



UNIVERSITAT DE BARCELONA



Environmental Monitoring at Ħaġar Qim and Mnajdra Temples

Final Report

October 2008

Order to Start Work: 14 September, 2007

End of Contract: Autumn 2008

Contracting Authority: Department of Contracts, Malta

Consultant: Universitat de Barcelona, Spain

Project Coordinator: Dr. Antonio Gómez-Bolea, Universitat de Barcelona, Spain

Participants: Dr. Esteve Llop Vallverdú, Universitat de Barcelona, Spain

Co-workers: Dr. Isabel Alvaro Martín, Universitat de Barcelona, Spain
(Bryophytes identification)

Dr. Pere Navarro Rosinés, Universitat de Barcelona, Spain
(Lichens identification)

Contents

1. Introduction	3
2. Monitoring	4
<u>2.1. Soils</u>	4
2.1.1. Methodology	4
2.1.2. Soils of rooms	5
2.1.3. Soils on top of walls	7
2.1.4. Discussion	8
<u>2.2. Stones</u>	10
2.2.1. Methodology	10
2.2.2. Vascular plants	12
2.2.3. Biological crust colonization	13
2.2.4. Controls	13
2.2.5. Observations	14
3. Current Global Biological Diversity on Soils and Stones	15
4. Futur under Shelter conditions and recomendations	17
<u>4.1. Soils</u>	17
<u>4.2. Stones</u>	18

Appendix I Soils

Appendix II Colonization

Appendix III Controls

1. Introduction

Biomonitoring uses several kinds of organisms to evaluate changes in different sorts of situations: forest management, atmospheric pollution, biodiversity studies, etc. In each situation, it is important to determine the lapse to be studied (time) and the kind of environment, in order to select the most appropriated organism to achieve the goal.

On Neolithic Temples of Mnajdra and Hagar Qim we can found a great diversity of photoautotrophic organisms: vascular plants, bryophytes, algae, cyanoprokaryota and lichens. We can distinguish two different biotopes: soils and stones.

For biomonitoring soils (include top of walls), vascular plants, bryophytes, algae and cyanoprokaryota are the most apparent. These organisms show seasonal changes during their development and can be inconspicuous if the environmental conditions are unfavourable, for example in summer. In this period, only seeds, spores or latent propagules remain. Consequently, monitoring with this kind of communities requires seasonal information about the presence and development state of each organism, for a complete year. A complete assessment of microclimatic changes (due to the shelters membranes) on the organisms need the seasonal field studies for a complete year before (1 year) and after (1 year) installing the shelters membranes.

For biomonitoring stones, lichens are the most apparent organisms. These organisms are always present and without evident seasonal changes in their thalli. Their low rate of growth, compared with other photoautotrophic organisms, determines that their reaction to environmental changes is slower. To assess changes in lichen communities needs yearly observations.

The environmental study of the temples of Hagar Qim and Mnajdra has been carried during a year, making one survey per season: fall (1-12 November, 2007), winter (3-13 February, 2008), spring (17-27 May, 2008) and summer (17-27 August, 2008).

2. Monitoring

Monitoring of the impact of the shelter on photoautotrophic organism was carried out in two different environments:

1. On soils, where plant communities have an important role to bind and retain mineral particles.
2. On rocks, mainly occupied by lichens that, in this case, clearly protect the stone surface from atmospheric environment, and with vascular plants, bryophytes, algae and cyanoprokaryotes.

2.1. Soils

We have differentiated two sorts of soils. There is the soil on the ground of temples, with areas affected by trampling of visitors and other areas preserved of trampling by ropes. The second kind of soil refers to the soil present on the top of the main walls of both temples. This soil is stony and away of visitor trampling.

2.1.1. Methodology

The photoautotrophic organisms growing on soils were identified for each single room and top of walls for each temple every season. A list of the species found in each space was elaborated in each survey (Appendix I, p. 4-13). In addition, we selected a control area in Hagar Qim dominated by biotic crust and similar to the soil crust present in the rooms. This area, located outside the area affected by the shelter, will allow comparing changes on soils (Appendix I, p.2-3).

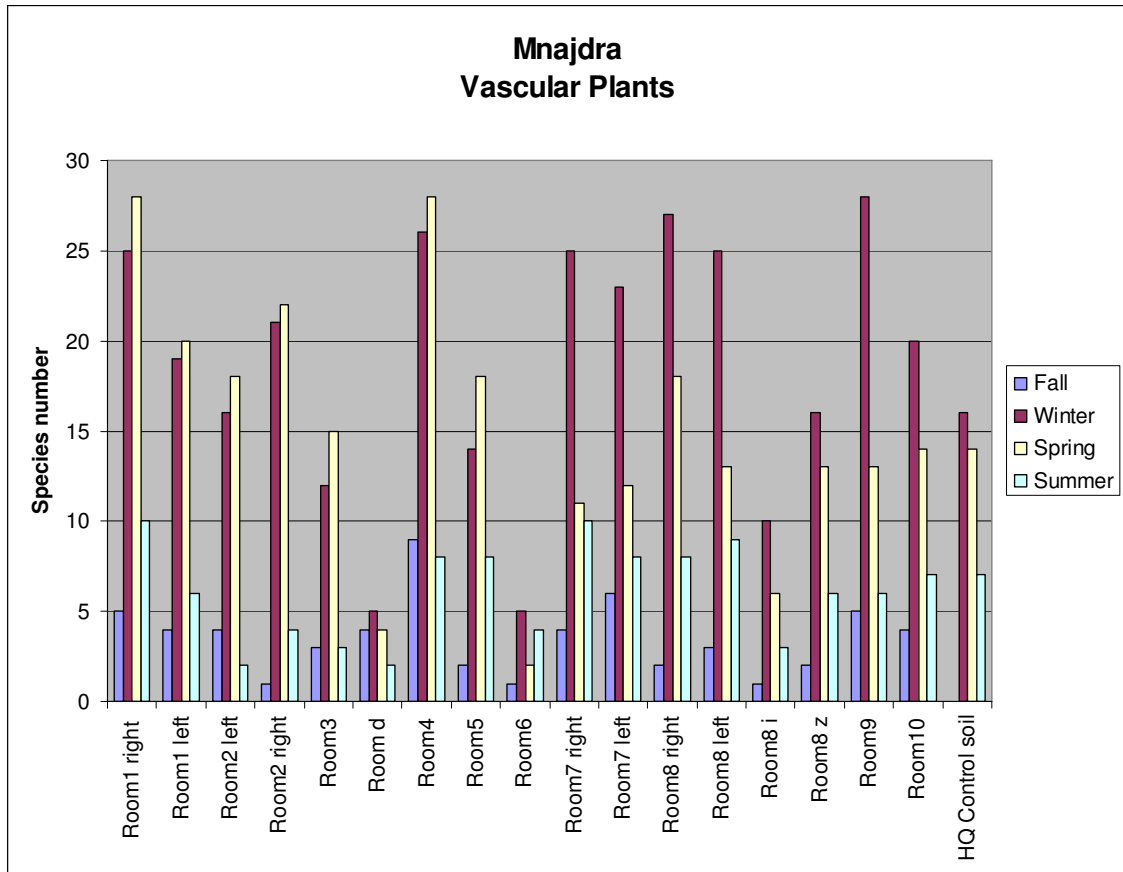
We have distinguished three communities:

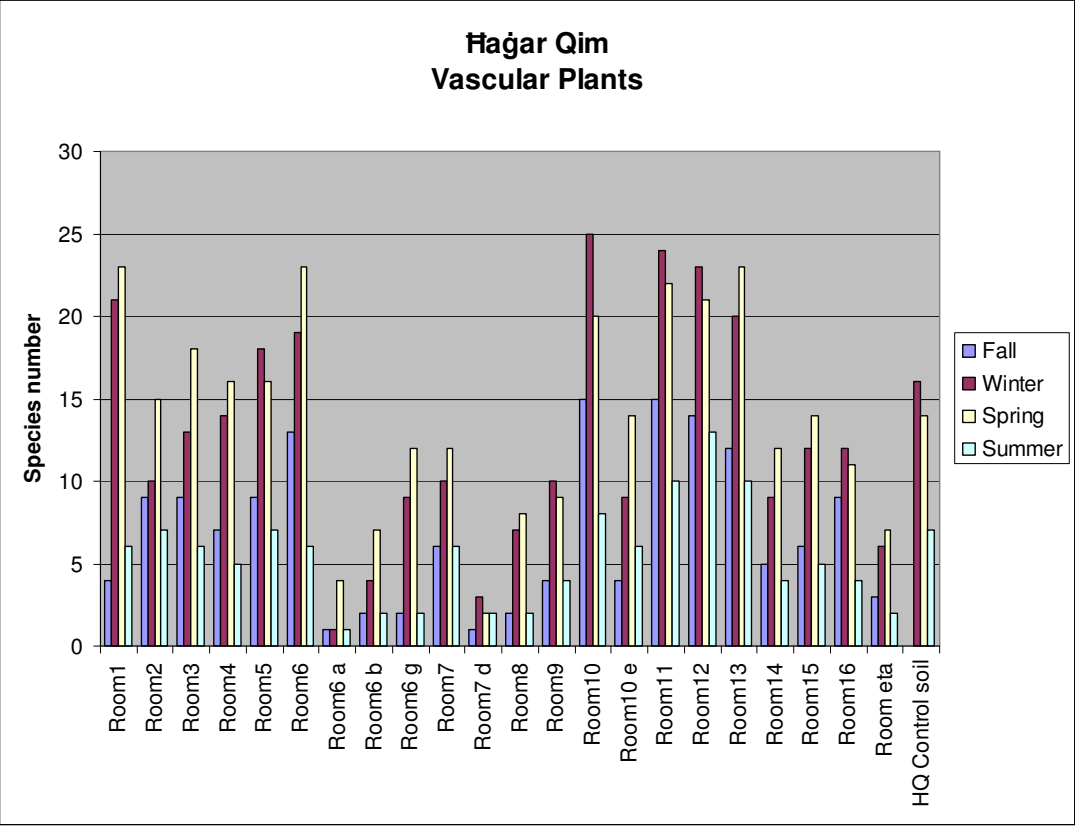
- Biotic crust: integrated by cyanoprokaryotes, lichens and bryophytes. Most of these communities are ephemeral.
- Grass: herbaceous communities dominated by graminoid plants.
- Others vascular plants: communities dominated by geophytes and hemicryptophytes.

Apart from the lists, a picture of soils from each room and top of walls was taken (Appendix I, p.24-56) and a map of plant cover of each room was elaborated at each seasonal survey (Appendix I, p.4, 14).

2.1.2. Soils of rooms

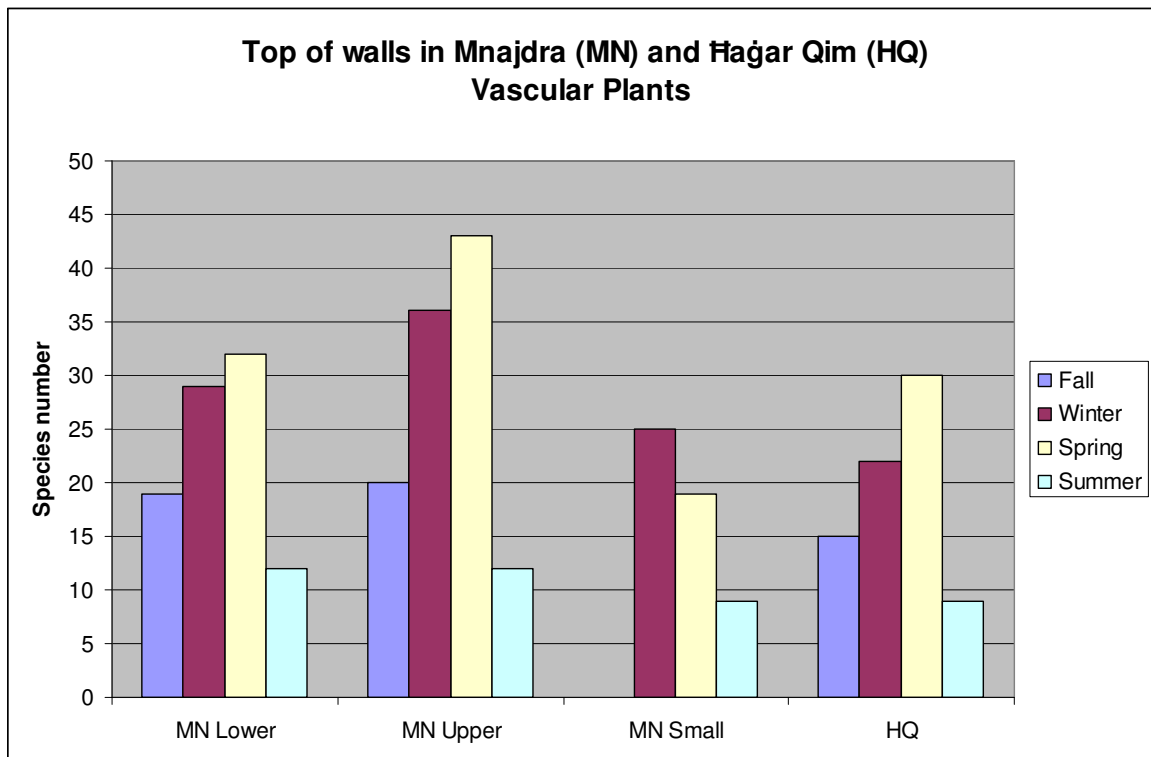
The comparison of the species richness of vascular plants on soils of the control and rooms of Mnajdra and Haġar Qim during each survey is presented in the graphs below. Because the control soil was selected during the winter survey, data from fall is not displayed.





2.1.3. Soils on top of walls

The seasonal change in species richness of vascular plants in the soils on the top of walls for both temples is compiled in the graph below. The value in fall survey for the small temple of Mnajdra could not be obtained.



2.1.4. Discussion

Soils of rooms as well as soils on top of walls show two patterns on the species richness of vascular plants. One set of soils has the maximum species richness in winter, while a second group of rooms achieves the maximum species richness during spring. Both groups have the minimum species richness during summer and fall. The group of soils showing the first pattern is formed by rooms δ , 7, 8, 9, 10, and the top of walls of the small temple in Mnajdra and rooms 5, 7 δ , 10, 11, 12 and 16 in Ħaġar Qim, including the control soil. The second pattern is observed in a greater number of rooms in both temples. The soils on top of walls from both temples also follow the second pattern, except for the small temple of Mnajdra.

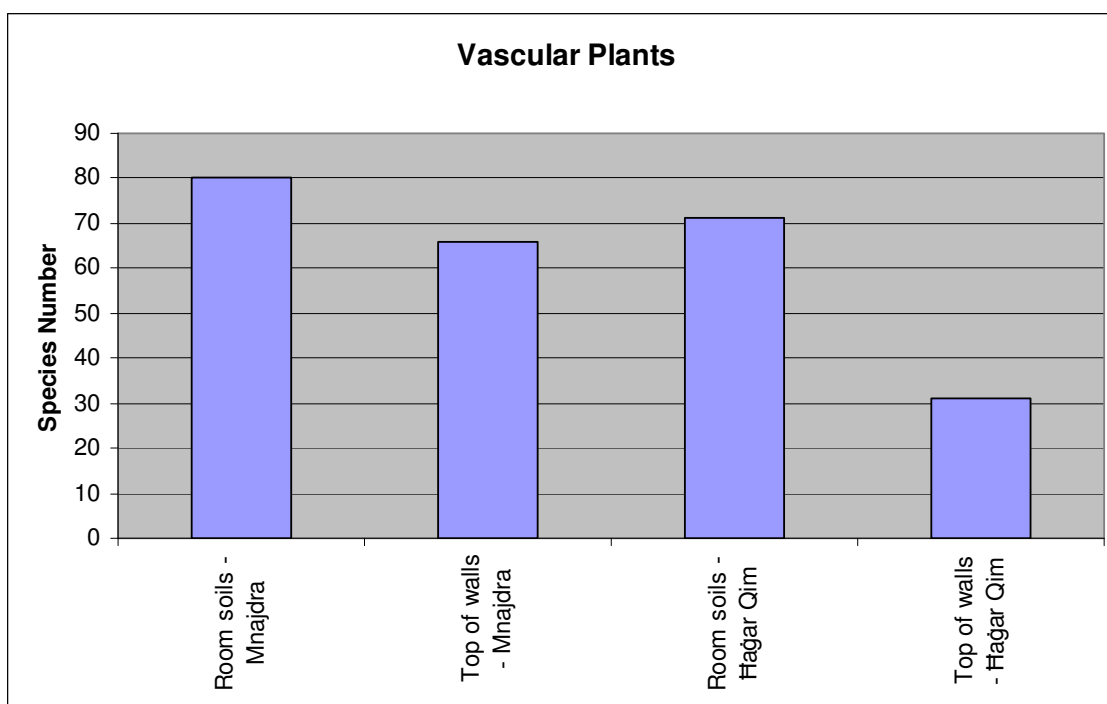
In all the soils, the maximum species richness in winter or spring correlates with a higher vegetation cover, in terms of percentage of cover, as can be evidenced from pictures included in Appendix I. The biomass of vascular plants is higher during wet seasons (winter and spring) than in dry ones (summer and fall).

The different observed patterns are associated with water available by vascular plants. Those soils with their maximum species richness in winter have a higher evaporation due to their lower walls, which allows a higher exposure to sun and wind. This lack of water is already noticeable in spring in soils following the first pattern.

The presence of well-developed biotic crust in some rooms (Mnajdra rooms 1, 3, 2, 5, 7, 8 and 9, and Ħaġar Qim rooms 2, 4, 6, 7, 10, 11, 12, 13, 14 and 15), with high diversity in bryophytes, means that soils are periodically flooded and consequently their drainage is low.

If the species richness of vascular plants is considered in absolute values, soils of Mnajdra have a higher number of species than soils of Ħaġar Qim, even when comparing room soils and soils on top of walls.

The differences in species richness between room soils and soils on top of walls are not so marked in Mnajdra, while in Ħaġar Qim they are quite obvious.



The soils on top of walls have a slightly different plant community than room soils. While room soils are predominantly occupied by annual plants, communities of soils on top of walls are mainly composed by shrubs (e.g. *Anthirrhinum siculum*, *Asparagus aphyllus*, *Capparis orientalis*, *Euphorbia melitensis*, *Phagnalon graecense*, *Prasium majus*, *Senecio bicolor* and *Thymus capitatus*), and plants bearing organs adapted to water reserve, e.g. leaves (*Sedum sediforme*, *Umbilicus rupestris*) or roots (*Foeniculum vulgare*). The abundance of perennial species reduces differences in species richness between seasons.

2.2. Stones

Lichens are the main inhabitants of stones that constitute the walls of both temples. We also find some vascular plants adapted to this environment, designated as rupicolous, mixed with lichens. Mosses use to grow in small holes and cavities of the stones. Monitoring of this environment is based on lichen communities.

2.2.1. Methodology

During each survey, we list the vascular plants growing on walls for each temple. Appendix II (p. 2-3) comprises the lists of vascular plants.

The colonization of stone walls by biological crusts has been evaluated. For both Temples, each wall was photographed. The established communities and their percentage of cover were annotated.

