. *ambigua*. When perennial herbs occur in these heavily grazed sacred groves, they are grazing-resistant due to a basal leaf rosette (*Hypochaeris radicata*) or a thick rhizome (*Rumex pulcher* s.l.). Therophytization is often linked with nitrification and ruderalization. In the intensely cultivated lowland areas, sacred groves are often the only remaining places offering shade for shepherds and their herds. First of all in summer the animals gather on such sites. This causes a seasonal concentration of the grazing pressure on the grove as well as an accumulation of the livestock's excrements.

The permanent removal of seedlings and saplings of the tree species by browsing animals culminates with an over-aged tree layer, which has not been able to regenerate successfully over decades. QUÉZEL & MÉDAIL (2003) used the term "forêts fossils" for this kind of Mediterranean forests. In *Quercus suber*-groves of subtype 2.4 we face such a fossil forest type, but fossilization can also be claimed for a number of *Olea europaea*-groves. At the moment we can only speculate how long rejuvenation was prevented. The sampling of stem-diameter-spectra in a number of holy groves in the next phase of our project and the calibration of diameter-age-relations by the analysis of core samples should allow us to answer this question.

6. Sacred sites in Morocco in comparison to other parts of the world

Sacred sites in Morocco have some biotic characters in common with sacred sites in other areas and in other cultures. In one character (diversity of the tree layer) they are clearly different. Some features shall be briefly outlined:

1. Like in Morocco, sacred sites are numerous and small in size in many parts of the world. The number of holy forests all over the Indian subcontinent is estimated to be some hundred thousand. CAMPBELL (2005) calculates at least 1900 for Ghana; MWIKOMENKE et al. (1998) counted some hundred in a small district of Tanzania. The groves are mostly only a few hectares in size.

2. Often sacred groves are remnants of natural forests. At least in the floristic composition of the tree layer, these forests represent to some extent the potential natural vegetation. The vegetation around Shinto shrines in Japan is considered by ITOW (1991) as near to climax. Holy forests in Togo, surrounded by savanna vegetation, testify to the potential forest climax (TCHAMIE 2000), sacred groves in NE India to the subtropical broad-leaved climax forest (UPADHAYA et al. 2003). A close-to-climax situation can be stated for our study area in Northern Morocco at least for the *Quercus coccifera*-groves. To what extent *Quercus suber* was co-dominant with *Olea europaea* on certain substrats before human interventions (Oleo-Quercetum suberis as potential natural vegetation) must remain unknown at the moment. Also unclear is the potential role of *Quercus canariensis* in humid *Quercus suber* groves.

   In the highlands of Northern Gondar in Ethiopia, church yards are remnants of the former widespread afro-montane *Podocarpus-Juniperus*-forests (ALEMAYEHU WASSIE et al. 2005). Their viable populations are the only sources for regeneration and expansion of this forest type, because the woody species do not form a permanent seed bank (ALEMAYEHU WASSIE & DEMEL TEKELAY 2006). Seed bank studies are not available from sacred groves in Mediterranean countries. Like in our study site on the Tangier Peninsula, the groves in Ethiopia are distributed over a broad range of different abiotic conditions and represent very different climax situations (AERTS et al. 2006).

3. Moderate disturbance of sacred sites can result in an increase of species diversity, not only from ruderals and annuals on the forest floor like in Morocco, but also from light-demanding woody species. This was observed for example in some groves in NE India (MISHRA

et al. 2004, UPADHAYA et al. 2004). This fact is in accordance with the intermediate disturbance hypothesis of biodiversity. Closed evergreen Mediterranean forests are very dark and species poor (PIGNATTI & PIGNATTI 1984). To maintain the structural and floristic diversity on sacred sites, protection and traditional utilization need to be balanced. Since the trees on sacred sites are traditionally taboo, they are protected against cutting. Although the trees are protected, grazing in many *Olea*- and *Quercus suber*-groves is too intensive and not sustainable. These holy forests will disappear in a long-term perspective due to a lack of regeneration.