The identified communities have been codified (1 to 14); table 1 displays the codes. For each stone surface, the percentage of the colonized area is indicated considering four levels (0, A, B and C, see table 1 for the values for each level). Appendix II (p. 4-41) compiles the colonization of walls.

Table 1. Codes for the communities of biological crusts and percentage of covering colonization.

code	community of biological crusts
1	community of <i>Caloplaca aurantia</i>
2	community of endolithic <i>Verrucaria</i> , <i>Caloplaca</i> sp. pl. and black crust
3	community of <i>Dirina massiliensis</i>
4	community of <i>Opegrapha</i> sp. pl.
5	community of <i>Verrucaria nigrescens</i>
6	community of endolithic <i>Verrucaria</i>
7	community of <i>Lecania spadicea</i>
8	community of <i>Roccella phycopsis</i>
9	community of <i>Caloplaca variabilis</i>
10	community of endolithic <i>Caloplaca</i>
11	community of <i>Caloplaca flavescens</i>
13	black crusts
14	community of <i>Coscinocladium gaditanum</i>
#	dead lichen crust
	percentage of colonization
A	colonized surface >61 %
B	colonized surface between 26% and 60%
C	colonized surface between 5% and 25%
0	Colonization not visible (<5% of surface covered)

The monospecific community of *Roccella phycopsis*, a fruticose lichen, clearly differentiates among the remaining lichen communities, mainly constituted by endolithic or epilithic crustose lichens. From each community we have selected three samples in case some of them deteriorate accidentally.

The samples of community of *Roccella phycopsis* include three groups of thalli. Each group occupies a surface of approximately 150 cm² and a picture of each group is taken. The evaluation of the vitality of each thallus follows the next criteria:

- Good: less than a 5% of the thallus surface is altered or with necroses.
- Medium: up to 25% of thallus surface is altered or with necroses.
- Low: more than 25% of thallus surface is altered or with necroses.

The most frequent crustose communities on vertical and horizontal stones have been selected for the monitoring. For each community three squares of 15 × 10 cm has been chosen, which have been photographed using a plastic frame fastened to the stone with adhesive tape. Afterwards, all the thalli are traced on a transparency film placed over the plastic frame using a permanent felt-tip pen with a thin point. The delimitation and identification of thalli is carried out using a hand-lens with 10× or 20× magnification.



Exemple of location of monitoring

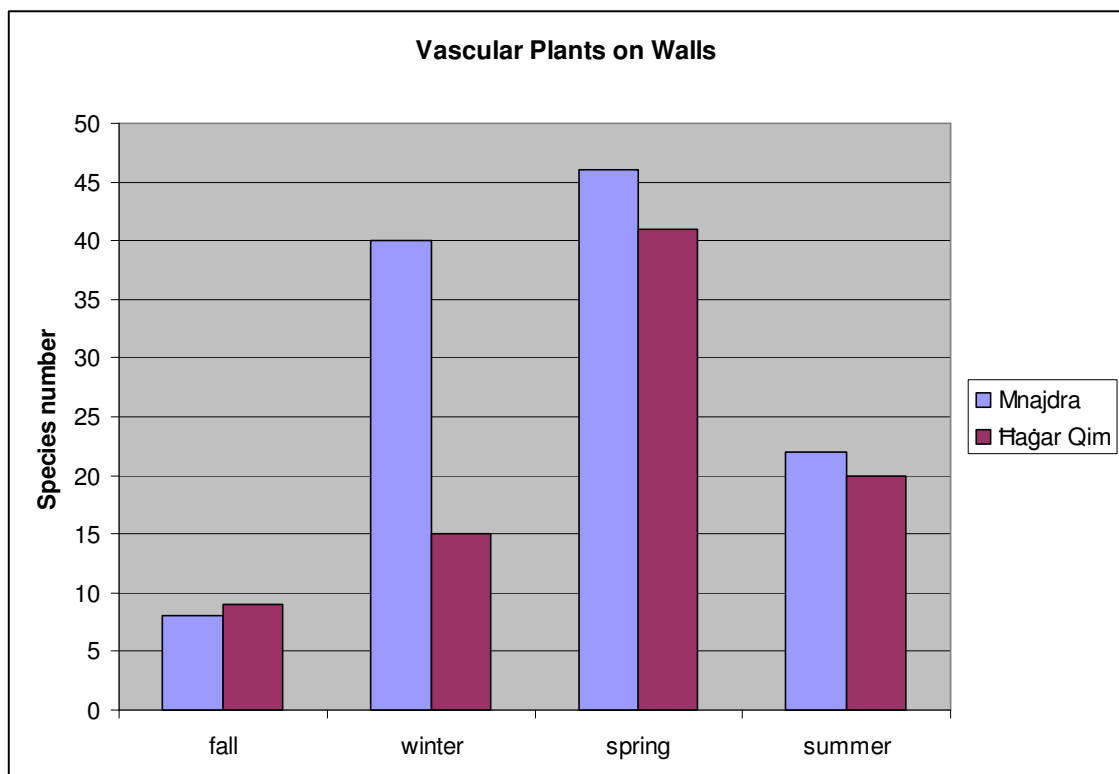
Each monitoring sample is pointed out by indicating the stone in the corresponding

temple map and giving the references of its location according to coordinates x and y (in cm) from the border of the stone to the centre of the frame (see exemple above).

Once in the lab, the draws are digitalized as JPG-files using a scanner in order to touch up pictures, when necessary, with the software Adobe Photoshop. The digitalized pictures are analyzed with ImageJ v. 1.37 to calculate the cover surface of each species. (Appendix III p. 4-45.)

2.2.2. Vascular plants

The seasonal changes on the vascular plant species richness in both temples are represented in the graph below. Appendix II (p. 2-3) compiles the lists.



The colonization in both temples by vascular plants is similar in autumn and their coverage is low. However, species richness reaches a maximum during spring, with 46 taxa in Mnajdra and 41 in Hagar Qim. While most of the plants are annual plants, there are some species like *Vitis vinifera* or *Ficus carica*, which can produce negative mechanical effects on the temples walls.

2.2.3. Biological crust colonization

Rock colonization is due to lichens, and secondarily to cyanoprokariotes or bryophytes.

In terms of conservation of stones, this colonization produces a biodeterioration of the stone. Otherwise, in situations such those affecting the temples of Mnajdra and Haġar Qim, which are exposed to harsh conditions implying a great deterioration by physical and chemical agents (e. g. wind erosion, maritime chlorides exposure, thermoclastism, etc.), the presence of bioderms plays a clear protective role. Erosion is greater and faster than biodeterioration. In those situations, bioderms, mainly composed by lichens, have a bioprotective role.

Different species constitute bioderms depending on stone exposure. The number of species is high on horizontal surfaces and low in ceilings. Species composition determines that each established community presents a different coloration. Thus, north-facing surfaces of vertical stones are predominantly grey coloured due to the presence of the community of *Dirina massiliensis*. Otherwise, on exposed horizontal surfaces orange pigmentation prevails because of the community of *Caloplaca aurantia*.

The knowledge of the current level of colonization, including the kind of community, is essential for the monitoring and for assessing changes in a futur.

2.2.4. Controls

The most abundant and characteristic communities are selected for each temple. As outer controls, existing communities have been selected closer to the main temple of Haġar Qim, which are not going to be sheltered.

We have selected six different lichen communities; three of them are present simultaneously in both temples (community of *Caloplaca aurantia*, community of *Dirina massiliensis*, and community of *Rocella phycopsis*).

Community of *Caloplaca aurantia*. This community develops on horizontal, sun exposed surfaces, where it covers almost the 100% of the surface with a predominating orange colour. The selected samples are found in Mnajdra and Haġar Qim. (Appendix III, p. 3-8, 24-26 and 37-39).

Community of *Dirina massiliensis*. This community grows on vertical, north facing

surfaces, usually covering completely the surface. The stone acquires a greyish coloration. The selected samples are found in both temples. In addition, we selected a young stage of colonization of this community in Mnajdra. (Appendix III, p. 9-11, 15-17 and 27-29).

Community of *Lecania spadicea*. The selected samples are found only in Mnajdra, where this community grows in vertical and shaded surfaces. It is composed by almost one lichen species (*Lecania spadicea*), with some mosses. The community covers quite completely the stone with a reddish brown colour. (Appendix III, p. 18-20).

Community of *Opegrapha calcarea*. This community colonizes vertical, north facing surfaces. Most of taxa are endolithic, only the blackish reproductive structures are noticeable on the rock surface. Stones do not change their colour significantly. The selected samples are from Mnajdra. (Appendix III, p. 12-14).

Community of *Roccella phycopsis*. This monospecific community develops on vertical surfaces under direct influence of sea wind, usually above 2 meters over the ground. The selected samples are found in both temples. (Appendix III, p. 21-22 and 33-35).

Community of *Verrucaria nigrescens*. The community grows on horizontal, shaded surfaces. It is composed of endolithic and epilithic species. The epilithic species has a black thallus that predominates in the colonized surfaces. The selected samples are found only in Haġar Qim. (Appendix III, p. 43-45).

2.2.5. Observations

The selected control communities have a low growth rate, therefore, no seasonal changes are observed on their cover. Otherwise, alterations on the colour are noticeable due to changes in the degree of humidity; these modifications are evident during the day as well as during the year.

Few alterations have been seen between winter and spring, on those communities growing on horizontal surfaces. These differences are due to the loss of small fragments of thalli (raindrops, particles blown by the wind, etc) or eroded lichen surfaces due to predation by snails. Noticed changes are signaled with red circles on the corresponding pictures of the Appendix III.

3. Current Global Biological Diversity on Soils and Stones

Cyanoprokaryotes

Nostoc commune

Scytonema julianum

Algae

Botrydium cystosum

Lichens

Arthonia varians on *Lecanora pruinosa*

Aspicilia calcarea

Aspicilia contorta ssp. *hoffmannii*

Botryolepraria lesdainii

Caloplaca aff. *subochracea*

Caloplaca agardhiana

Caloplaca aurantia

Caloplaca calcitrapa

Caloplaca citrina

Caloplaca flavescens

Caloplaca lactea

Caloplaca marmorata

Caloplaca navasiana

Caloplaca subochracea

Caloplaca tavaresiana

Caloplaca variabilis

Caloplaca variabilis f. *paepalostoma*

Caloplaca variabilis ssp. *ocellulata* var. *chalybaea*

Candelariella aurella

Catapyrenum rufescens

Catapyrenum squamulosum

Catillaria chalybeia

Catillaria detractula

Clauzadea metzlerii

Clauzadea monticola

Collema crispum

Collema crispum var. *graniforme*

Collema cristatum

Collema fragrans

Collema tenax var. *corallinum*

Collema tenax var. *crustaceum*

Coscinocladium gaditanum

Diploicia canescens

Diplotomma epipolium

Dirina massiliensis f. *massiliensis*

Dirina massiliensis f. *sorediata*

Lecania spadicea

Lecania turicensis

Lecanographa grumulosa

Lecanora albescens

Lecanora crenulata

Lecanora dispersa

Lecanora pruinosa

Lichenostigma elongata on *Aspicilia calcarea*

Muellerella sp. on *Aspicilia* sp.

Opegrapha calcarea

Opegrapha durieui

Opegrapha mougeotii

Opegrapha rupestris

Opegrapha saxatilis on *Verrucaria calciseda* and *Caloplaca* sp.

Opegrapha subelevata

Opegrapha variaeformis

Petractis thelotremella

Porina linearis

Psora decipiens

Psorotichia riparia

Rinodina immersa

Roccella phycopsis

Squamarina cartilaginea

Staurothele hymenogonia

Thelidium decipiens

Thelidium hospitum

Toninia aromatica

Topelia rosea

Verrucaria calciseda

Verrucaria macrostoma

Verrucaria nigrescens

Bryophytes

Aloina aloides

Bryum caespitium

Bryum donianum

Didymodon sp.

Enthostodon convexus

Fissidens bryoides

Fissidens ovatifolius

Microbryum davallianum

Tortula muralis

Trichostomum brachydontium

Weissia controversa

Vascular plants

Ajuga iva

Allium commutatum

Alyssum maritimum

Anagallis arvensis

Antirrhinum siculum

Arisarum vulgare

Asparagus aphyllus

Asphodellus aestivus

Astragalus baeticus

Atractylis gummifera

Avena barbata

Beta maritima

Blackstonia perfoliata

Borago officinalis

Brachypodium distachyon

Brassica rapa

Bromus sp.

Calendula arvensis

Campanula erinus
Capparis orientalis
Carlina involucrata
Carthamus lanatus
Catapodium rigidum
Centaurea nicaeensis
Centaureum erythraea
Chamaerops humilis
Chrysanthemum coronarium
Convolvulus althaeoides
Convolvulus arvensis
Convolvulus siculus
Conyza bonaerensis
Cynodon dactylon
Daucus carota
Diploaxis erucoides
Diploaxis tenuifolia
Echium parviflorum
Erodium malacoides
Erodium moschatum
Euphorbia helioscopia
Euphorbia melitensis
Euphorbia pinea
Euphorbia sulcata
Ficus carica
Foeniculum vulgare
Fumaria officinalis
Galactites tomentosa
Galium murale
Hedypnois cretica
Heliotropium europaeum
Hippocrepis multisiliquosa
Hirschfeldia incana
Hordeum leporinum
Hyoseris radiata
Hyparrhenia hirta
Hypericum pubescens
Hypericum triquetrifolium
Hypochaeris achyrophorus
Inula viscosa
Lactuca serriola
Lotus cytisoides
Lotus edulis
Lotus ornithopodioides
Malva sylvestris

Medicago orbicularis
Medicago polymorpha
Mercurialis annua
Narcissus serotinus
Ononis reclinata
Orobanche ramosa ssp. mutelii
Oryzopsis miliacea
Oxalis pes-caprae
Paretaria judaica
Phagnalon graecense
Phleum phleoides
Plantago lagopus
Plantago lanceolata
Poa infirma
Polycarpon tetraphyllum
Polypogon monspeliensis
Prasium majus
Psoralea bituminosa
Reichardia picroides
Reseda alba
Sagina apetala
Salvia verbenaca
Satureja microphylla
Scabiosa maritima
Scilla autumnalis
Sedum sediforme
Senecio bicolor
Senecio vulgaris
Silene colorata
Silene nocturna
Solanum nigrum
Sonchus oleraceus
Sonchus tenerrimus
Spergularia bocconeii
Stipa offneri
Thymus capitatus
Trifolium nigrescens
Trifolium stellatum
Trifolium tomentosum
Trisetum aureum
Umbilicus rupestris
Urginea pancration
Urospermum picroides
Valantia muralis
Vitis vinifera

4. Futur under Shelter conditions and recommendations

4.1. Soils

Usually, on room soils, there is a normal process of evapotranspiration of water accumulated by condensation and precipitation. The shelter will protect soils from rain, but not from condensation. Will this amount of water be enough for autotrophic organism growth? If these organisms disappear, water from soil and condensation will evaporate, and consequently, phenomena of inverse lixiviation can appear. In addition, the disappearance of vascular plants entails the loss of the rhizodermis. Rhizodermis and biological crust act as binding agents in the soil. Their loss will lead to the erosion of soil and release of mineral particles, which will incorporate in the atmosphere.

The observed soil crusts represent an inconspicuous community but very important to aggregate and structure the mineral particles. Cryptogamous plants and cyanoprokaryotes integrate these biological crusts, and they require being completely flooded temporarily. The disappearance of these crusts will lead to an unbinding of soil, which consequently will be eroded and the mineral particles will move and lose.

The release of mineral particles into an altered atmosphere, with a slowing of internal currents, could induce an increase in the deposition of dust on the walls of the temples.

Our advices are:

- Seasonal monitoring of room soils during a year after the installation of the shelter and assessment of changes.
- To do not remove vegetation of soil, in case the amount of water was enough to keep it naturally. When we need keeping room soils clean, grass mowing with a string trimmer has been shown a good method. On the other side, this procedure should avoid pulling out roots and removing plant debris. To maintain roots and plant debris will protect soils from erosion.
- To keep soil well aired, do not cover the bare soil with material that impedes good ventilation.
- To observe the lower areas of walls in order to notice accumulation of humidity from the soil, this will favour the growth of cyanoprokaryotes or even bryophytes.
- To consider the installation of a raised artificial soil that will allow a good airing of the natural soil.

The soils on top of walls will also lose the vegetation cover, likewise room soils, and consequently will be desestructured. In addition, there will be a gravimetric process where the soil particles will fall through the gaps of the wall stones.

Predominant plants growing on soils on top of walls are mainly shrubs (see p. 9) and geophytes (e.g. *Asphodelus aestivus*, *Scilla autumnalis*, *Urginea pancration*). These plants obtain and retain water more efficiently; therefore the lost of vegetation and its consequences, because of shelter, will be noticed later than on room soils.

Our suggestion is:

- Seasonal monitoring, of soils on top of walls, during a year after the installation of the shelter and assessment of changes.
- To consider using some artificial consolidative material to bind the mineral part of soil on top of walls.

4.2. Stones

Due to the desestructuration of soils and depending on internal air currents, particles deposition can happen mainly on horizontal surfaces of stones.

The support of the shelter can provide more perching areas for birds with the aesthetical effect on stones, but also as an income of nutrients for some organisms. This happens currently in some shelter areas, such those spaces in Room 6 from Hağar Qim, with scaffoldings, where birds use to perch with the consequently accumulation of excrements.

As a consequence of the presence of the shelter, deterioration of stone due to physical and chemical agents will diminish. Under these circumstances, the protective role played by biological crusts is going not to be as relevant. Consequently, biodeterioration should be more important than bioprotection.

The shelter will generate different micro environmental conditions, resulting in less variation in temperature, humidity and light. This homogenization of the microclimate will render a reduction of the community diversity, but it will not imply, necessarily, a diminution of cover. The current situation with a high coverage by several communities will undergo to a high cover also, but by few communities.

Under shelter conditions, water availability will be strongly different that in open exposition. While the shelter will intercept rainfall, there are other sources of water from the atmosphere, such as high relative humidity, dew, or fog. These sources can make

possible the growth of organisms on the stone. These changes on water availability will promote changes of saxicolous inhabitants (including photoautotrophic organisms like lichens, cyanoprokaryotes, algae, bryophytes..., and heterotrophic organisms like fungi). Communities dominated by algae or a different lichen community can displace the current lichen communities. This displacement will imply the death of the present species. The availability of organic matter will enhance the proliferation of fungi, which can black the stones temporarily. Then, new communities will occupy the free space. Depending on the amount of humidity and, specially, the persistence of the humidity throughout the day and the year, algae communities can substitute lichen communities. Light amount, reduced because of the shelter, would not act as a restricting factor for those organisms. Changes in the intensity and quality of the light go to promote changes in the specific composition of communities. These modifications will result in changes in the coloration of the stone surface.

Air temperature will be higher after the shelter installation, as reported by a previous Environmental Monitoring. Consequently, water retention of atmosphere will increase. The numerous atmospheric variables (temperature of the air, temperature on the rock surface, atmospheric humidity, dew, fog, wind, etc.) and their variations, generate a matrix of several microclimatic possibilities. Facing with so many possibilities and the lack of specific data, is impossible for us to make a trustworthy prediction.

Any scenario will entail changes in the lichen communities that will modify the colouring of stone surfaces, mainly those with a high lichen cover. These changes will take place in a longer term than those due to the disappearance of vascular plants.

Our suggestion is:

- Yearly monitoring of walls after the installation of the shelter, repeating the data on colonization and control samples



Environmental Monitoring at Haġar Qim and Mnajdra Temples

Final Report

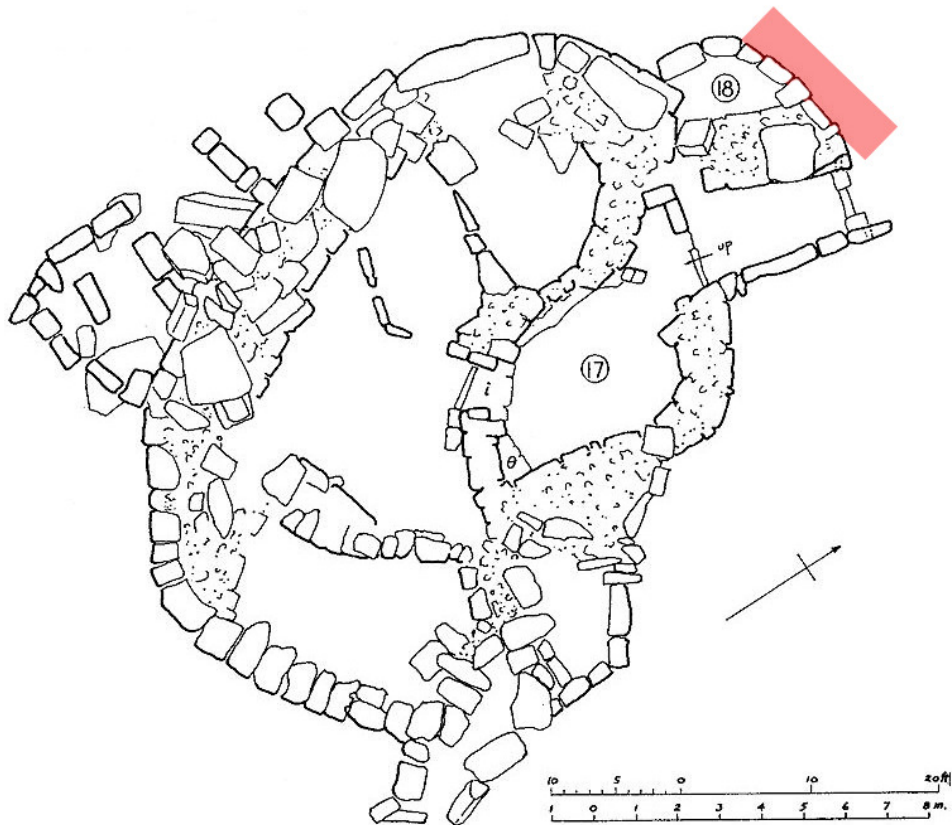
October 2008

Appendix I Soils

Contents

1. Control soil -----	2
2. Soils from Mnajdra -----	4
2.1. Room soils -----	4
2.2. Soils on top of walls-----	12
3. Soils from Haġar Qim -----	15
3.1. Room soils -----	15
3.2. Soils on top of walls -----	24
4. Compared Pictures of Mnajdra -----	25
4.1. Room soils -----	25
4.2. Soils on top of walls -----	31
5. Compared Pictures of Haġar Qim -----	40
5.1. Room soils -----	40
5.2. Soils on top of walls-----	53

1. Control soil



Location of control soil in Hagar Qim, which will remain unsheltered.



Detail of biological crust on control soil in Hagar Qim.

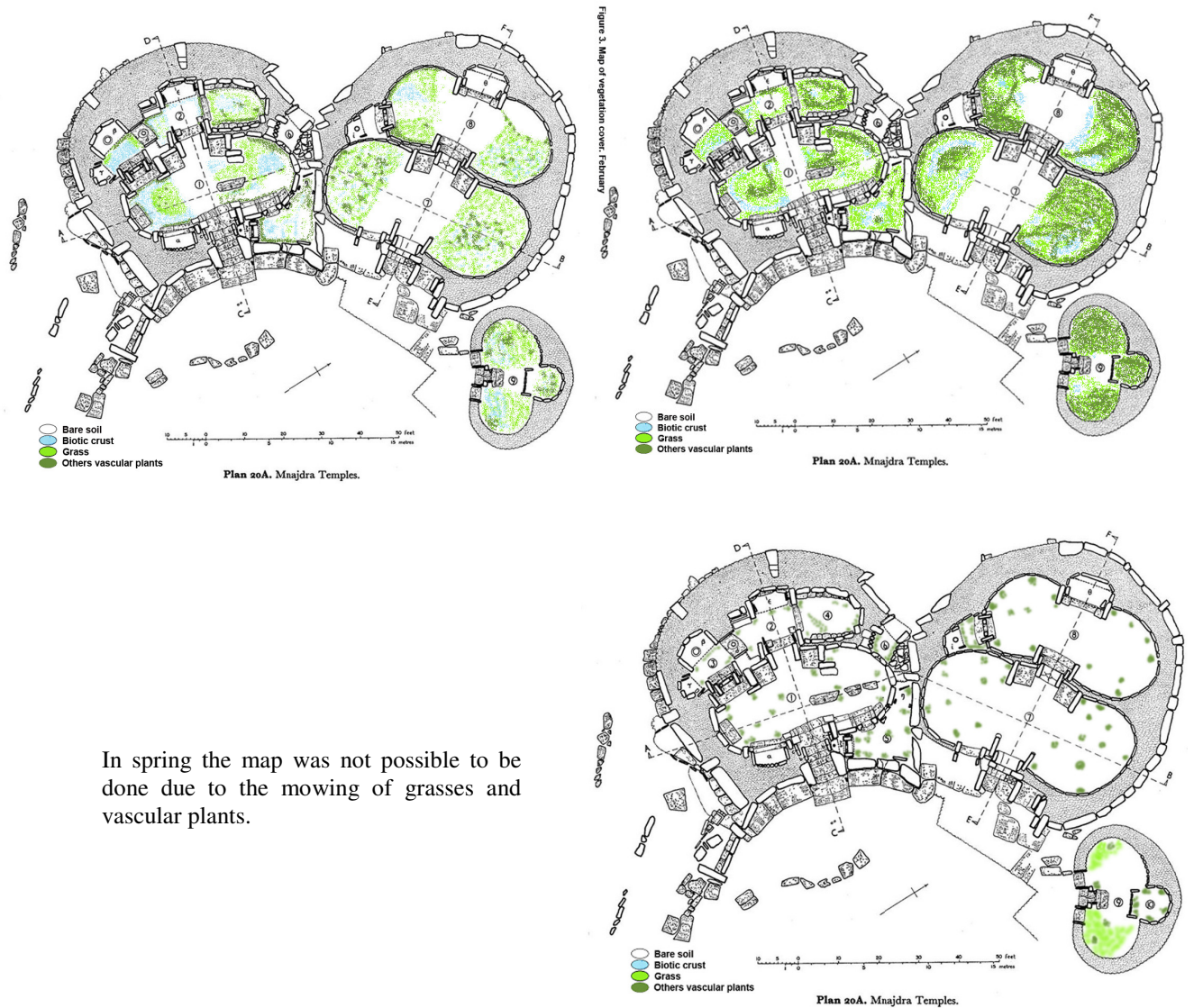
Species list from the control soil in Haġar Qim (f = fall, w = winter, sp = spring, su = summer)

Taxon	f	w	sp	su
<u>Lichens</u>				
<i>Collema</i> sp.		x	x	
<u>Bryophytes</u>				
<i>Aloina aloides</i>		x	x	x
<i>Fossombronia</i> sp.		x		
Pottiales		x	x	x
<i>Sphaerocarpos</i> sp.		x		
<u>Vascular plants</u>				
<i>Ajuga iva</i>			x	x
<i>Alyssum maritimum</i>		x		x
<i>Asparagus aphyllus</i>				x
Asteraceae		x		
<i>Campanula erinus</i>			x	
<i>Catapodium rigidum</i>			x	
<i>Centaureum erythraea</i>			x	
<i>Convolvulus althaeoides</i>		x	x	x

<i>Conyza bonaerensis</i>		x		
<i>Daucus carota</i>		x		
<i>Echium parviflorum</i>			x	
<i>Erodium malacoides</i>		x		
<i>Galium murale</i>		x	x	
<i>Hordeum leporinum</i>		x	x	
<i>Hyoseris radiata</i>			x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Oryzopsis miliacea</i>		x		x
<i>Oxalis pes-caprae</i>		x		
<i>Parietaria judaica</i>		x	x	x
<i>Phleum phleoides</i>		x	x	
<i>Poa infirma</i>		x		
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>		x		
<i>Senecio bicolor</i>				x
<i>Sonchus oleraceus</i>		x		
<i>Spergularia bocconeii</i>		x	x	

2. Soils from Mnajdra

2.1. Room soils



Maps of vegetation cover in autumn (up left), winter (up right) and summer (down right).

Lists of photoautotrophic organisms from the rooms (f = fall, w = winter, sp = spring, su = summer)

Room 1, right side

	f	w	sp	su
<u>Cyanoprokaryotes</u>				
<i>Nostoc commune</i>	x			
<u>Bryophytes</u>				
<i>Riccia</i> sp.	x	x		
<u>Vascular plants</u>				
<i>Ajuga iva</i>				x
<i>Alyssum maritimum</i>	x	x	x	x
<i>Arisarum vulgare</i>	x	x		
<i>Avena barbata</i>			x	
<i>Beta maritima</i>			x	
<i>Bromus</i> sp.		x	x	
<i>Chrysanthemum coronarium</i>		x		
<i>Centaurea nicaeensis</i>			x	
<i>Conyza bonaerensis</i>		x		
<i>Daucus carota</i>			x	
<i>Diplotaxis eruroides</i>		x	x	
<i>Echium parviflorum</i>		x	x	
<i>Erodium moschatum</i>		x	x	
<i>Euphorbia sulcata</i>		x		
<i>Foeniculum vulgare</i>	x	x	x	x
<i>Galactites tomentosa</i>		x		
<i>Galium murale</i>		x	x	
<i>Hordeum leporinum</i>			x	
<i>Hyoseris radiata</i>			x	
<i>Hypericum triquetrifolium</i>			x	x
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus ornithopodioides</i>		x		
<i>Medicago polymorpha</i>		x	x	
<i>Oryzopsis miliacea</i>				x
<i>Parietaria judaica</i>		x	x	x
<i>Phagnalon graecense</i>				x
<i>Plantago lanceolata</i>		x	x	x
<i>Polycarpon tetraphyllum</i>			x	
<i>Polypogon monspeliensis</i>			x	
<i>Prasium majus</i>			x	
<i>Psoralea bituminosa</i>		x	x	x
<i>Reichardia picroides</i>	x	x	x	x
<i>Reseda alba</i>		x	x	

<i>Sagina apetala</i>		x		
<i>Senecio vulgaris</i>		x		
<i>Sonchus oleraceus</i>	x	x		
<i>Stipa offneri</i>			x	
<i>Trifolium stellatum</i>		x	x	
<i>Trifolium tomentosum</i>		x	x	
<i>Urospermum picroides</i>		x	x	

Room 1, left side

	f	w	sp	su
Algae				
algae		x		
<u>Bryophytes</u>				
<i>Sphaerocarpos</i> sp.		x		
<u>Vascular plants</u>				
<i>Alyssum maritimum</i>		x		
<i>Arisarum vulgare</i>	x	x		
Asteraceae		x		
<i>Borago officinalis</i>		x		
<i>Brassica rapa</i>		x		
<i>Bromus</i> sp.			x	
<i>Catapodium rigidum</i>			x	
<i>Centaurea erythraea</i>			x	
<i>Convolvulus althaeoides</i>			x	
<i>Diplotaxis tenuifolia</i>		x		
<i>Euphorbia sulcata</i>		x		
<i>Fumaria officinalis</i>		x		
<i>Galactites tomentosa</i>		x		
<i>Galium murale</i>		x	x	
<i>Hordeum leporinum</i>			x	
<i>Hyoseris radiata</i>			x	
<i>Hypericum triquetrifolium</i>			x	x
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus ornithopodioides</i>			x	
<i>Malva sylvestris</i>			x	
<i>Medicago polymorpha</i>		x		
<i>Oryzopsis miliacea</i>		x	x	x
<i>Oxalis pes-caprae</i>		x		
<i>Parietaria judaica</i>		x	x	x
<i>Phleum phleoides</i>			x	
<i>Plantago lanceolata</i>			x	

<i>Poa infirma</i>	x	x	
<i>Polycarpon tetraphyllum</i>		x	
<i>Polypogon monspeliensis</i>		x	
<i>Reichardia picroides</i>	x	x	x
<i>Sagina apetala</i>	x		
<i>Senecio vulgaris</i>	x		
<i>Solanum nigrum</i>	x		
<i>Sonchus oleraceus</i>	x	x	
<i>Spergularia bocconeii</i>		x	
<i>Trifolium sp.</i>	x		
<i>Trisetum aureum</i>		x	

Room 2, left side

	f	w	sp	su
<u>Lichens</u>				
<i>Nostoc commune</i>	x			
<u>Bryophytes</u>				
<i>Anthoceros laevis</i>		x		
<i>Fissidens sp.</i>		x		
<i>Pottiales</i>		x		
<u>Vascular plants</u>				
<i>Alyssum maritimum</i>		x		
<i>Anagallis arvensis</i>			x	
<i>Arisarum vulgare</i>	x	x		
<i>Avena barbata</i>			x	
<i>Borago officinalis</i>		x		
<i>Bromus sp.</i>		x		
<i>Catapodium rigidum</i>			x	
<i>Centaurium erythraea</i>			x	
<i>Convolvulus althaeoides</i>			x	x
<i>Conyza bonariensis</i>	x	x		
<i>Euphorbia sulcata</i>		x		
<i>Fumaria officinalis</i>		x		
<i>Galactites tomentosa</i>		x		
<i>Galium murale</i>		x	x	
<i>Hordeum leporinum</i>			x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Medicago polymorpha</i>		x	x	
<i>Oxalis pes-caprae</i>		x		
<i>Parietaria judaica</i>	x	x	x	x
<i>Phleum phleoides</i>			x	
<i>Poa infirma</i>		x	x	
<i>Polycarpon tetraphyllum</i>			x	

<i>Polypogon monspeliensis</i>		x	
<i>Reichardia picroides</i>		x	
<i>Sagina apetala</i>	x		
<i>Silene nocturna</i>		x	
<i>Sonchus oleraceus</i>	x	x	x
<i>Trifolium stellatum</i>		x	x

Room 2, right side

	f	w	sp	su
Algae				
<i>Botrydium cystosum</i>		x		
<u>Bryophytes</u>				
<i>Sphaerocarpos sp.</i>		x		
<u>Vascular plants</u>				
<i>Alyssum maritimum</i>		x		
<i>Arisarum vulgare</i>	x	x		
<i>Asteraceae</i>		x		
<i>Borago officinalis</i>		x		
<i>Brassica rapa</i>		x		
<i>Bromus sp.</i>			x	
<i>Catapodium rigidum</i>			x	
<i>Centaurium erythraea</i>			x	
<i>Convolvulus althaeoides</i>			x	
<i>Diplotaxis tenuifolia</i>		x		
<i>Euphorbia sulcata</i>		x		
<i>Fumaria officinalis</i>		x		
<i>Galactites tomentosa</i>		x		
<i>Galium murale</i>		x	x	
<i>Hordeum leporinum</i>			x	
<i>Hyoseris radiata</i>			x	
<i>Hypericum triquetrifolium</i>			x	x
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus ornithopodioides</i>			x	
<i>Malva sylvestris</i>			x	
<i>Medicago polymorpha</i>		x		
<i>Oryzopsis miliacea</i>		x	x	x
<i>Oxalis pes-caprae</i>		x		
<i>Parietaria judaica</i>		x	x	x
<i>Phleum phleoides</i>			x	
<i>Plantago lanceolata</i>			x	
<i>Poa infirma</i>		x	x	
<i>Polycarpon tetraphyllum</i>			x	
<i>Polypogon monspeliensis</i>			x	

<i>Reichardia picroides</i>	x	x	x
<i>Sagina apetala</i>	x		
<i>Senecio vulgaris</i>	x		
<i>Solanum nigrum</i>	x		
<i>Sonchus oleraceus</i>	x	x	
<i>Spergularia bocconeii</i>		x	
<i>Trifolium sp.</i>	x		
<i>Trisetum aureum</i>		x	

Room 3

	f	w	sp	su
<u>Cyanoprokaryotes</u>				
<i>Nostoc commune</i>	x			
<i>Scytonema julianum</i>	x			
<u>Algae</u>				
algae	x			
<u>Bryophytes</u>				
<i>Anthoceros laevis</i>	x			
<i>Enthostodon convexus</i>	x	x		
<i>Fissidens bryoides</i>	x	x		
<i>Fissidens ovatifolius</i>	x	x		
<i>Fossombronina sp.</i>	x			
<i>Sphaerocarpos sp.</i>	x			
<u>Vascular Plants</u>				
<i>Alyssum maritimum</i>	x	x	x	x
<i>Arisarum vulgare</i>	x	x		
<i>Avena barbata</i>			x	
<i>Bryum sp.</i>	x	x		
<i>Campanula erinus</i>			x	
<i>Caryophyllaceae</i>	x			
<i>Catapodium rigidum</i>			x	
<i>Centaureum erythraea</i>			x	
<i>Euphorbia sulcata</i>	x			
<i>Galactites tomentosa</i>	x			
<i>Galium murale</i>	x	x		
<i>Hordeum leporinum</i>			x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Oryzopsis miliacea</i>	x			
<i>Oxalis pes-caprae</i>	x	x		
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>	x			
<i>Polycarpon tetraphyllum</i>			x	
<i>Polypogon monspeliensis</i>			x	

<i>Reichardia picroides</i>		x	x
<i>Senecio vulgaris</i>	x		
<i>Sonchus oleraceus</i>		x	
<i>Trifolium sp.</i>	x		
<i>Trisetum aureum</i>		x	

Room δ (between rooms 2 & 3)

	f	w	sp	su
<u>Vascular Plants</u>				
<i>Alyssum maritimum</i>	x	x		
<i>Asphodelus aestivus</i>	x	x		
<i>Conyza bonaerensis</i>				x
<i>Euphorbia melitensis</i>	x	x		
<i>Hordeum leporinum</i>			x	
<i>Parietaria judaica</i>		x	x	x
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>	x	x	x	

Room 4

	f	w	sp	su
<u>Lichens</u>				
<i>Collema sp.</i>	x	x		
<u>Vascular Plants</u>				
<i>Alyssum maritimum</i>	x	x	x	x
<i>Anagallis arvensis</i>		x		
<i>Antirrhinum siculum</i>		x	x	
<i>Arisarum vulgare</i>	x	x		
<i>Asparagus aphyllus</i>	x	x		x
<i>Avena barbata</i>			x	
<i>Borago officinalis</i>		x		
<i>Bromus sp.</i>		x	x	
<i>Campanula erinus</i>			x	
<i>Centaureum erythraea</i>			x	
<i>Chrysanthemum coronarium</i>		x		
<i>Convolvulus althaeoides</i>		x	x	x
<i>Conyza bonaerensis</i>	x	x		
<i>Daucus carota</i>		x	x	x
<i>Diplotaxis tenuifolia</i>	x	x		
<i>Echium parviflorum</i>		x		
<i>Erodium malacoides</i>			x	
<i>Euphorbia sulcata</i>		x		
<i>Galactites tomentosa</i>		x		
<i>Galium murale</i>		x	x	
<i>Hordeum leporinum</i>			x	