4. In comparison to sacred groves in tropical and subtropical biomes, Marabout forests in Morocco are poor in woody species. The tree layer in sacred groves in West and East Africa, SW-China and India is extremely rich. This is shown for example in studies analysing the tree and shrub layer of holy forests in different parts of India. ALEMMEREN JAMIR & PANDEY (2003) record 400 species from three sacred groves in the Himalayan foothills, many of them East-Himalayan endemics, KHUMBONGMAYUM et al. (2006) counted 96 woody species from four groves, UPADHAYA et al. (2004) 159 tree and shrub species on two sites of 2 ha size, both located in NE India. CHANDRASHEKARA & SANKAR (1998) document 73 tree species from three holy forests in the Kerala area, 13 of them endemic to the West Ghats. In Morocco, the tree layer is often a mixture of a few species or even mono-dominant, and these taxa are of circum- or Western Mediterranean distribution. The majority of rare and endemic plant species in Morocco is not linked to closed forests and sacred sites, but to extreme edaphic conditions and to open habitats (DEIL 1994, FENNANE & IBN TATOU 1998).

Concerning the legal status, socio-cultural context and the long-term conservation perspective of sacred groves, the following trends can be stated:

1. Like in many other countries (see WILY 2008 for a synopsis of Sub-Saharan Africa), sacred sites in Morocco are not protected by law. Only exceptionally, sacred sites have been included in priority programmes of nature conservation. But even without any official status, sacred sites can function to some extent like nature reserves.

2. A declining respect of the traditional taboos versus sacred sites is seen in most of the developing societies in Africa, India and SE Asia (see several contributions in SHERIDAN & NYAMWERU 2008). In Morocco, the traditional religious activities and beliefs guarantee and favour the existence of sacred groves at the moment. Their conservation in the long term however depends on trends in the society which are contradictory. On the one hand LANG (1992) states that the religious value of the saint's cult is in no way on the verge of disappearing and still plays an important role in Morocco. On the other hand, there are clear socio-cultural changes. A tendency of secularisation for example can be stated in rural as well as in urban pilgrimage places in Morocco (BERRIANE 1990, 1992, LINDNER 1999). The plant cover around Marabout sites can be deteriorated by the increasing number of participant in the pilgrimages and by the recent trend to transform them into domestic tourism events.

Acknowledgements

We first want to express our great thanks to the population of the study area and to the local authorities for allowing us to enter their sacred sites and cemeteries and for their great hospitality. We are indebted to the Moroccan administration for research permission, to Fateh Khadija for field assistance and to Dr. Randy Cassada for the linguistic correction of the text. Financial support by the German Research Foundation (DFG) and by the German Federal Ministry of Economic Cooperation and Development (BMZ) is greatly acknowledged (Az. DE 402/6-1).

Zusammenfassung

Heilige Stätten aus verschiedenen Kulturkreisen und Religionen sind seit einiger Zeit in den Fokus des Naturschutzes gerückt, da oft biotische wie auch abiotische (z.B. Quellen) Elemente einem besonderen Schutz durch die lokale Bevölkerung unterliegen und sie deshalb häufig naturnahe Waldreste enthalten. Während es aus Südostasien und Schwarzafrika zahlreiche Untersuchungen insbesondere zu Flora und Vegetation solcher Orte gibt, ist hierüber aus dem islamischen Kulturkreis nur wenig und aus Nordafrika noch weniger bekannt. Daher untersuchen wir in einem von der DFG geförderten Forschungsprojekt die Vegetation von muslimischen Heiligenstätten und Friedhöfen im ländlichen Raum auf der Halbinsel von Tanger in NW Marokko und vergleichen dies mit Heiligenwäldchen in anderen Gebieten der Erde. Wir gehen auf mehreren räumlichen Ebenen (Landschaft, Naturraum, Heiligenstätte) unterschiedlichen Aspekten wie Häufigkeit, Größe, Lage, Biotoptypen, Vegetation und Flora nach. Der Schwerpunkt der hier präsentierten ersten Ergebnisse liegt dabei auf dem Waldanteil, oft als Marabutwäldchen oder Heilige Haine bezeichnet.