<i>Hyoseris radiata</i>			x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus edulis</i>			x	
<i>Malva sylvestris</i>		x	x	
<i>Medicago polymorpha</i>		x	x	
<i>Oryzopsis miliacea</i>		x		
<i>Oxalis pes-caprae</i>	x	x	x	
<i>Parietaria judaica</i>			x	x
<i>Plantago lanceolata</i>			x	
<i>Poa infirma</i>		x	x	
<i>Polycarpon tetraphyllum</i>			x	
<i>Reichardia picroides</i>	x	x	x	x
<i>Reseda alba</i>			x	
<i>Solanum nigrum</i>		x	x	x
<i>Sonchus oleraceus</i>	x	x	x	x
<i>Stipa offneri</i>			x	
<i>Trifolium sp.</i>		x		
<i>Trisetum aureum</i>			x	
<i>Urospermum picroides</i>			x	

Room 5

	f	w	sp	su
<u>Cyanoprokaryotes</u>				
<i>Nostoc commune</i>	x			
<u>Lichens</u>				
<i>Collema sp.</i>		x		
<u>Bryophytes</u>				
<i>Fissidens sp.</i>		x		
<i>Fossombronia sp.</i>	x	x		
Pottiales		x	x	x
<i>Riccia sp. 2</i>	x	x		
<i>Sphaerocarpos sp.</i>		x		
<u>Vascular Plants</u>				
<i>Alyssum maritimum</i>	x	x	x	x
<i>Antirrhinum siculum</i>			x	x
<i>Atractylis gummifera</i>		x	x	
<i>Bromus sp.</i>		x	x	
<i>Campanula erinus</i>			x	
<i>Centaureum erythraea</i>			x	
<i>Conyza bonaerensis</i>		x		x
<i>Daucus carota</i>		x	x	x
<i>Echium parviflorum</i>			x	
<i>Galactites tomentosa</i>		x		

<i>Galium murale</i>		x	x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus ornithopodoides</i>		x	x	
<i>Medicago polymorpha</i>			x	
<i>Oryzopsis miliacea</i>		x	x	x
<i>Parietaria judaica</i>	x	x	x	x
<i>Phleum phleoides</i>			x	
<i>Poa infirma</i>		x		
<i>Polycarpon tetraphyllum</i>			x	
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>				x
<i>Satureja microphylla</i>		x	x	x
<i>Senecio vulgaris</i>		x		
<i>Sonchus oleraceus</i>		x	x	

Room 6

	f	w	sp	su
<u>Vascular Plants</u>				
<i>Alyssum maritimum</i>		x		x
<i>Asparagus aphyllus</i>				x
<i>Daucus carota</i>		x		x
<i>Galium murale</i>		x		
<i>Parietaria judaica</i>	x	x	x	x
<i>Polycarpon tetraphyllum</i>			x	
<i>Sonchus oleraceus</i>		x		

Room 7 right side

	f	w	sp	su
<u>Lichens</u>				
<i>Collema sp.</i>			x	x
Cyanolichen		x		
<u>Bryophytes</u>				
<i>Fossombronia sp.</i>		x	x	
Pottiales			x	x
<i>Riccia sp. pl.</i>		x	x	
<u>Vascular Plants</u>				
<i>Alyssum maritimum</i>		x	x	
<i>Astragalus baeticus</i>			x	
<i>Avena barbata</i>			x	x
<i>Beta maritima</i>			x	x
<i>Bromus sp.</i>			x	x
<i>Calendula sp.</i>				x
<i>Carlina involucrata</i>				x
<i>Chrysanthemum coronarium</i>		x		

<i>Convolvulus althaeoides</i>		x		x
<i>Conyza bonaerensis</i>		x		
<i>Daucus carota</i>		x	x	x
<i>Diplotaxis erucoides</i>	x	x		
<i>Diplotaxis tenuifolia</i>	x	x	x	x
<i>Echium parviflorum</i>		x		
<i>Euphorbia sulcata</i>		x		
<i>Foeniculum vulgare</i>				x
<i>Galium murale</i>		x		
<i>Lotus ornithopodioides</i>		x		
<i>Medicago polymorpha</i>		x	x	
<i>Mercurialis annua</i>		x		
<i>Oxalis pes-caprae</i>	x	x		
<i>Parietaria judaica</i>			x	x
<i>Poa infirma</i>		x		
<i>Psoralea bituminosa</i>		x	x	x
<i>Reichardia picroides</i>		x	x	x
<i>Reseda alba</i>		x		
<i>Satureja microphylla</i>		x	x	x
<i>Senecio vulgaris</i>		x		
<i>Sonchus oleraceus</i>		x		

Room 7, left side

	f	w	sp	su
<u>Lichens</u>				
<i>Collema</i> sp.	x	x	x	
<i>Cyanolichen</i>	x	x		
<u>Bryophytes</u>				
<i>Fossombronia</i> sp. 1	x	x		
<i>Pottiales</i>		x	x	x
<i>Riccia</i> sp. pl.	x	x		
<i>Sphaerocarpos</i> sp.		x		
<u>Vascular Plants</u>				
<i>Alyssum maritimum</i>	x	x		
<i>Antirrhinum siculum</i>		x		
<i>Arisarum vulgare</i>		x		
<i>Astragalus baeticus</i>		x		
<i>Beta maritima</i>		x		
<i>Bromus</i> sp.		x	x	
<i>Carlina involucrata</i>				x
<i>Daucus carota</i>	x	x	x	x
<i>Diplotaxis tenuifolia</i>	x	x	x	x
<i>Echium parviflorum</i>		x		

<i>Euphorbia sulcata</i>		x		
<i>Foeniculum vulgare</i>		x		x
<i>Galactites tomentosa</i>		x		
<i>Galium murale</i>		x		
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus ornithopodioides</i>		x	x	
<i>Medicago polymorpha</i>		x		
<i>Oxalis pes-caprae</i>	x	x		
<i>Parietaria judaica</i>	x	x	x	x
<i>Polypogon monspeliensis</i>			x	
<i>Psoralea bituminosa</i>		x	x	x
<i>Reichardia picroides</i>		x	x	x
<i>Reseda alba</i>		x		
<i>Satureja microphylla</i>		x	x	x
<i>Senecio vulgaris</i>		x		
<i>Sonchus oleraceus</i>	x	x		
<i>Spergularia bocconeii</i>			x	
<i>Trisetum aureum</i>			x	

Room 8, right side

	f	w	sp	su
<u>Lichens</u>				
<i>Catapyrenium</i> sp.		x	x	
<i>Collema</i> sp.		x	x	
<u>Bryophytes</u>				
<i>Aloina aloides</i>	x	x	x	x
<i>Fossombronia</i> sp.		x		
<i>Microbryum davallianum</i>	x	x	x	x
<i>Petalophyllum ralfsii</i>		x		
<u>Vascular plants</u>				
<i>Alyssum maritimum</i>		x	x	
<i>Antirrhinum siculum</i>		x		
<i>Astragalus baeticus</i>		x		
<i>Avena barbata</i>			x	
<i>Beta maritima</i>		x	x	x
<i>Bromus</i> sp.		x	x	
<i>Calendula arvensis</i>		x		
<i>Catapodium rigidum</i>			x	
<i>Chrysanthemum coronarium</i>		x		
<i>Convolvulus althaeoides</i>		x	x	x
<i>Daucus carota</i>		x	x	
<i>Diplotaxis tenuifolia</i>	x	x	x	x
<i>Echium parviflorum</i>		x		

<i>Erodium malacoides</i>	x		
<i>Euphorbia sulcata</i>	x		
<i>Foeniculum vulgare</i>	x		x
<i>Galium murale</i>	x		
<i>Hordeum leporinum</i>		x	
<i>Hypochaeris achyrophorus</i>		x	
<i>Lotus edulis</i>		x	
<i>Medicago polymorpha</i>	x		
<i>Mercurialis annua</i>	x		
<i>Oxalis pes-caprae</i>	x	x	
<i>Parietaria judaica</i>		x	x
<i>Poa infirma</i>	x		
<i>Polypogon monspeliensis</i>		x	
<i>Psoralea bituminosa</i>	x	x	x
<i>Reichardia picroides</i>	x	x	x
<i>Reseda alba</i>	x		
<i>Senecio vulgaris</i>	x		
<i>Sonchus oleraceus</i>	x	x	x

Room 8 left side

	f	w	sp	su
<u>Cyanoprokaryotes</u>				
<i>Nostoc commune</i>		x		
<u>Lichens</u>				
<i>Collema</i> sp.	x	x	x	
<u>Bryophytes</u>				
<i>Fossombronina</i> sp. 1	x	x		
Pottiales		x	x	
<i>Riccia</i> sp. 3	x	x		
<i>Weissia</i> sp. (cf)		x		
<u>Vascular Plants</u>				
<i>Ajuga iva</i>				x
<i>Alyssum maritimum</i>		x		
<i>Arisarum vulgare</i>		x		
<i>Astragalus baeticus</i>		x		
<i>Avena barbata</i>		x		
<i>Beta maritima</i>		x	x	
<i>Bromus</i> sp.		x		
<i>Chrysanthemum coronarium</i>		x		
<i>Convolvulus althaeoides</i>		x	x	x
<i>Conyza bonaerensis</i>				x
<i>Daucus carota</i>		x	x	
<i>Diploxaxis tenuifolia</i>	x		x	x

<i>Echium parviflorum</i>		x	x	x
<i>Euphorbia sulcata</i>		x		
<i>Galactites tomentosa</i>		x		
<i>Galium murale</i>		x		
<i>Hyoseris radiata</i>				x
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus edulis</i>			x	
<i>Malva sylvestris</i>		x		
<i>Medicago polymorpha</i>		x		
<i>Oxalis pes-caprae</i>	x	x		
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x		
<i>Polypogon monspeliensis</i>			x	
<i>Psoralea bituminosa</i>		x	x	x
<i>Reichardia picroides</i>		x	x	x
<i>Reseda alba</i>		x		
<i>Sagina apetala</i>		x		
<i>Senecio vulgaris</i>		x		
<i>Sonchus oleraceus</i>		x	x	
<i>Spergularia bocconeii</i>			x	
<i>Urospermum picroides</i>		x		

Room 8, space 1

	f	w	sp	su
<u>Bryophytes</u>				
Pottiales		x	x	
<u>Vascular Plants</u>				
<i>Beta maritima</i>		x		
<i>Bromus</i> sp.		x	x	
<i>Catapodium rigidum</i>			x	
<i>Daucus carota</i>		x		x
<i>Diploxaxis tenuifolia</i>				x
<i>Galium murale</i>		x		
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus ornithopodioides</i>		x		
<i>Oxalis pes-caprae</i>		x	x	
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x		
<i>Polypogon monspeliensis</i>			x	
<i>Sagina apetala</i>		x		
<i>Sonchus oleraceus</i>		x		

Room 8, space 0

	f	w	sp	su
--	---	---	----	----

<u>Vascular Plants</u>				
<i>Alyssum maritimum</i>			x	
<i>Antirrhinum siculum</i>		x		
<i>Asparagus aphyllus</i>		x		x
<i>Beta maritima</i>		x		
<i>Bromus sp.</i>		x	x	
<i>Convolvulus althaeoides</i>		x	x	x
<i>Conyza bonaerensis</i>	x	x	x	
<i>Daucus carota</i>		x	x	x
<i>Diplotaxis tenuifolia</i>	x	x	x	x
<i>Echium parviflorum</i>		x	x	
<i>Galium murale</i>			x	
<i>Lotus ornithopodioides</i>		x		
<i>Mercurialis annua</i>		x	x	
<i>Oryzopsis miliacea</i>			x	x
<i>Oxalis pes-caprae</i>		x		
<i>Parietaria judaica</i>		x	x	x
<i>Polycarpon tetraphyllum</i>			x	
<i>Psoralea bituminosa</i>		x		
<i>Reichardia picroides</i>		x		
<i>Spergularia bocconeii</i>			x	
<i>Urospermum picroides</i>		x		

Room 9

	f	w	sp	su
<u>Bryophytes</u>				
<i>Aloina aloides</i>	x			
<i>Anthoceros laevis</i>	x	x		
<i>Fossombronina sp.</i>	x	x		
<i>Riccia sp. 1</i>	x	x		
<i>Riccia sp. 2</i>	x	x		
<i>Sphaerocarpos sp.</i>		x		
<u>Vascular Plants</u>				
<i>Alyssum maritimum</i>	x	x	x	x
<i>Anagallis arvensis</i>		x	x	
<i>Arisarum vulgare</i>		x		
<i>Bromus sp.</i>			x	
<i>Calendula arvensis</i>		x		
<i>Conyza bonaerensis</i>				x
<i>Cynodon dactylon</i>				x
<i>Diplotaxis erucoides</i>	x	x		
<i>Echium parviflorum</i>		x		
<i>Erodium malacoides</i>		x		

<i>Euphorbia helioscopia</i>		x	x	
<i>Euphorbia sulcata</i>		x		
Fabaceae		x		
<i>Foeniculum vulgare</i>		x		x
<i>Galactites tomentosa</i>		x		
<i>Hordeum leporinum</i>		x	x	
<i>Hypericum triquetrifolium</i>		x		x
<i>Lotus ornithopodioides</i>		x		
<i>Malva sylvestris</i>		x		
<i>Medicago orbicularis</i>		x		
<i>Medicago polymorpha</i>		x	x	
<i>Mercurialis annua</i>		x		
<i>Oryzopsis miliacea</i>			x	
<i>Oxalis pes-caprae</i>	x	x	x	
<i>Poa infirma</i>		x	x	
<i>Polycarpon tetraphyllum</i>			x	
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>		x		x
<i>Sagina apetala</i>		x		
<i>Senecio vulgaris</i>		x		
<i>Sonchus oleraceus</i>	x	x	x	
<i>Sonchus tenerrimus</i>		x		
<i>Spergularia bocconeii</i>			x	
<i>Urginea pancration</i>	x	x		

Room 10

	f	w	sp	su
<u>Bryophytes</u>				
Pottiales		x		
<i>Riccia sp.</i>		x		
<u>Vascular Plants</u>				
<i>Alyssum maritimum</i>		x	x	
<i>Anagallis arvensis</i>			x	
<i>Antirrhinum siculum</i>				x
<i>Arisarum vulgare</i>	x	x		
<i>Bromus sp.</i>		x	x	
<i>Calendula arvensis</i>		x	x	
<i>Catapodium rigidum</i>			x	
<i>Convolvulus althaeoides</i>		x	x	x
<i>Convolvulus siculus</i>			x	
<i>Conyza bonaerensis</i>	x	x		
<i>Daucus carota</i>		x		
<i>Diplotaxis erucoides</i>	x	x		

<i>Echium parviflorum</i>	x		
<i>Erodium malacoides</i>	x		
<i>Euphorbia helioscopia</i>	x		
Fabaceae	x		
<i>Foeniculum vulgare</i>	x		x
<i>Hordeum leporinum</i>		x	
<i>Hypericum triquetrifolium</i>	x	x	x
<i>Lotus ornithopodioides</i>		x	
<i>Mercurialis annua</i>	x		

<i>Oryzopsis miliacea</i>	x	x	x
<i>Oxalis pes-caprae</i>	x	x	x
<i>Poa infirma</i>		x	
<i>Polycarpon tetraphyllum</i>			x
<i>Psoralea bituminosa</i>			x
<i>Reichardia picroides</i>			x
<i>Sonchus oleraceus</i>		x	
<i>Trifolium sp.</i>		x	

2.2. Soils on top of walls

Photoautotrophic organisms on the top of walls (f = fall, w = winter, sp = spring, su = summer)

The lower temple

	f	w	sp	su
<u>Lichens</u>				
<i>Collema sp.</i>	x	x	x	
<u>Bryophytes</u>				
<i>Barbula sp.</i>	x	x		x
<u>Vascular Plants</u>				
<i>Allium commutatum</i>			x	
<i>Alyssum maritimum</i>	x	x	x	x
<i>Anthriscum sicutum</i>	x	x	x	
<i>Arisarum vulgare</i>	x	x		
<i>Asparagus aphyllus</i>	x	x	x	x
<i>Asphodelus aestivus</i>	x	x	x	x
<i>Avena barbata</i>			x	
<i>Borago officinalis</i>		x		
<i>Bromus sp.</i>		x	x	
<i>Capparis orientalis</i>	x	x	x	x
<i>Carthamus lanatus</i>			x	
<i>Chrysanthemum coronarium</i>		x	x	
<i>Convolvulus althaeoides</i>	x	x	x	x
<i>Daucus carota</i>		x		
<i>Diplotaxis tenuifolia</i>	x	x	x	
<i>Echium parviflorum</i>		x	x	
<i>Euphorbia melitensis</i>	x	x	x	x
<i>Foeniculum vulgare</i>	x	x	x	x
<i>Fumaria officinalis</i>		x	x	
<i>Galactites tomentosa</i>		x		

<i>Galium murale</i>		x		
<i>Hedypnois cretica</i>			x	
<i>Lotus cytoides</i>	x		x	x
<i>Lotus ornithopodioides</i>		x	x	
<i>Medicago polymorpha</i>			x	
<i>Narcissus serotinus</i>	x			
<i>Oxalis pes-caprae</i>	x	x		
<i>Parietaria judaica</i>		x	x	
<i>Plantago lagopus</i>			x	
<i>Polypogon monspeliensis</i>			x	
<i>Prasium majus</i>	x	x	x	x
<i>Reichardia picroides</i>			x	x
<i>Reseda alba</i>	x	x	x	
<i>Sedum sediforme</i>	x	x	x	x
<i>Senecio bicolor</i>	x	x	x	x
<i>Senecio vulgaris</i>		x		
<i>Sonchus oleraceus</i>		x	x	
<i>Thymus capitatus</i>	x	x	x	
<i>Trifolium stellatum</i>			x	
<i>Urginea pancration</i>	x	x	x	

The upper temple

	f	w	sp	su
<u>Bryophytes</u>				
<u>Pottiales</u>			x	x
<u>Vascular plants</u>				
<i>Allium commutatum</i>			x	
<i>Alyssum maritimum</i>	x	x	x	

<i>Anthirrhinum siculum</i>	x	x	x	x
<i>Arisarum vulgare</i>	x	x		
<i>Asparagus aphyllus</i>	x	x	x	x
<i>Asphodelus aestivus</i>	x	x	x	
<i>Avena barbata</i>			x	
<i>Beta maritima</i>		x	x	
<i>Borago officinalis</i>		x	x	
<i>Brachypodium distachyon</i>	x	x	x	
<i>Bromus</i> sp.		x	x	
<i>Campanula erinus</i>			x	
<i>Catapodium rigidum</i>			x	
<i>Chamaerops humilis</i>			x	
<i>Chrysanthemum coronarium</i>		x	x	
<i>Convolvulus althaeoides</i>	x	x	x	x
<i>Daucus carota</i>			x	x
<i>Diplotaxis erucoides</i>		x		
<i>Diplotaxis tenuifolia</i>	x	x	x	x
<i>Echium parviflorum</i>		x	x	
<i>Erodium malacoides</i>		x		
<i>Euphorbia melitensis</i>	x	x	x	x
<i>Euphorbia sulcata</i>		x	x	
<i>Foeniculum vulgare</i>	x	x	x	x
<i>Galactites tomentosa</i>		x	x	
<i>Hedypnois cretica</i>			x	
<i>Hippocrepis multisiliquosa</i>			x	
<i>Hyparrhenia hirta</i>			x	
<i>Hypericum triquetrifolium</i>			x	x
<i>Hypochaeris achyrophorus</i>			x	
<i>Inula viscosa</i>	x	x	x	x
Liliaceae		x		
<i>Lotus cytisoides</i>			x	
<i>Lotus ornithopodioides</i>		x		
<i>Medicago polymorpha</i>		x		
<i>Mercurialis annua</i>	x	x	x	
<i>Narcissus serotinus</i>	x			
<i>Orobancha ramosa</i> ssp. <i>mutelii</i>			x	
<i>Oxalis pes-caprae</i>	x	x	x	
<i>Parietaria judaica</i>			x	
<i>Phagnalon graecense</i>	x	x	x	x
<i>Polypogon monspeliensis</i>			x	
<i>Psoralea bituminosa</i>	x	x	x	x
<i>Reichardia picroides</i>	x	x	x	
<i>Reseda alba</i>		x	x	

<i>Scilla autumnalis</i>	x	x		
<i>Sedum sediforme</i>	x	x	x	x
<i>Senecio vulgaris</i>		x		
<i>Sonchus oleraceus</i>			x	
<i>Trifolium stellatum</i>		x	x	
<i>Urginea pancration</i>	x	x		
<i>Urospermum picroides</i>		x	x	
<i>Valantia muralis</i>		x	x	

The small temple

	f	w	sp	su
<u>Bryophytes</u>				
<i>Weissia</i> sp (cf.)		x	x	x
<u>Vascular Plants</u>				
<i>Allium commutatum</i>		x		
<i>Alyssum maritimum</i>		x	x	x
<i>Arisarum vulgare</i>		x		
<i>Asphodelus aestivus</i>		x		
<i>Avena barbata</i>		x		
<i>Beta maritima</i>			x	
<i>Borago officinalis</i>		x		
<i>Brachypodium distachyon</i>		x		
<i>Bromus</i> sp.		x		
<i>Calendula arvensis</i>		x	x	
<i>Catapodium rigidum</i>			x	
<i>Convolvulus althaeoides</i>		x	x	x
<i>Convolvulus arvensis</i>			x	
<i>Cynodon dactylon</i>				x
<i>Diplotaxis tenuifolia</i>				x
<i>Echium parviflorum</i>		x	x	
<i>Erodium malacoides</i>		x		
<i>Euphorbia melitensis</i>			x	x
<i>Euphorbia sulcata</i>		x		
<i>Hedypnois cretica</i>			x	
<i>Hippocrepis multisiliquosa</i>		x		
<i>Hypericum triquetrifolium</i>			x	x
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus ornithopodioides</i>		x	x	
<i>Medicago orbicularis</i>		x		
<i>Medicago polymorpha</i>		x		
<i>Mercurialis annua</i>		x		
<i>Orobancha ramosa</i> ssp. <i>mutelii</i>			x	
<i>Oxalis pes-caprae</i>		x		

<i>Polypogon monspeliensis</i>		x	
<i>Psoralea bitumonosa</i>	x	x	x
<i>Reichardia picroides</i>	x	x	x
<i>Reseda alba</i>		x	
<i>Sedum sediforme</i>	x	x	x

<i>Senecio vulgaris</i>	x		
<i>Sonchus tenerrimus</i>	x	x	
<i>Urginea pancrati</i>	x		

3. Soils from Haġar Qim

3.1. Room soils



Plan 18A. Haġar Qim Temples: main building.



Maps of vegetation cover in autumn (up left), winter (up right), spring (down left) and summer (down right).

Lists of photoautotrophic organisms from the rooms (f = fall, w = winter, sp = spring, su = summer)

Room 1

	f	w	sp	su
<u>Bryophytes</u>				
Pottiales	x	x	x	x
<u>Vascular Plants</u>				
<i>Alyssum maritimum</i>		x		
<i>Asparagus aphyllus</i>		x	x	
<i>Asphodellus aestivus</i>		x		
<i>Avena barbata</i>			x	
<i>Beta maritima</i>			x	
<i>Campanula erinus</i>			x	
<i>Centaureum erythraea</i>			x	
<i>Convolvulus althaeoides</i>	x	x	x	x
<i>Conyza bonaerensis</i>	x	x		x
<i>Daucus carota</i>	x	x	x	x
<i>Diplotaxis tenuifolia</i>	x	x		x
<i>Echium parviflorum</i>		x	x	
<i>Galactites tomentosa</i>		x		
<i>Galium murale</i>		x	x	
<i>Hippocrepis multisiliquosa</i>		x	x	
<i>Hordeum leporinum</i>			x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Medicago polymorpha</i>		x	x	
<i>Oryzopsis miliacea</i>		x	x	x
<i>Oxalis pes-caprae</i>		x		
<i>Parietaria judaica</i>		x	x	x
<i>Plantago lanceolata</i>		x	x	
<i>Poa infirma</i>		x	x	
<i>Polycarpon tetraphyllum</i>			x	
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>		x	x	
<i>Sagina apetala</i>		x		
<i>Senecio vulgaris</i>		x		
<i>Sonchus oleraceus</i>		x	x	
<i>Spergularia bocconeii</i>			x	
<i>Urospermum picroides</i>		x	x	

Room 2

	f	w	sp	su
<u>Lichens</u>				

<i>Collema</i> sp.	x	x	x	
lichen with perithecia	x	x	x	
<u>Bryophytes</u>				
<i>Fossombronia</i> sp.	x	x		
<i>Petalophyllum ralfsii</i>		x		
Pottiales	x	x	x	x
<u>Vascular Plants</u>				
<i>Arisarum vulgare</i>	x			
<i>Asparagus aphyllus</i>	x			
Asteraceae			x	
<i>Campanula erinus</i>			x	
<i>Centaureum erythraea</i>			x	
<i>Convolvulus althaeoides</i>	x	x	x	x
<i>Conyza bonaerensis</i>	x			x
<i>Daucus carota</i>	x	x	x	x
<i>Diplotaxis tenuifolia</i>		x	x	x
<i>Galium murale</i>		x	x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus ornithopodioides</i>			x	
<i>Medicago polymorpha</i>		x	x	
<i>Oryzopsis miliacea</i>				x
<i>Oxalis pes-caprae</i>	x	x		
<i>Parietaria judaica</i>	x	x	x	x
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>	x	x	x	x
<i>Senecio vulgaris</i>		x		
<i>Sonchus oleraceus</i>	x	x	x	
<i>Urospermum picroides</i>			x	

Room 3

	f	w	sp	su
<u>Bryophytes</u>				
Pottiales	x	x	x	x
<u>Vascular Plants</u>				
<i>Alyssum maritimum</i>	x	x	x	x
<i>Arisarum vulgare</i>	x			
<i>Asparagus aphyllus</i>				x
<i>Avena barbata</i>			x	
<i>Beta maritima</i>		x	x	
<i>Bromus</i> sp.			x	

<i>Convolvulus althaeoides</i>	x	x	x	x
<i>Conyza bonaerensis</i>	x			
<i>Daucus carota</i>	x	x	x	x
<i>Diplotaxis tenuifolia</i>	x		x	x
<i>Galium murale</i>			x	
<i>Hippocrepis multsiliquosa</i>		x		
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus ornithopodioides</i>			x	
<i>Medicago polymorpha</i>		x		
<i>Oryzopsis miliacea</i>			x	
<i>Oxalis pes-caprae</i>	x	x		
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x	x	
<i>Polycarpon tetraphyllum</i>			x	
<i>Polypogon monspeliensis</i>			x	
Poaceae		x		
<i>Reichardia picroides</i>	x	x	x	
<i>Sonchus oleraceus</i>		x	x	
<i>Urospermum picroides</i>		x	x	

Room 4

	f	w	sp	su
<u>Bryophytes</u>				
<i>Fossombronia</i> sp.	x	x		
<i>Petalophyllum ralfsii</i>	x	x		
Pottiales	x	x	x	x
<i>Riccia</i> sp. 1	x			
<u>Vascular Plants</u>				
<i>Alyssum maritimum</i>		x		
Asteraceae		x		
<i>Beta maritima</i>		x	x	x
<i>Bromus</i> sp.		x	x	
<i>Centaurium erythraea</i>			x	
<i>Conyza bonaerensis</i>	x	x		x
<i>Daucus carota</i>		x	x	
<i>Diplotaxis tenuifolia</i>	x		x	x
<i>Galium murale</i>		x	x	
<i>Hordeum leporinum</i>			x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Medicago polymorpha</i>		x	x	
<i>Oxalis pes-caprae</i>	x	x		
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x	x	

<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>	x	x	x	x
<i>Sonchus oleraceus</i>	x	x	x	
<i>Spergularia bocconeii</i>			x	
<i>Urospermum picroides</i>			x	

Room 5

	f	w	sp	su
<u>Lichens</u>				
<i>Collema</i> sp.	x			
<u>Bryophytes</u>				
<i>Riccia</i> sp. 1	x			
unidentified mosses	x			
<u>Vascular Plants</u>				
<i>Asparagus aphyllus</i>	x	x	x	
Asteraceae		x		
<i>Beta maritima</i>		x	x	x
<i>Centaurium erythraea</i>			x	
<i>Convolvulus althaeoides</i>			x	x
<i>Conyza bonaerensis</i>	x	x		x
<i>Daucus carota</i>	x	x	x	
<i>Diplotaxis tenuifolia</i>	x	x	x	x
<i>Galactites tomentosa</i>		x		
<i>Galium murale</i>		x	x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus edulis</i>			x	
<i>Medicago polymorpha</i>		x	x	
<i>Oryzopsis miliacea</i>	x	x	x	x
<i>Oxalis pes-caprae</i>	x	x		
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x	x	
<i>Reichardia picroides</i>	x	x	x	x
<i>Sagina apetala</i>		x		
<i>Satureja microphylla</i>		x		
<i>Senecio vulgaris</i>		x		
<i>Sonchus oleraceus</i>	x		x	
<i>Urospermum picroides</i>		x		

Room 6

	f	w	sp	su
<u>Cyanoprokaryotes</u>				
<i>Nostoc commune</i>		x		
<u>Lichens</u>				
<i>Collema</i> sp.	x	x	x	

<u>Bryophytes</u>				
<i>Fossombronia</i> sp.	x	x		
<i>Petalophyllum ralfsii</i>		x		
<u>Pottiales</u>	x	x	x	x
<i>Riccia</i> sp. 1	x			
<i>Riccia</i> sp. 2	x			
<u>Vascular Plants</u>				
<i>Astragalus baeticus</i>			x	
<i>Brachypodium distachyon</i>	x			
<i>Catapodium rigidum</i>			x	
<i>Centaurium erythraea</i>			x	
<i>Conyza bonaerensis</i>	x	x	x	x
<i>Daucus carota</i>	x	x	x	
<i>Diplotaxis eruroides</i>		x		
<i>Diplotaxis tenuifolia</i>	x		x	
<i>Echium parviflorum</i>	x	x	x	
<i>Euphorbia pinea</i>	x	x	x	
<i>Ficus carica</i>	x	x	x	x
<i>Galactites tomentosa</i>	x	x		
<i>Galium murale</i>		x	x	
<i>Hippocrepis multisiliquosa</i>		x		
<i>Hordeum leporinum</i>			x	
<i>Hyoseris radiata</i>		x	x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus edulis</i>			x	
<i>Malva sylvestris</i>		x		
<i>Medicago polymorpha</i>	x	x	x	
<i>Oryzopsis miliacea</i>			x	x
<i>Oxalis pes-caprae</i>		x		
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x	x	
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>	x	x	x	x
<i>Sagina apetala</i>		x		
<i>Scabiosa maritima</i>				x
<i>Senecio vulgaris</i>	x	x		
<i>Sonchus oleraceus</i>	x	x	x	
<i>Trifolium tomentosum</i>			x	
<i>Urospermum picroides</i>			x	

Room 6, space α

	f	w	sp	su
<u>Bryophytes</u>				

<u>Pottiales</u>	x	x		
<u>Vascular Plants</u>				
<i>Galium murale</i>			x	
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>			x	
<i>Polypogon monspeliensis</i>		x	x	

Room 6, space β

	f	w	sp	su
<u>Vascular Plants</u>				
<i>Conyza bonaerensis</i>	x			
<i>Daucus carota</i>		x	x	
<i>Galium murale</i>		x	x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Medicago polymorpha</i>			x	
<i>Oryzopsis miliacea</i>			x	x
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x		
<i>Sonchus oleraceus</i>			x	

Room 6, space γ.

	f	w	sp	su
<u>Bryophytes</u>				
<u>Pottiales</u>	x	x		
<u>Vascular Plants</u>				
<i>Asparagus aphyllus</i>			x	
<i>Blackstonia perfoliata</i>			x	
<i>Centaurium erythraea</i>			x	
<i>Convolvulus althaeoides</i>			x	
<i>Conyza bonaerensis</i>	x	x		
<i>Daucus carota</i>		x	x	
<i>Diplotaxis tenuifolia</i>		x		
<i>Galium murale</i>		x	x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus edulis</i>			x	
<i>Medicago polymorpha</i>			x	
<i>Oryzopsis milacea</i>		x	x	x
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x		
<i>Polypogon monspeliensis</i>			x	
<i>Sagina apetala</i>		x		
<i>Sonchus oleraceus</i>		x		

Room 7

Bryophytes				
<i>Fossombronia</i> sp.		x		
Pottiales	x	x	x	x
<i>Sphaerocarpos</i> sp.		x		
Vascular Plants				
<i>Asparagus aphyllus</i>	x			
<i>Brachypodium distachyon</i>	x			
<i>Centaureum erythraea</i>			x	
<i>Convolvulus althaeoides</i>		x	x	x
<i>Conyza bonaerensis</i>	x	x		
<i>Daucus carota</i>	x	x	x	x
<i>Galium murale</i>		x	x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Medicago polymorpha</i>			x	
<i>Oryzopsis miliacea</i>		x		x
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x	x	
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>	x	x	x	x
<i>Sagina apetala</i>		x		
<i>Scabiosa maritima</i>				x
<i>Sonchus oleraceus</i>		x		
<i>Trifolium nigrescens</i>			x	
<i>Urospermum picroides</i>			x	

Room 7 space d

	f	w	sp	su
Bryophytes				
<i>Fissidens</i> sp.	x	x	x	
Pottiales		x		
Vascular Plants				
<i>Convolvulus althaeoides</i>		x	x	x
<i>Parietaria judaica</i>	x	x	x	x
<i>Senecio vulgaris</i>		x		

Room 8

	f	w	sp	su
Bryophytes				
Pottiales		x		
Vascular Plants				
<i>Conyza bonaerensis</i>	x			x
<i>Galium murale</i>		x	x	
<i>Hypochaeris achyrophorus</i>			x	

<i>Medicago polymorpha</i>			x	
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x	x	
<i>Reichardia picroides</i>		x	x	
<i>Sagina apetala</i>		x		
<i>Sonchus oleraceus</i>		x	x	
<i>Urospermum picroides</i>		x	x	

Room 9

	f	w	sp	su
Bryophytes				
Pottiales		x	x	x
Vascular Plants				
<i>Convolvulus althaeoides</i>		x	x	x
<i>Convolvulus arvensis</i>	x			
<i>Conyza bonaerensis</i>	x			
<i>Daucus carota</i>		x	x	
<i>Galium murale</i>		x	x	
<i>Hirschfeldia incana</i>		x		
<i>Hypochaeris achyrophorus</i>		x	x	
<i>Medicago polymorpha</i>			x	
<i>Oryzopsis miliacea</i>			x	x
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x		
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>		x		
<i>Sagina apetala</i>		x		
<i>Scabiosa maritima</i>			x	x
<i>Sonchus oleraceus</i>	x	x		

Room 10

	f	w	sp	su
Cyanoprokaryotes				
cyanoprokaryote	x			
Lichens				
<i>Catapyrenium</i> sp.		x	x	
<i>Collema</i> sp.	x	x	x	
Bryophytes				
<i>Fossombronia</i> sp.	x	x		
<i>Petalophyllum ralfsii</i>	x	x		
Pottiales	x	x	x	x
Vascular plants				
<i>Ajuga iva</i>			x	
<i>Alyssum maritimum</i>	x	x		

<i>Asparagus aphyllus</i>	x			
Asteraceae		x		
<i>Astragalus baeticus</i>		x		
<i>Avena barbata</i>		x	x	
<i>Beta maritima</i>		x	x	
<i>Bromus</i> sp.			x	
<i>Centaureum erythraea</i>			x	
<i>Convolvulus althaeoides</i>	x	x	x	x
<i>Conyza bonaerensis</i>	x	x		
<i>Daucus carota</i>	x	x	x	x
<i>Diplotaxis tenuifolia</i>	x	x	x	x
<i>Echium parviflorum</i>	x	x		x
<i>Euphorbia pinea</i>	x	x	x	
<i>Galium murale</i>		x		
<i>Hippocrepis multisiliquosa</i>	x	x		
<i>Hirschfeldia incana</i>		x		
<i>Hypochaeris achyrophorus</i>			x	
<i>Medicago polymorpha</i>	x	x	x	
<i>Oryzopsis miliacea</i>	x	x	x	x
<i>Oxalis pes-caprae</i>	x	x		
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x	x	
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>	x	x	x	x
<i>Sagina apetala</i>		x		
<i>Scabiosa maritima</i>			x	x
<i>Senecio vulgaris</i>		x		
<i>Silene colorata</i>		x		
<i>Sonchus oleraceus</i>	x	x	x	
<i>Trifolium nigrescens</i>			x	
<i>Urospermum picroides</i>		x	x	

Room 10, space ζ

	f	w	sp	su
<u>Bryophytes</u>				
Pottiales	x	x	x	x
<i>Riccia</i> sp. 2	x			
<u>Vascular plants</u>				
<i>Campanula erinus</i>			x	
<i>Centaureum erythraea</i>			x	
<i>Convolvulus althaeoides</i>		x	x	
<i>Conyza bonaerensis</i>	x	x		
<i>Daucus carota</i>	x	x	x	x

<i>Ficus carica</i>			x	x
<i>Galium murale</i>		x	x	
<i>Hypochaeris achyrophorus</i>		x	x	
<i>Lactuca serriola</i>				x
<i>Medicago polymorpha</i>		x	x	
<i>Oryzopsis miliacea</i>			x	x
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x	x	
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>				x
<i>Sonchus oleraceus</i>	x	x	x	
<i>Urospermum picroides</i>			x	