Heilige Stätten sind ein häufiges Element der Kulturlandschaft in Nordmarokko. Im Schnitt trifft man auf 100 km^2 26 Heiligenstätten an. Von den im Jahr 2008 näher untersuchten 73 Lokalitäten besitzen 61 eine vegetationsbedeckte Fläche rings um das Heiligengrab, die einem Schutzstatus unterliegt. Die Flächen sind klein (Durchschnittsgröße 0,7 ha). 64 % besitzen eine Waldfläche von mindestens 500 m^2.

Die Heiligenwäldchen lassen sich vegetationskundlich drei Waldgesellschaften zuordnen, die von verschiedenen Baumarten dominiert und charakterisiert werden, namentlich von *Quercus coccifera*, *Quercus suber* bzw. *Olea europaea* var. *sylvestris*. Es hängt vor allem vom Substrat ab, welche Baumart zur Dominanz gelangt. Es zeigt sich, daß nur ein Teil der Waldbestände auf Heiligenstätten naturnahe ist. Zahlreiche heilige Stätten und Friedhöfe werden beweidet. Die drei Hauptwaldtypen lassen sich pflanzensoziologisch in acht Untertypen gliedern, die vor allem durch die Nutzungsintensität differenziert werden. Bei Beweidung verändert sich die Vegetationsstruktur (Reduktion auf zwei bis drei Schichten) und die Artenzusammensetzung. Die stenöken perennen Waldbodenarten werden von euryöken Annuellen abgelöst. Die Prozesse der Therophytisierung und Ruderalisierung finden also auch an diesen Orten statt, die gewissen religiösen Tabus unterliegen. Eine permanente Überweidung führt zunächst zur Überalterung der Baumschicht („Fossilierung“) und letztendlich – trotz des Nutzungstabus der Baumschicht – zum Verschwinden der Heiligen Haine, da keine Verjüngung der Gehölze stattfindet. Neben dieser nicht-nachhaltigen Nutzung gibt es jedoch auch gut erhaltene Bestände. Sie sind wegen ihrer Einzigartigkeit als intakte mediterrane Hartlaubwälder, wegen ihrer Repräsentativität als Klimax-nahe Vegetation und aufgrund ihrer landschaftsästhetischen Rolle unbedingt schützenswert.

References

ACHHAL, A., O. AKABALI, M. BARBERO, A. BENABID, A. M'HIRIT, C. PEYRE, P. QUÉZEL & S. RIVAS-MARTÍNEZ (1980): A propos de la valeur bioclimatique et dynamique de quelques essences forestières au Maroc. – Ecologia Mediterranea **5**: 211-249

AERTS, R., K. VAN OVERTVELD, M. HAILE, M. HERMY, J. DECKERS & B. MUYS (2006): Species composition and diversity of small Afromontane forest fragments in northern Ethiopia. – Plant Ecology **187**(1): 127-142.

AITPAEVA, G. (2006): The phenomenon of sacred sites in Kyrgyzstan: interweaving of mythology and reality. - In: SCHAAF, T. & C. LEE (eds.): Conserving cultural and biological diversity: the role of sacred natural sites and cultural landscapes: 118-123. Paris.

AJBILOU, R., T. MARAŇÓN & J. ARROYO (2003): Distribución de clases diamétricas y conservación de bosques en el norte de Marruecos. – Investigación Agraria Sistemas y Recursos Forestales **12**(2): 111-123.

AJBILOU, R., T. MARAÑÓN & J. ARROYO (2006): Ecological and biogeographical analyses of Mediterranean forests of northern Morocco. – Acta Oecologica **29**(1): 104-113.

ALEMAYEHU WASSIE, DEMEL TEKETAY & N. POWELL (2005): Church forests in North Gonder. Administrative Zone, northern Ethiopia. – Forests, Trees and Livelihoods **15**(4): 349-373.

ALEMAYEHU WASSIE & DEMEL TEKETAY (2006): Soil seed banks in church forests of northern Ethiopia: implications for the conservation of woody plants. – Flora **201**(1): 32-43.

ALEMMEREN JAMIR, S. & H.N. PANDEY (2003): Vascular plant diversity in the sacred groves of Jaintia Hills in northeast India. – Biodiversity and Conservation **12**(7):1497-1510.

ANDERSON, D.M., J. SALICK, R.K. MOSELEY & O. XIAOKUN (2005): Conserving the sacred medicine mountains: A vegetation analysis of Tibetan sacred sites in Northwest Yunnan. – Biodiversity and Conservation **14**(13): 3065-3091.

BARBERO, M., P. QUÉZEL & S. RIVAS-MARTÍNEZ (1981): Contribution à l'étude des groupements forestiers et préforestiers du Maroc. – Phytocoenologia **9**(3): 311-412.

BARBERO, M., G. BONIN, R. LOISEL & P. QUÉZEL (1990): Changes and disturbances of forest ecosystems caused by human activities in the western part of the mediterranean basin. – Vegetatio **87**(2): 151-173.

BENABID, A. (1984): Étude phytoécologique des peuplements forestiers et pré-forestiers du Rif centro-occidental (Maroc). – Travaux de l'Institut Scientifique, Série botanique **34**. 64 pp. - Rabat.

BENABID, A. (1991): La préservation de la forêt au Maroc. – In: REJDALI, M. & V.H. HEYWOOD (eds.): Conservation des ressources végétales: 97-104. Rabat.

BENZLER, A., U. DEIL & C. JUNG (1998): Eichenwälder in der Sierra del Aljibe (Andalusien) im Vergleich zu Wäldern im Westrif (Nordmarokko). – Documents phytosociologiques N.S. **18**: 1-22.

BERRIANE, M. (1990): Tourisme national et migrations de loisir au Maroc: acculturation ou évolution interne? - In: BENCHERIFA, A. & H. POPP (eds.): Le Maroc - espace et société. – Passauer Mittelmeerstudien, vol. spec. **1**: 195-214. Passau.

BERRIANE, M. (1992): Tourisme national et migrations de loisirs au Maroc (Étude géographique). – Publications de la Faculté des lettres et des sciences humaines, Série Thèses et Mémoires, **16**. 500 pp. - Rabat.

BONGERS, F., ALEMAYEHU WASSIE, F.J. STERCK, TESFAYE BEKELE & DEMEL TEKETAY (2006): Ecological restoration and church forests in northern Ethiopia. – Journal of the Drylands **1**(1): 35-44.

BOURQUIA, R. (1990): Espace physique, espace mythique. Réflexion sur la représentation de l'espace tribal chez les Zemmour. - In: BENCHERIFA, A. & H. POPP (eds.): Le Maroc - espace et société. – Passauer Mittelmeerstudien, vol. spec. **1**: 247-254. - Passau.

BRAUN-BLANQUET, J. (1964): Pflanzensoziologie. Grundzüge der Vegetationskunde. 3rd ed., 865 pp. – Wien, New York.

BRIGNON, C. & C. SAUVAGE (1962): Carte des étages bioclimatiques au 1/2.000.000. – In: Comité National de Géographie du Maroc: Atlas du Maroc. Section II, N° 6b: 6-9. - Rabat.

CAMPBELL, M.O. (2005): Sacred groves for forest conservation in Ghana's coastal savannas: assessing ecological and social dimensions. – Singapore Journal of Tropical Geography **26**(2): 151-169.