Room 11

	f	w	sp	su
<u>Lichens</u>				
<i>Collema</i> sp.	x	x	x	
<u>Bryophytes</u>				
cf. <i>Pleurochate</i> sp.	x			
<i>Fossombronia</i> sp.	x	x		
<i>Petalophyllum ralfsii</i>		x		
Pottiales	x	x	x	x
<i>Riccia</i> sp.		x		
<i>Sphaerocarpos</i> sp.		x		
<u>Vascular plants</u>				
<i>Ajuga iva</i>	x	x	x	x
<i>Anthoceros laevis</i>		x		
<i>Arisarum vulgare</i>		x		
Asteraceae		x	x	
<i>Atractylis gummifera</i>	x			
<i>Avena barbata</i>		x	x	
<i>Brachypodium distachyon</i>	x			
<i>Bromus</i> sp.		x		
<i>Campanula erinus</i>			x	
<i>Carlina involucreta</i>				x
<i>Centaureum erythraea</i>			x	
<i>Convolvulus althaeoides</i>	x	x	x	x
<i>Conyza bonaerensis</i>	x	x		
<i>Daucus carota</i>	x	x		
<i>Diplotaxis tenuifolia</i>	x	x	x	x
<i>Euphorbia pinea</i>				x
<i>Foeniculum vulgare</i>		x	x	x
<i>Galactites tomentosa</i>		x		

<i>Galium murale</i>		x	x	
<i>Heliotropium europaeum</i>	x			
<i>Hippocrepis multisiliquosa</i>	x	x		
<i>Hirschfeldia incana</i>		x		
<i>Hordeum leporinum</i>			x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus edulis</i>			x	
<i>Lotus ornithopodioides</i>			x	
<i>Medicago polymorpha</i>	x	x	x	
<i>Oryzopsis miliacea</i>		x	x	x
<i>Oxalis pes-caprae</i>		x		
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x	x	
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>	x	x	x	x
<i>Sagina apetala</i>		x		
<i>Satureja microphylla</i>	x			
<i>Scabiosa maritima</i>	x		x	x
<i>Sonchus oleraceus</i>	x	x		
<i>Stipa offneri</i>			x	
<i>Trifolium</i> sp.		x		
<i>Urospermum picroides</i>			x	

Room 12

	f	w	sp	su
<u>Lichens</u>				
<i>Collema</i> sp.	x	x	x	
<u>Bryophytes</u>				
<i>Anthoceros laevis</i>		x		
<i>Fossombronia</i> sp.	x	x		
Pottiales	x	x	x	x
<i>Riccia</i> sp. 1	x	x		
<i>Riccia</i> sp. 2	x	x		
<i>Sphaerocarpos</i> sp.		x		
<u>Vascular plants</u>				
<i>Ajuga iva</i>	x			x
<i>Arisarum vulgare</i>	x	x		
<i>Asparagus aphyllus</i>		x		
Asteraceae			x	
<i>Avena barbata</i>		x	x	
<i>Beta maritima</i>		x	x	x
<i>Calendula arvensis</i>		x		
<i>Centaurium erythraea</i>			x	

<i>Convolvulus althaeoides</i>		x	x	x
<i>Conyza bonaerensis</i>	x	x		x
<i>Daucus carota</i>	x	x	x	x
<i>Diplotaxis eruroides</i>	x			
<i>Diplotaxis tenuifolia</i>	x	x	x	x
<i>Echium parviflorum</i>	x		x	x
<i>Euphorbia pinea</i>				x
<i>Foeniculum vulgare</i>			x	x
<i>Galactites tomentosa</i>	x	x	x	
<i>Galium murale</i>		x		
<i>Hippocrepis multisiliquosa</i>	x	x		
<i>Hirschfeldia incana</i>		x		
<i>Hordeum leporinum</i>			x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus cytisoides</i>	x			
<i>Lotus edulis</i>			x	x
<i>Lotus ornithopodioides</i>		x		
<i>Medicago polymorpha</i>	x	x	x	
<i>Ononis reclinata</i>			x	
<i>Oxalis pes-caprae</i>		x		
<i>Parietaria judaica</i>	x	x	x	x
<i>Plantago lanceolata</i>			x	
<i>Poa infirma</i>		x		
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>	x	x	x	x
<i>Sagina apetala</i>		x		
<i>Scabiosa maritima</i>			x	x
<i>Senecio vulgaris</i>		x		
<i>Sonchus oleraceus</i>	x	x		
<i>Trifolium nigrescens</i>		x		
<i>Urospermum picroides</i>			x	

Room 13

	f	w	sp	su
<u>Cyanoprokaryotes</u>				
cyanoprokaryote	x			
<u>Lichens</u>				
<i>Collema</i> sp.	x			
<u>Bryophytes</u>				
<i>Anthoceros laevis</i>		x		
cf. <i>Pleurochaete</i> sp.	x			
<i>Fossombronia</i> sp.	x	x		
<i>Petalophyllum ralfsii</i>	x	x		

Pottiales	x	x	x	x
<i>Riccia</i> sp. 2	x			
<i>Sphaerocarpos</i> sp.		x		
<u>Vascular plants</u>				
<i>Ajuga iva</i>				x
<i>Arisarum vulgare</i>	x			
<i>Asparagus aphyllus</i>				x
Asteraceae		x		
<i>Beta maritima</i>			x	
<i>Bromus</i> sp.			x	
<i>Catapodium rigidum</i>			x	
<i>Convolvulus althaeoides</i>	x	x	x	x
<i>Convolvulus arvensis</i>	x			
<i>Conyza bonaerensis</i>	x	x	x	x
<i>Daucus carota</i>	x	x	x	x
<i>Diplotaxis tenuifolia</i>	x	x	x	
<i>Echium parviflorum</i>	x	x	x	
<i>Euphorbia pinea</i>		x	x	x
<i>Galactites tomentosa</i>			x	
<i>Galium murale</i>		x	x	
<i>Hippocrepis multisiliquosa</i>	x	x		
<i>Hypericum pubescens</i>		x	x	x
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus edulis</i>			x	
<i>Medicago polymorpha</i>	x	x	x	
<i>Oxalis pes-caprae</i>		x		
<i>Parietaria judaica</i>	x		x	x
<i>Phagnalon graecense</i>		x		
<i>Poa infirma</i>		x		
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>	x	x	x	x
<i>Reseda alba</i>			x	
<i>Sagina apetala</i>		x		
<i>Scabiosa maritima</i>			x	x
<i>Senecio vulgaris</i>		x		
<i>Sonchus oleraceus</i>		x		
<i>Trifolium nigrescens</i>		x	x	
<i>Trifolium tomentosum</i>			x	
<i>Urospermum picroides</i>			x	

Room 14

	f	w	sp	su
<u>Lichens</u>				

<i>Collema</i> sp.	x	x	x	
<u>Bryophytes</u>				
<i>Fissidens</i> sp.	x			
<i>Fossombronia</i> sp.	x	x		
Pottiales	x	x	x	
<u>Vascular plants</u>				
Asteraceae		x		
<i>Avena barbata</i>		x	x	
<i>Bromus</i> sp.			x	
<i>Catapodium rigidum</i>			x	
<i>Centaurium erythraea</i>			x	
<i>Convolvulus althaeoides</i>	x	x	x	x
<i>Conyza bonaerensis</i>	x			
<i>Galium murale</i>		x	x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Oryzopsis miliacea</i>				x
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x		
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>	x	x		
<i>Scabiosa maritima</i>	x	x	x	x
<i>Sonchus oleraceus</i>		x		
<i>Spergularia bocconeii</i>			x	
<i>Urospermum picroides</i>			x	

Room 15

	f	w	sp	su
<u>Lichens</u>				
<i>Collema</i> sp.	x	x	x	
<u>Bryophytes</u>				
<i>Petalophyllum ralfsii</i>		x		
Pottiales	x	x	x	x
<i>Sphaerocarpos</i> sp.		x		
<u>Vascular plants</u>				
<i>Alyssum maritimum</i>	x	x	x	x
<i>Arisarum vulgare</i>		x		
<i>Beta maritima</i>			x	
<i>Catapodium rigidum</i>			x	
<i>Centaurium erythraea</i>			x	
<i>Convolvulus althaeoides</i>	x	x	x	x
<i>Conyza bonaerensis</i>	x			x
<i>Daucus carota</i>		x	x	
<i>Galium murale</i>		x	x	

<i>Hyoseris radiata</i>	x	x		
<i>Hypochaeris achyrophorus</i>			x	
<i>Lotus edulis</i>			x	
<i>Oryzopsis miliacea</i>	x			
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x	x	
<i>Polypogon monspeliensis</i>			x	
<i>Reichardia picroides</i>		x	x	x
<i>Sagina apetala</i>		x		
<i>Sonchus oleraceus</i>	x	x		

<i>Hordeum leporinum</i>			x	
<i>Hyoseris radiata</i>		x		
<i>Hypericum pubescens</i>			x	
<i>Oryzopsis miliacea</i>	x			
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x	x	
<i>Polypogon monspeliensis</i>			x	
<i>Sagina apetala</i>		x		
<i>Sonchus oleraceus</i>	x			
<i>Spergularia bocconeii</i>			x	

Room 16

	f	w	sp	su
Bryophytes				
Pottiales	x	x	x	x
Vascular plants				
<i>Arisarum vulgare</i>	x	x		
<i>Asparagus aphyllus</i>	x	x		
Asteraceae		x		
<i>Catapodium rigidum</i>		x	x	
<i>Centaurea erythraea</i>			x	
<i>Convolvulus althaeoides</i>	x		x	x
<i>Conyza bonaerensis</i>	x			
<i>Daucus carota</i>	x			
<i>Diplotaxis tenuifolia</i>		x		x
<i>Galium murale</i>		x	x	
<i>Hyoseris radiata</i>		x	x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Oryzopsis miliacea</i>	x	x	x	x
<i>Parietaria judaica</i>	x	x	x	x
<i>Reichardia picroides</i>		x	x	
<i>Sagina apetala</i>		x		
<i>Scabiosa maritima</i>	x			
<i>Sonchus oleraceus</i>	x	x	x	
<i>Urospermum picroides</i>			x	

Room η (outside of room 7)

	f	w	sp	su
Bryophytes				
Pottiales	x	x	x	x
Vascular plants				
<i>Bromus sp.</i>		x		
<i>Conyza bonaerensis</i>				x
<i>Galium murale</i>		x	x	

3.2. Soils on top of walls

Photoautotrophic organisms on the top of walls (f = fall, w = winter, sp = spring, su = summer)

	f	w	sp	su
Bryophytes				
<i>Bryum</i> sp.		x	x	x
<i>Fossombronia</i> sp.		x		
Vascular plants				
<i>Alyssum maritimum</i>	x	x	x	x
<i>Arisarum vulgare</i>	x	x	x	
<i>Asparagus aphyllus</i>	x	x	x	x
<i>Asphodelus aestivus</i>	x	x	x	
<i>Avena barbata</i>		x	x	
<i>Beta maritima</i>		x	x	x
<i>Brachypodium distachyon</i>	x	x	x	
<i>Bromus</i> sp.		x	x	
<i>Convolvulus althaeoides</i>	x	x	x	x
<i>Daucus carota</i>	x	x	x	
<i>Diploaxis tenuifolia</i>	x	x	x	
<i>Echium parviflorum</i>	x	x	x	
<i>Foeniculum vulgare</i>	x	x	x	x

<i>Galium murale</i>		x	x	
<i>Hypochaeris achyrophorus</i>			x	
<i>Hippocrepis multisiliquosa</i>			x	
<i>Lotus edulis</i>			x	
<i>Lotus ornithopodioides</i>			x	
<i>Medicago polymorpha</i>	x	x	x	
<i>Orobanche ramosa</i> ssp. <i>mutelii</i>			x	
<i>Oryzopsis miliacea</i>			x	x
<i>Oxalis pes-caprae</i>	x	x	x	
<i>Parietaria judaica</i>	x	x	x	x
<i>Poa infirma</i>		x	x	
<i>Prasium majus</i>			x	
<i>Reichardia picroides</i>	x	x	x	x
<i>Reseda alba</i>		x	x	
<i>Senecio bicolor</i>				x
<i>Senecio vulgaris</i>		x	x	
<i>Sonchus oleraceus</i>	x	x	x	
<i>Urospermum picroides</i>			x	

4. Compared Pictures of Mnajdra (MN)

4.1. Room Soils



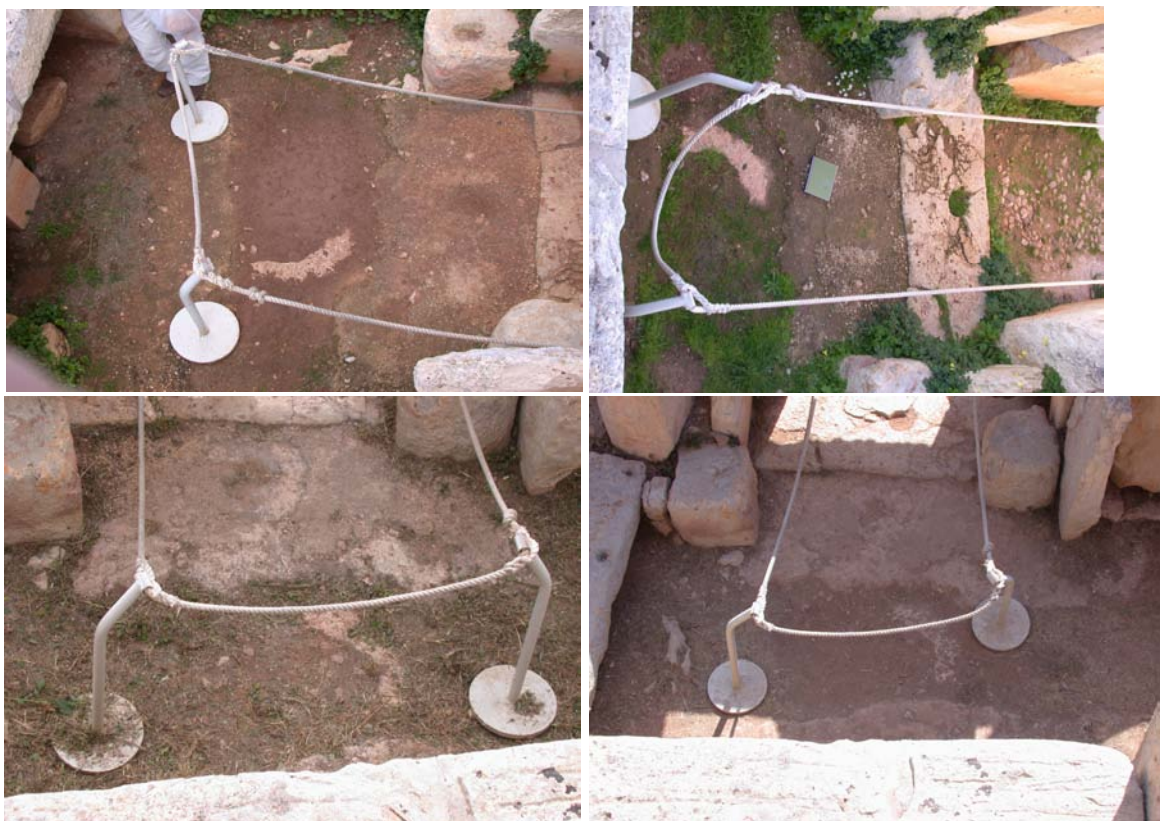
MN, Room 1, right side. Autumn (up left), winter (up right), spring (down left) and summer (down right).



MN, Room 1, left side. Autumn (up left), winter (up right), spring (down left) and summer (down right).



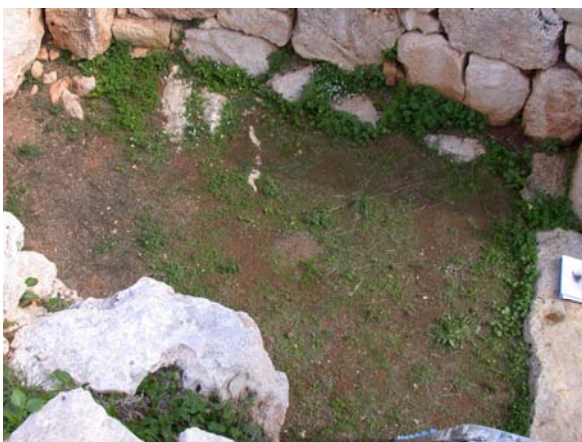
MN, Room 2, left side. November (up left), february (up right), may (down left) and summer (down right).



MN, Room 2, central part. Autumn (up left), winter (up right), spring (down left) and summer (down right).



MN, Room 3. Autumn (up left), winter (up right), spring (down left) and summer (down right).



MN, Room 4. Autumn (up left), winter (up right), spring (down left) and summer (down right).



MN, Room 5. Autumn (up left), winter (up right), spring (down left) and summer (down right).



MN, Room 7, left side. Winter (up left), spring (up right) and summer (down left).



MN, Room 7, right side. Winter (up left), spring (up right) and summer (down left).



MN, Room 8, left side. Autumn (up left), winter (up right), spring (down left) and summer (down right).

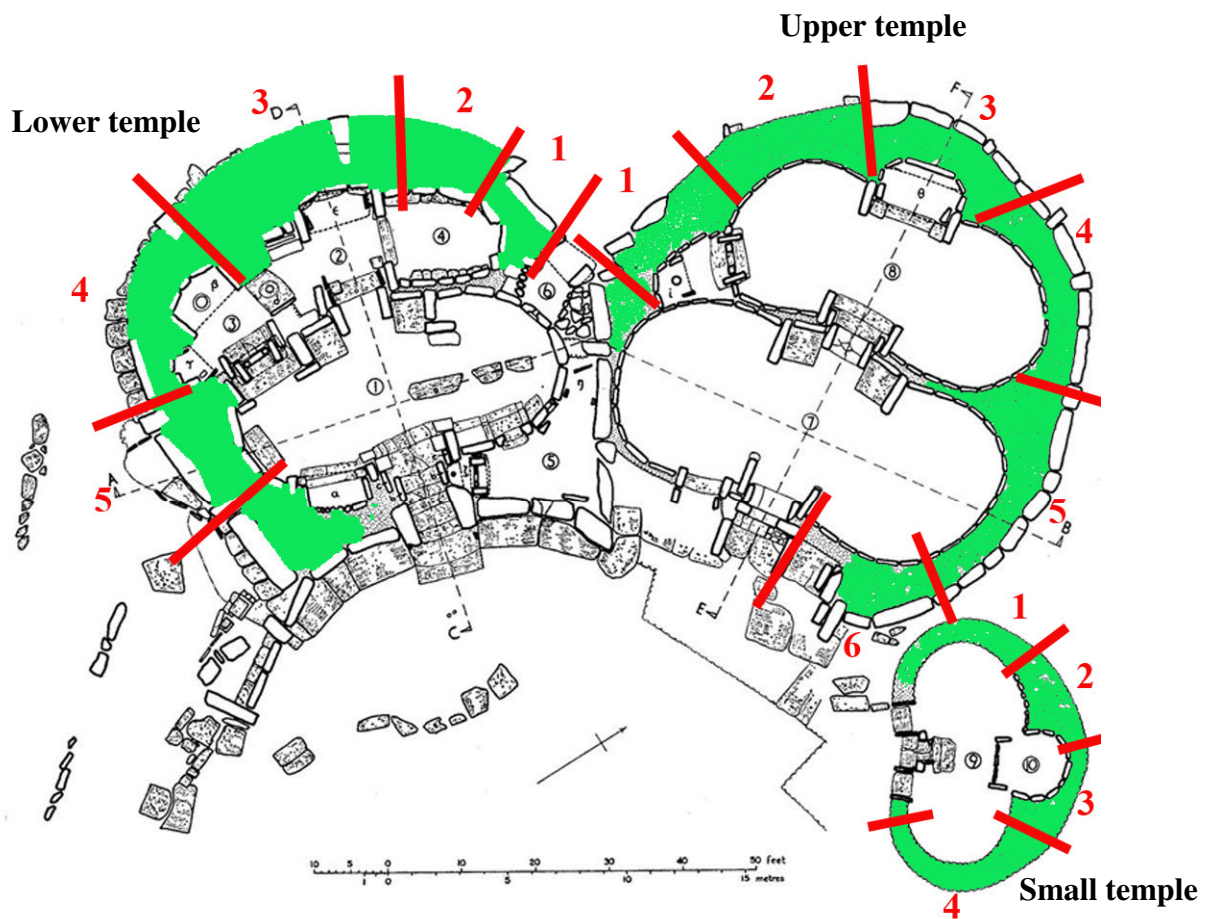


MN, Room 8, right side. Autumn (up left), winter (up right), spring (down left) and summer (down right).