CHANDRASHEKARA, U.M. & S. SANKAR (1998): Ecology and management of sacred groves in Kerala, India. – Forest Ecology and Management **112**(1): 165-177.

DAFNI, A. (2007): The supernatural characters and powers of sacred trees in the Holy Land. – Journal of Ethnobiology and Ethnomedicine **3**(10).

DEIL, U. (1984): Zur Vegetation im Zentralen Rif (Nordmarokko) - unter besonderer Berücksichtigung der Zedernwälder und ihrer Ersatzgesellschaften. – Dissertationes Botanicae **74**. 179 pp. Vaduz.

DEIL, U. (1994): Felsgesellschaften beiderseits der Straße von Gibraltar. – Hoppea, Denkschriften der Regensburgischen Botanischen Gesellschaft **55**: 757-814.

DEIL, U. (2003): Holy forests in Northern Morocco - A Materialization of the Noosphere in the Biosphere. – Bocconea **16**(2): 897-904.

DEIL, U., H. CULMSEE & M. BERRIANE (2005): Sacred groves in Morocco - a society's conservation of nature for spiritual reasons. – Silva Carelica **49**: 185-201.

DEIL, U., H. CULMSEE & M. BERRIANE (2008): Sacred groves in Morocco - vegetation mosaic and biological values. - In: SHERIDAN, M.J. & C. NYAMWERU (eds.): African Sacred Groves: Ecological Dynamics and Social Change: 87-102. Oxford.

DEMDAM, H., L. TAÏQUI & E. SEVA (2008): Vers une base de Données Spatiales des Sites Sacrés de la Province de Tétouan (N du Maroc). Apport de la Cartographie officielle. – Mediterranea **19**(2): 9-68.

EMBERGER, L. (1939): Carte phytogéographique du Maroc 1:1,500,000. - In: EMBERGER, L.: Aperçu général sur la végétation du Maroc. –Veröffentlichungen des Geobotanischen Instituts Rübel **14**: 40-157. - Bern.

FATEH, K. (2008): Potentialités de la végétation naturelle et rôle des sites maraboutiques (Marabouts et cimetières) dans l'évaluation de l'état de la biodiversité. Cas du Nord-Ouest du Maroc. – Mémoire Troisième Cycle, I.A.V. 151 pp. Rabat.

FENNANE, M. (1988): Phytosociologie des tétraclinaies marocaines. – Bulletin de l'Institut Scientifique Rabat **12**: 99-148.

FENNANE, M. & M. IBN TATTOU (1998): Catalogue des plantes vasculaires rares, menacées ou endémiques du Maroc. – Bocconea **8**: 5-243.

GADGIL, M. & V.D. VARTAK (1976): The Sacred groves of Western Ghats in India. – Economic Botany **30**(2): 152-160.

GELLNER, E. (1969): Saints of the Atlas. 317 pp. Chicago.

GUINKO, S. (1985): Contribution à l'étude de la végétation et de la flore du Burkina Faso. Les reliques boisées ou bois sacrés. – Bois et forêts des tropiques **208**: 29-36.

HAY-EDIE, T. & M. HADLEY (1998): Natural Sacred Sites - A comparative Approach to Their Cultural and Biological Significance. - In: RAMAKRISHNAN, P.S., K.G. SAXENA & U.M. CHANDRASHEKARA (eds.): Conserving the sacred for biodiversity management: 47-67. Oxford, New Delhi.

HUGHES, J.D. & M.D.S. CHANDRAN (1998): Sacred Groves around the Earth: An Overview. - In: RAMAKRISHNAN, P.S., K.G. SAXENA & U.M. CHANDRASHEKARA (eds.): Conserving the sacred for biodiversity management: 47-67. Oxford, New Delhi.

ITOW, S. (1991): Species turnover and diversity patterns along an evergreen broadleaved forest coenocline. – Journal of Vegetation Science **2**(4): 477-484.