MN, Room 8, central part. Autumn (up left), winter (up right), spring (down left) and summer (down right).

4.2. Soils on top of walls



Plan 20A. Mnajdra Temples.

Map of the sectors represented in the pictures.



Lower Temple: sector 1. Winter (up left), spring (up right) and summer (down left).



Lower Temple: sector 2. Winter (up left), spring (up right) and summer (down left).



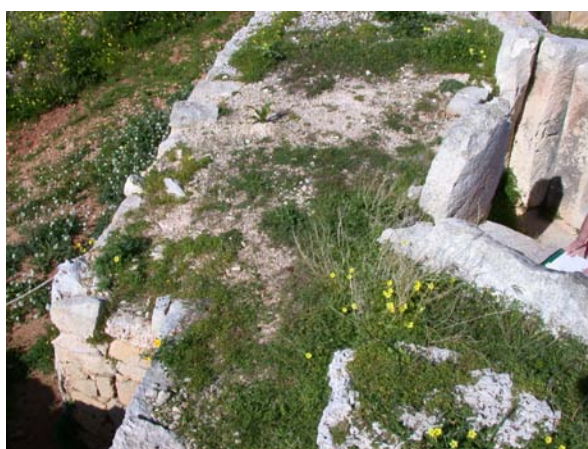
Lower Temple: sector 3. Winter (up left), spring (up right) and summer (down left).



Lower Temple: sector 4. Winter (up left), spring (up right) and summer (down left).



Lower Temple: sector 5. Winter (up left), spring (up right) and summer (down left).



Upper Temple: sector 1. Winter (up left), spring (up right) and summer (down left).



Upper Temple: sector 2. Winter (up left), spring (up right) and summer (down left).



Upper Temple: sector 3. Winter (up left), spring (up right) and summer (down left).



Upper Temple: sector 4. Winter (up left), spring (up right) and summer (down left).



Upper Temple: sector 5. Winter (up left), spring (up right) and summer (down left).



Upper Temple: sector 6. Winter (up left), spring (up right) and summer (down left).



Small Temple: sector 1. Winter (up left), spring (up right) and summer (down left).



Small Temple: sector 2. Winter (up left), spring (up right) and summer (down left).



Small Temple: sector 3. Winter (up left), spring (up right) and summer (down left).



Small Temple: sector 4. Winter (up left),
spring (up right) and summer (down left).

5. Compared Pictures of Haġar Qim (HQ)

5.1 Room Soils



HQ, Room 1a. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 1b. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 1'. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 2. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 3. Autumn (up left), winter (up right), spring (down left) and summer (down right).



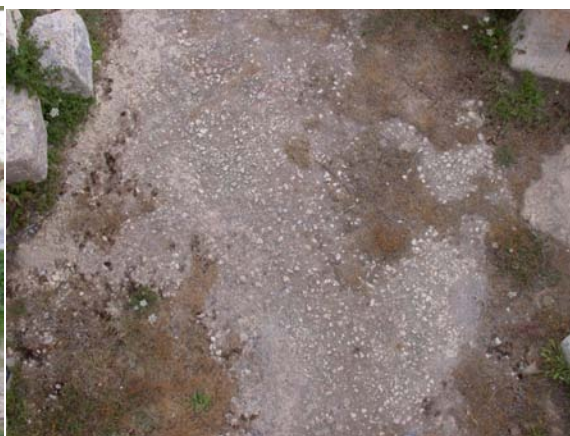
HQ, Room 4. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 5. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 6a. Autumn (up left), winter (up right), spring (down left) and summer (down right).



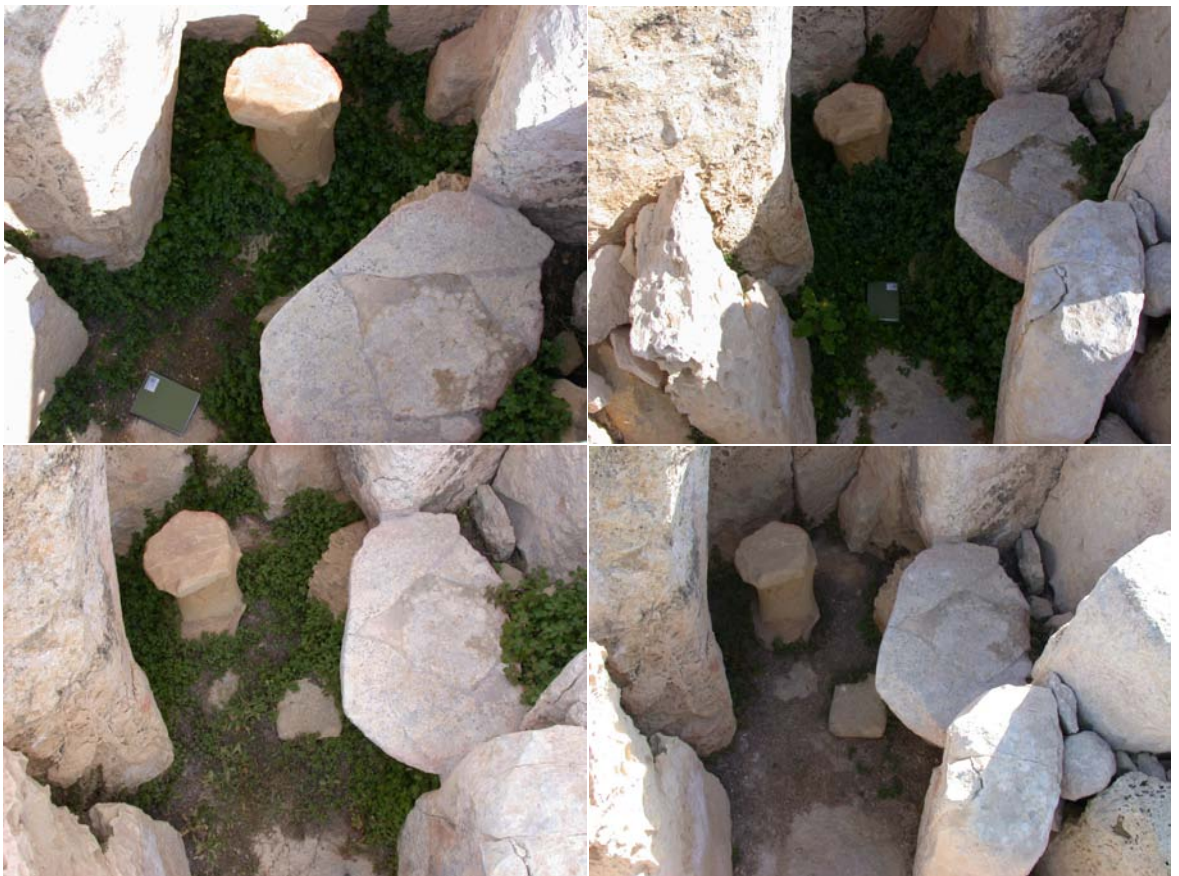
HQ, Room 6b. Winter (up left), spring (up right) and summer (down left).



HQ, Room 6c. Winter (up left), spring (up right) and summer (down left).



HQ, Room 7. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 8. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 9. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 10a. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 10c. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 11a. Autumn (up left), winter (up right), spring (down left) and summer (down right).



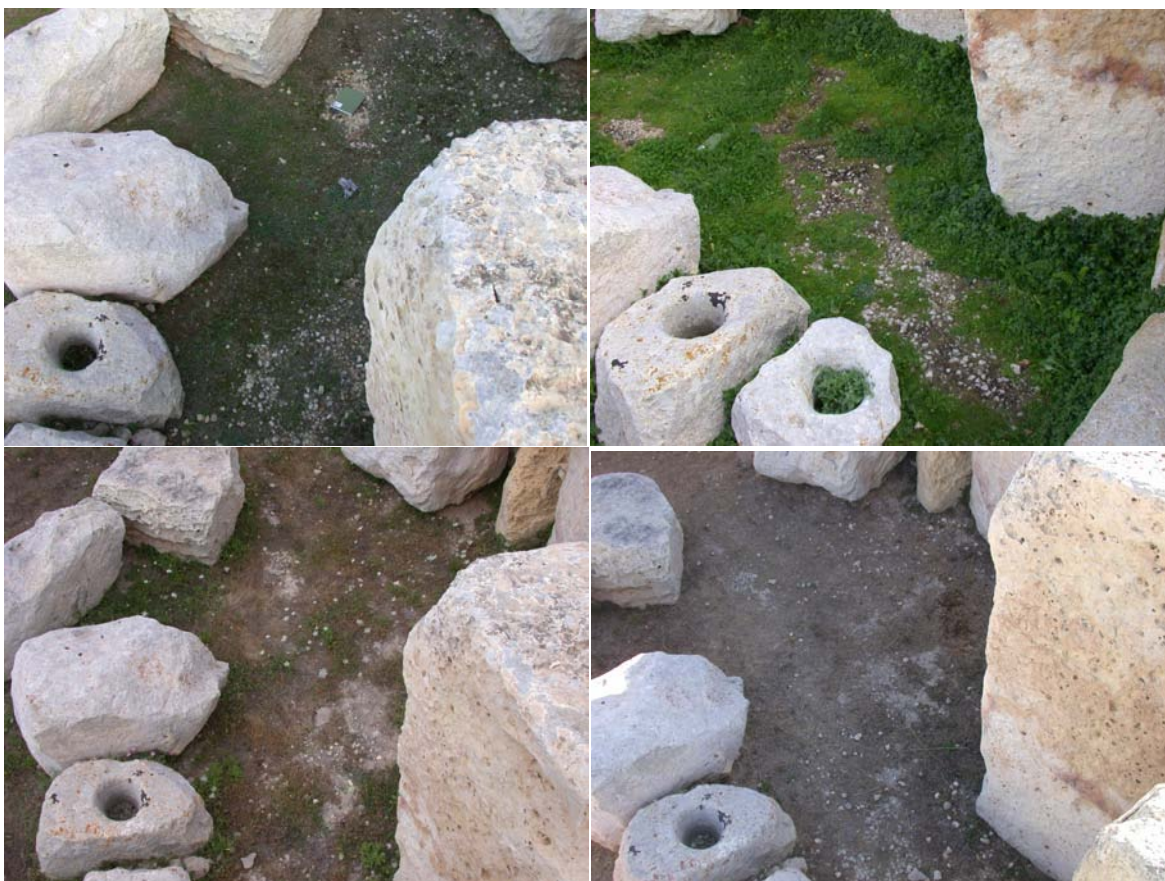
HQ, Room 11b. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 12a. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 12b. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 13a. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room13b. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 13c. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 14. Autumn (up left), winter (up right), spring (down left) and summer (down right).

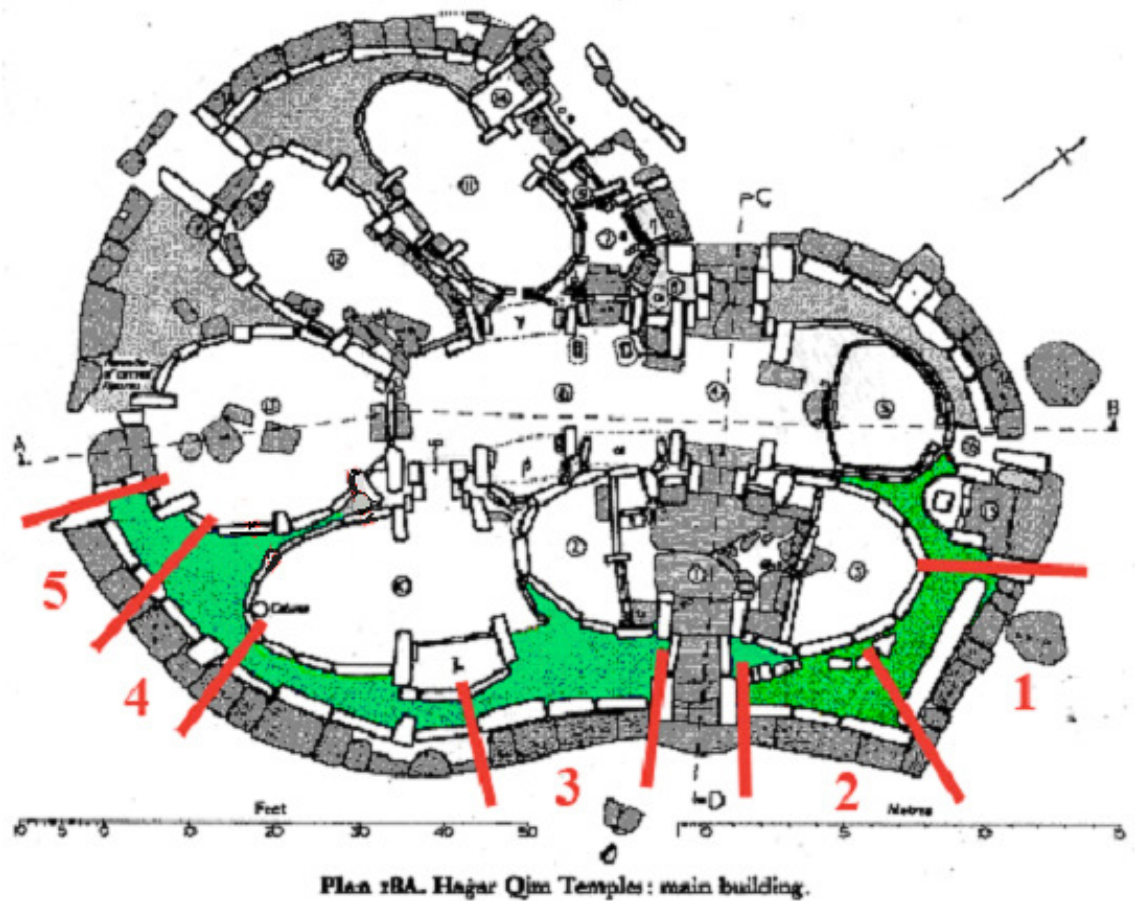


HQ, Room 15. Autumn (up left), winter (up right), spring (down left) and summer (down right).



HQ, Room 16. Autumn (up left), winter (up right), spring (down left) and summer (down right).

5.2. Soils on top of walls



Map of the sectors represented in the pictures.



Sector 1. Winter (up left), spring (up right) and summer (down left).



Sector 2. Winter (up left), spring (up right) and summer (down left).



Sector 3. Winter (up left), spring (up right) and summer (down left).



Sector 4. Winter (up left), spring (up right) and summer (down left).



Sector 5. Winter (up left), spring (up right) and summer (down left).



Environmental Monitoring at Haġar Qim and Mnajdra Temples

Final Report

October 2008

Appendix II Colonization

Contents

1. Vascular plants from walls -----	2
1.1. Mnajdra -----	2
1.2. Haġar Qim -----	2
2. Biological crust colonization -----	4
2.1. Mnajdra -----	4
2.2. Haġar Qim -----	25

1. Vascular plants from walls

1.1. Mnajdra

taxon	f	w	sp	su
<i>Allium commutatum</i>		x	x	
<i>Alyssum maritimum</i>	x	x	x	
<i>Anagallis arvensis</i>		x	x	
<i>Antirrhinum siculum</i>	x	x	x	x
<i>Arisarum vulgare</i>	x	x	x	
<i>Asparagus aphyllus</i>		x	x	x
<i>Asphodelus aestivus</i>		x	x	
<i>Avena barbata</i>		x	x	
<i>Beta maritima</i>		x	x	x
<i>Borago officinalis</i>		x		
<i>Brachypodium distachyon</i>			x	
<i>Bromus sp.</i>		x	x	
<i>Campanula erinus</i>			x	
<i>Capparis orientalis</i>	x		x	x
<i>Catapodium rigidum</i>			x	x
<i>Chrysanthemum coronarium</i>		x	x	
<i>Convolvulus althaeoides</i>		x	x	x
<i>Convolvulus arvensis</i>		x		
<i>Cynodon dactylon</i>				x
<i>Daucus carota</i>		x	x	
<i>Diplotaxis tenuifolia</i>		x	x	x
<i>Echium parviflorum</i>		x	x	
<i>Euphorbia melitensis</i>	x	x	x	x
<i>Euphorbia sulcata</i>		x		
<i>Ficus carica</i>	x	x	x	x
<i>Foeniculum vulgare</i>		x	x	x
<i>Fumaria officinalis</i>		x		

f = fall, w = winter, sp = spring, su = summer

<i>Galactites tomentosa</i>		x		
<i>Galium murale</i>		x	x	
<i>Hedypnois cretica</i>			x	
<i>Lotus cytisoides</i>		x	x	x
<i>Mercurialis annua</i>		x		
<i>Oryzopsis miliacea</i>		x	x	x
<i>Oxalis pes-caprae</i>		x	x	
<i>Parietaria judaica</i>		x	x	x
<i>Phleum pheloides</i>			x	
<i>Plantago lanceolata</i>			x	
<i>Prasium majus</i>		x	x	
<i>Psoralea bituminosa</i>			x	x
<i>Reichardia picroides</i>		x	x	x
<i>Reseda alba</i>		x	x	x
<i>Satureja microphylla</i>	x	x	x	x
<i>Scilla autumnalis</i>	x	x	x	
<i>Sedum sediforme</i>		x	x	x
<i>Senecio bicolor</i>		x	x	x
<i>Senecio vulgaris</i>		x		
<i>Solanum nigrum</i>			x	x
<i>Sonchus oleraceus</i>		x	x	x
<i>Spergularia bocconeae</i>			x	
<i>Trisetum aureum</i>			x	
<i>Umbilicus rupestris</i>			x	
<i>Urginea pancracion</i>		x	x	
<i>Urospermum picroides</i>		x	x	
<i>Valantia muralis</i>			x	

1.2. Haġar Qim

taxon	f	w	sp	su
<i>Alyssum maritimum</i>			x	x
<i>Arisarum vulgare</i>	x	x	x	
<i>Asparagus aphyllus</i>		x	x	x
<i>Avena barbata</i>			x	
<i>Beta maritima</i>			x	x
<i>Brachypodium distachyon</i>			x	
<i>Bromus sp.</i>			x	

<i>Campanula erinus</i>			x	
<i>Catapodium rigidum</i>	x	x	x	x
<i>Centaurium erythraea</i>			x	
<i>Convolvulus althaeoides</i>	x	x	x	x
<i>Conyza bonaerensis</i>	x		x	
<i>Daucus carota</i>		x	x	x
<i>Diplotaxis erucoides</i>	x			
<i>Diplotaxis tenuifolia</i>			x	x