JÄCKLE, H. & B. FROSCH (2008): Die Bedeutung von Heiligen Hainen in Nordmarokko für die regionale Biotoptypen- und Artenvielfalt. – Treffpunkt Biologische Vielfalt **8**: 155-160.

KHUMBONGMAYUM, A.D., M.L. KHAN & R.S. TRIPATHI (2006): Biodiversity conservation in sacred groves of Manipur, northeast India: population structure and regeneration status of woody species. – Biodiversity and Conservation **15**(8): 2439-2456.

KOKOU, K. & A.D. KOKUTSE (2006): Rôle de la régénération naturelle dans la dynamique actuelle des forêts sacrées littorales du Togo. – Phytocoenologia **36**(3): 403-419.

LANG, H. (1992): Der Heiligenkult in Marokko. Formen und Funktionen der Wallfahrten. – Passauer Mittelmeerstudien **3**. 235 pp. Passau.

LINDNER, P. (1999): Lieux saints ou lieux de cures? Le processus de transformation des centres traditionels de pélerinage: cas de Sidi Hrazem et de Moulay Yacoub (Maroc). - In: BERRIANE, M. & H. POPP (eds.): Le Tourisme au Maghreb. – Publications de la Faculté des Lettres et des Sciences Humaines, Série Colloques et Seminaires **77**: 305-323. - Rabat.

LISSOVSKY, N. (2004): Sacred trees - Holy land. – Studies in the History of Gardens and Designed Landscapes **24**(1): 65-89.

LIU, H., Z. XU, Y. XU & J. WANG (2002): Practice of conserving plant diversity through traditional beliefs: a case study in Xishuangbanna, southwest China. – Biodiversity and Conservation **11**(4): 705-713.

MGUMIA, F.H. & G. OBA (2003): Potential role of sacred groves in biodiversity conservation in Tanzania. – Environmental Conservation **30**(3): 259-265.

MINISTÈRE DE L'AGRICULTURE (1965-2002): Carte du Maroc. 1 :50000.

MINISTÈRE DE L'ÉNERGIE ET DES MINES (1980): Carte géologique du Maroc: Carte géologique de la chaîne rifaine 1 :500,000. Editions du Service Géologique du Maroc. Notes et Mémoires, **245a**.

MISHRA, B.P., O.P. TRIPATHI, R.S. TRIPATHI & H.N. PANDEY (2004): Effects of anthropogenic disturbance on plant diversity and community structure of a sacred grove in Meghalaya, northeast India. – Biodiversity and Conservation **13**(2): 421-436.

MWIHOMEKE, S.T., T.H. MSANGI, C.K. MABULA, J. YLHÄISI & K.C.H. MNDEME (1998): Traditionally protected forests and nature conservation in the North Pare Mountains and Handeni district, Tansania. – Journal of East African Natural History **87**(1): 279-290.

NEUMANN, K., & P. MÜLLER-HAUDE (1999): Forêts sèches au sud-ouest du Burkina Faso: végétation - sols - action de l'homme. – Phytocoenologia **29**(1):53-85.

PIGNATTI, E. & S. PIGNATTI (1984): Sekundäre Vegetation und floristische Vielfalt im Mittelmeerraum. – Phytocoenologia **12**(2-3): 351-358.

QUÉZEL, P. & M. BARBERO (1990): Les forêts Méditerranéennes: problèmes posés par leur signification historique, écologique et leur conservation. – Acta Botanica Malacitana **15**: 145-178.

QUÉZEL, P. & F. MÉDAIL (2003): Écologie et biogéographie des forêts du bassin méditerranéen. 571 pp. Paris.

RAMAKRISHNAN, P.S. (1996): Conserving the sacred: from species to landscapes. – Nature and Resources **32**: 11-19.

RAMAKRISHNAN, P.S., K.G. SAXENA & U.M. CHANDRASHEKARA (eds.) (1998): Conserving the sacred for biodiversity management. 480 pp. Oxford, New Delhi.

RAMANUJAM, M.P. & D. KADAMBAN (2001): Plant biodiversity of two tropical dry evergreen forests in the Pondicherry region of South India and the role of belief systems in their conservation. – Biodiversity and Conservation **10**(7): 1203-1217.

RAMANUJAM, M.P. & K. PRAVEEN KUMAR CYRIL (2003): Woody species diversity of four sacred groves in the Pondicherry region of South India. – Biodiversity and Conservation **12**(2): 289-299.

RIVAS-MARTÍNEZ, S., T.E. DÍAZ, F. FERNÁNDEZ-GONZÁLEZ, J. IZCO, J. LOIDI, M. LOUSÃ & A. PENAS (2002): Vascular plant communities of Spain and Portugal. – Itinera Geobotanica **15**(2): 433-922.

SAUVAGE, C. (1961): Recherches géobotaniques sur les subéraies marocaines. – Travaux de l'Institut Scientifique Chérifien: Série botanique **21**. 462 pp. Rabat.

SCHAAF, T. & C. LEE (eds.) (2006): Conserving cultural and biological diversity: the role of sacred natural sites and cultural landscapes. –341 pp. Paris.

SHERIDAN, M.J. (2008): The dynamics of African sacred groves. Ecological, social and symbolic processes. - In: SHERIDAN, M.J. & C. NYAMWERU (eds.): African sacred groves: Ecological dynamics and social change: 9-41. Oxford.

SHERIDAN, M.J. & C. NYAMWERU (2008) (eds.): African sacred groves: Ecological dynamics and social change. 230 pp. Oxford.

TAÏQUI, L., E. SEVA, J.L. ROMÁN & A. R'HA (2005): Los bosquetes de los khaloa (morabitos) del Rif, Atlas Medio y región del Sus de Marruecos. – Ecosistemas **14**(3): 31-41.

TCHAMIÈ, T.T.K. (2000): Évolution de la flore et de la végétation des bois sacrés des massifs Kabyè et des régions environnantes (Togo). – Lejeunia **164**: 1-36.

TER BRAAK, C.J.F. & P. ŠMILAUER (2002): Canoco for Windows Version 4.5

UPADHAYA, K., H.N. PANDEY, P.S. LAW & R.S. TRIPATHI (2003): Tree diversity in sacred groves of the Jaintia hills in Meghalaya, northeast India. – Biodiversity and Conservation **12**(3): 583-597.

UPADHAYA, K., H.N. PANDEY, P.S. LAW & R.S. TRIPATHI (2004): Diversity and population characteristics of woody species in subtropical humid forests exposed to cultural disturbances in Meghalaya, Northeast, India. – Tropical Ecology **45**(2): 303-314.

VALDÉS, B., M. REJDALI, A. ACHHAL EL KADMIRI, J.L. JURY & J.M. MONTSERRAT (eds.) (2002): Catalogue des plantes vasculaires du Nord du Maroc, incluant des clés d'ídentification. Volume I and II. 913pp. – Madrid.

VERDUGO, D. & J. KADIRI FAKIR (1995): Cultural Landscapes: Maraboutic sites in Morocco. - In: VON DROSTE ZU HÜLSHOFF, B., M. RÖSSLER & H. PLACHTER (eds.): Cultural landscapes of universal value: 96-105. Jena.

WADLEY, R.L. & C.J.P. COLFER (2004): Sacred forest, hunting, and conservation in West Kalimantan, Indonesia. – Human Ecology **32**(3): 313-338.

WILY, L.A. (2008): Are sacred groves in sub-Saharan Africa safe? The legal status of forests. - In: SHERIDAN, M.J. & C. NYAMWERU (eds.): African sacred groves: Ecological dynamics and social change: 207-220. Oxford.

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