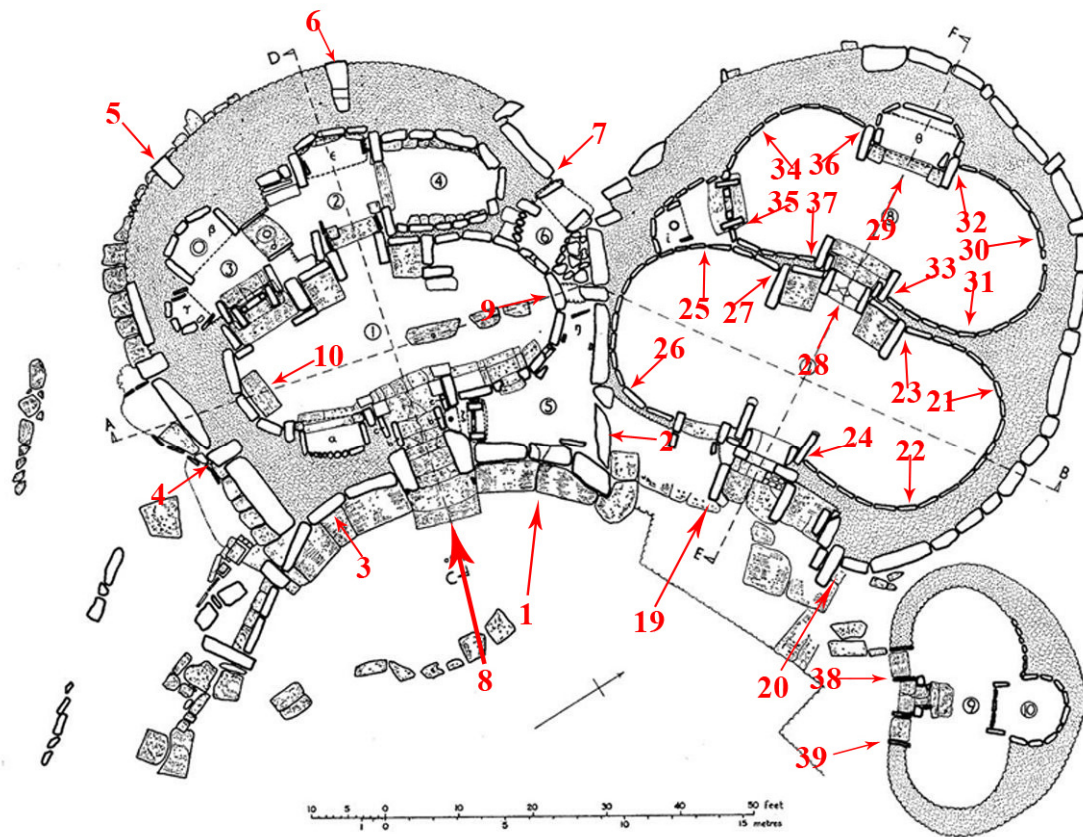
<i>Echium parviflorum</i>			x	x
<i>Euphorbia pinea</i>		x	x	x
<i>Ficus carica</i>			x	x
<i>Foeniculum vulgare</i>		x	x	x
<i>Galium murale</i>			x	
<i>Hedypnois cretica</i>			x	
<i>Hordeum leporinum</i>			x	
<i>Hypericum pubescens</i>			x	x
<i>Hypochoeris achyrophorus</i>			x	
<i>Inula viscosa</i>			x	x
<i>Lotus edulis</i>			x	
<i>Medicago polymorpha</i>			x	
<i>Oryzopsis miliacea</i>		x	x	x
<i>Oxalis pes-caprae</i>	x	x	x	
<i>Parietaria judaica</i>	x	x	x	x

f = fall, w = winter, sp = spring, su = summer

<i>Phleum phleoides</i>			x	
<i>Plantago lanceolata</i>			x	
<i>Prasium majus</i>		x		
<i>Poa infirma</i>			x	
<i>Polypogon maritimus</i>			x	
<i>Prasium majus</i>			x	
<i>Reichardia picroides</i>		x	x	x
<i>Reseda alba</i>		x	x	
<i>Salvia verbenaca</i>			x	
<i>Scabiosa maritima</i>	x		x	x
<i>Senecio bicolor</i>		x	x	x
<i>Sonchus oleraceus</i>	x	x	x	x
<i>Urospermum picroides</i>			x	
<i>Vitis vinifera</i>				x

2. Biological crust colonization

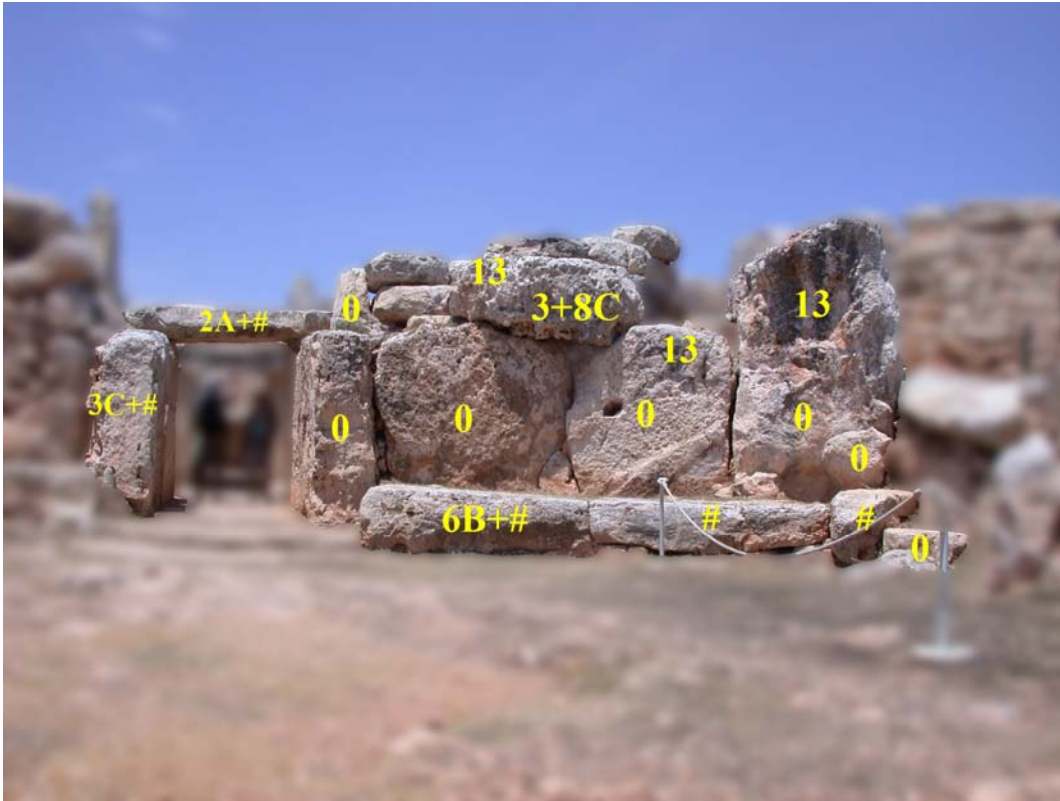
2.1. Mnajdra



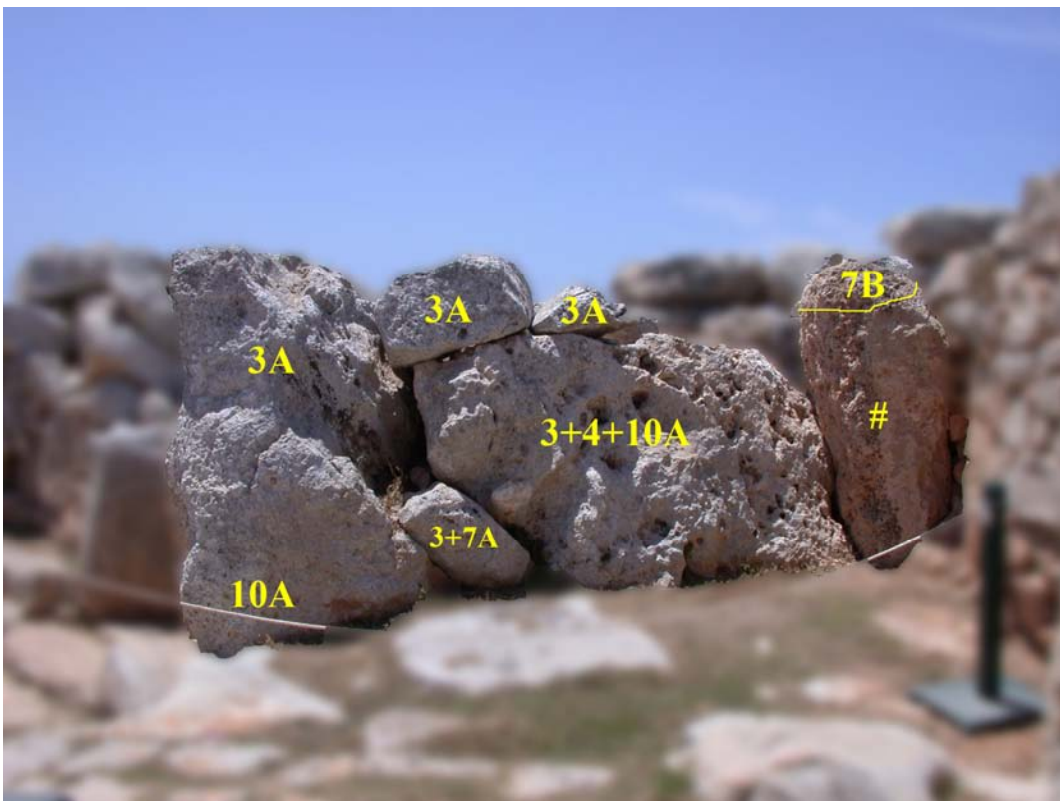
Plan 20A. Mnajdra Temples.

Numbers indicate the localization of pictures displayed below. Some pictures are not numbered in this plan, and their location is explained in the figure capture.

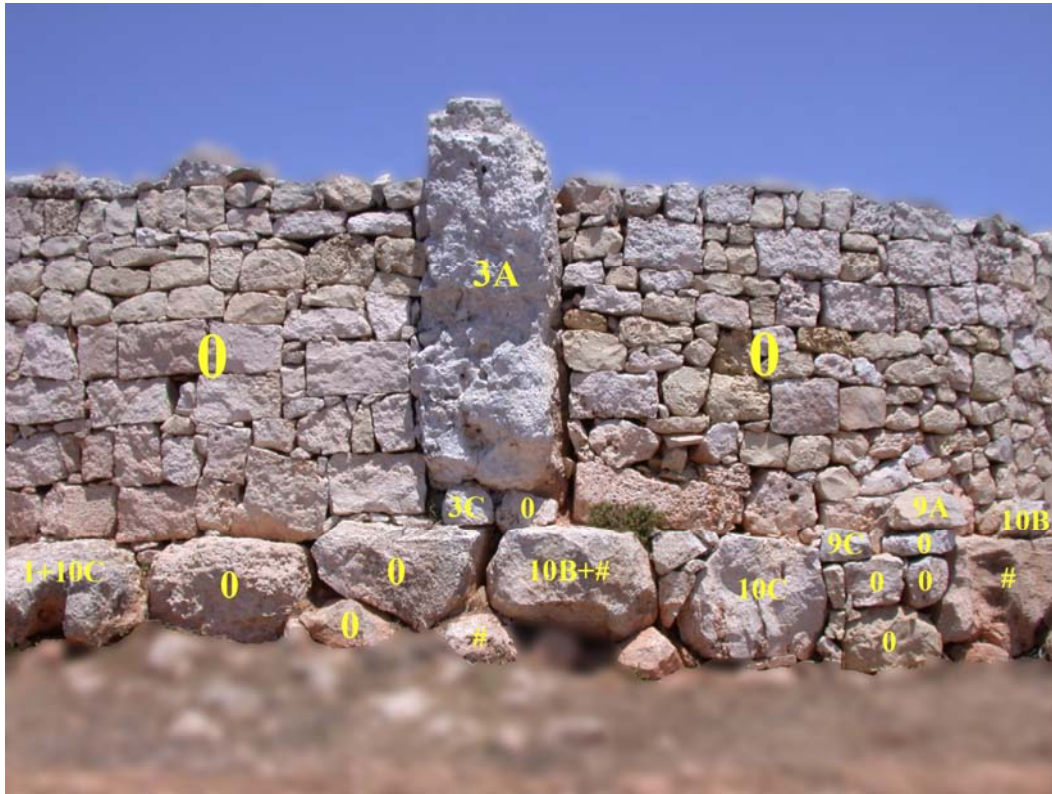
Table 1. Codes for the communities of biological crusts and percentage of covering colonization	
code	community of biological crusts
1	community of <i>Caloplaca aurantia</i>
2	community of endolithic <i>Verrucaria</i> , <i>Caloplaca</i> sp. pl. and black crust
3	community of <i>Dirina massiliensis</i>
4	community of <i>Opegrapha</i> sp. pl.
5	community of <i>Verrucaria nigrescens</i>
6	community of endolithic <i>Verrucaria</i>
7	community of <i>Lecania spadicea</i>
8	community of <i>Rocella phycopsis</i>
9	community of <i>Caloplaca variabilis</i>
10	community of endolithic <i>Caloplaca</i>
11	community of <i>Caloplaca flavescens</i>
13	black crusts
14	community of <i>Coscinocladium gaditanum</i>
#	dead lichen crust
percentage of colonization	
A	colonized surface >61 %
B	colonized surface between 26% and 60%
C	colonized surface between 5% and 25%
0	Colonization not visible (<5% of surface covered)



Colonization MN1.



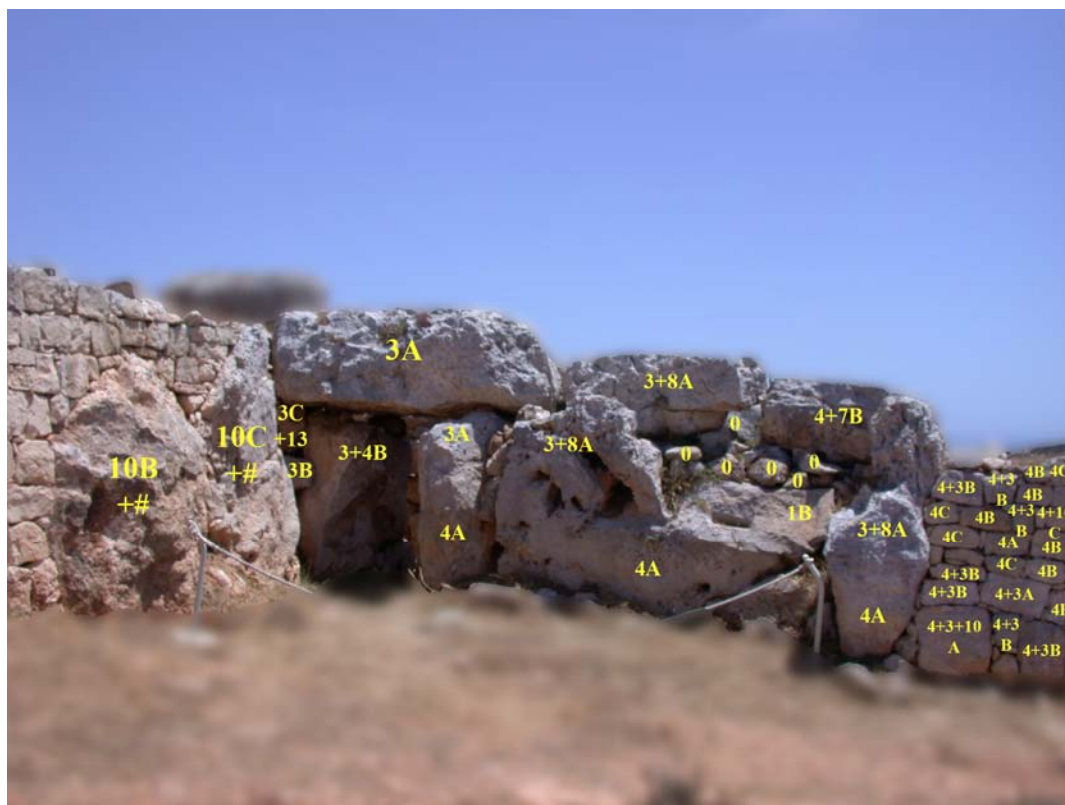
Colonization MN2.



Colonization MN5.



Colonization MN6.



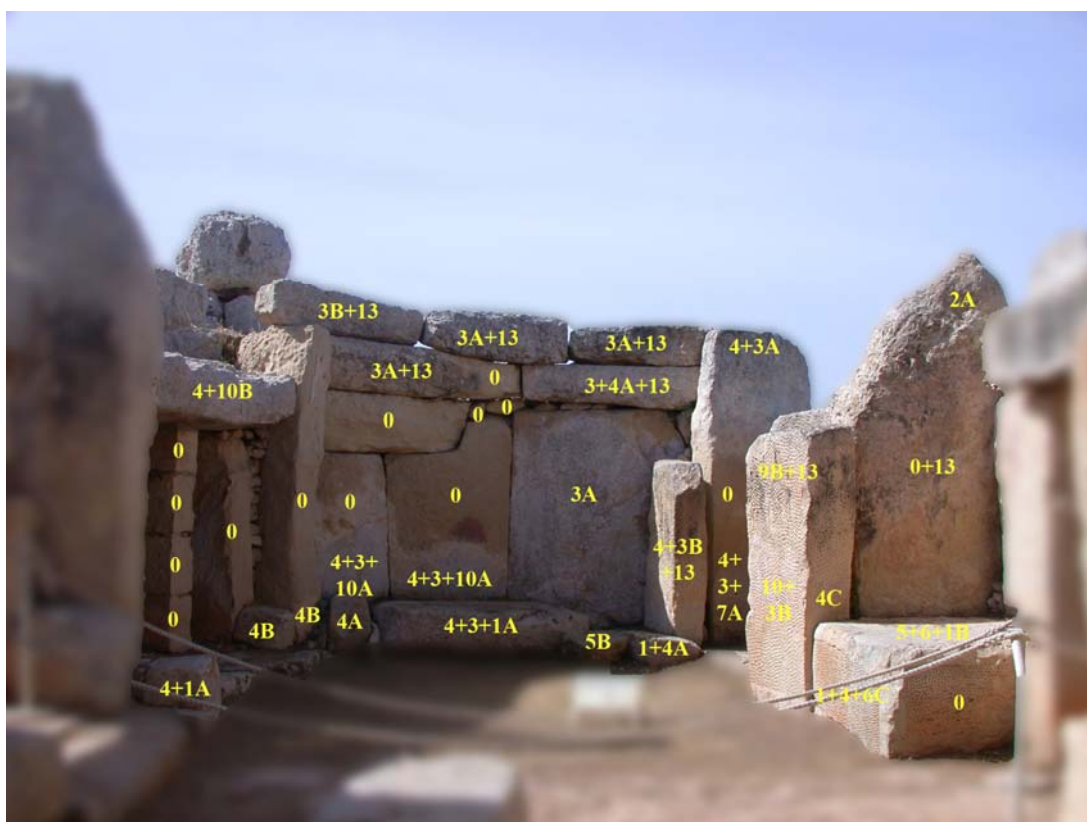
Colonization MN7.



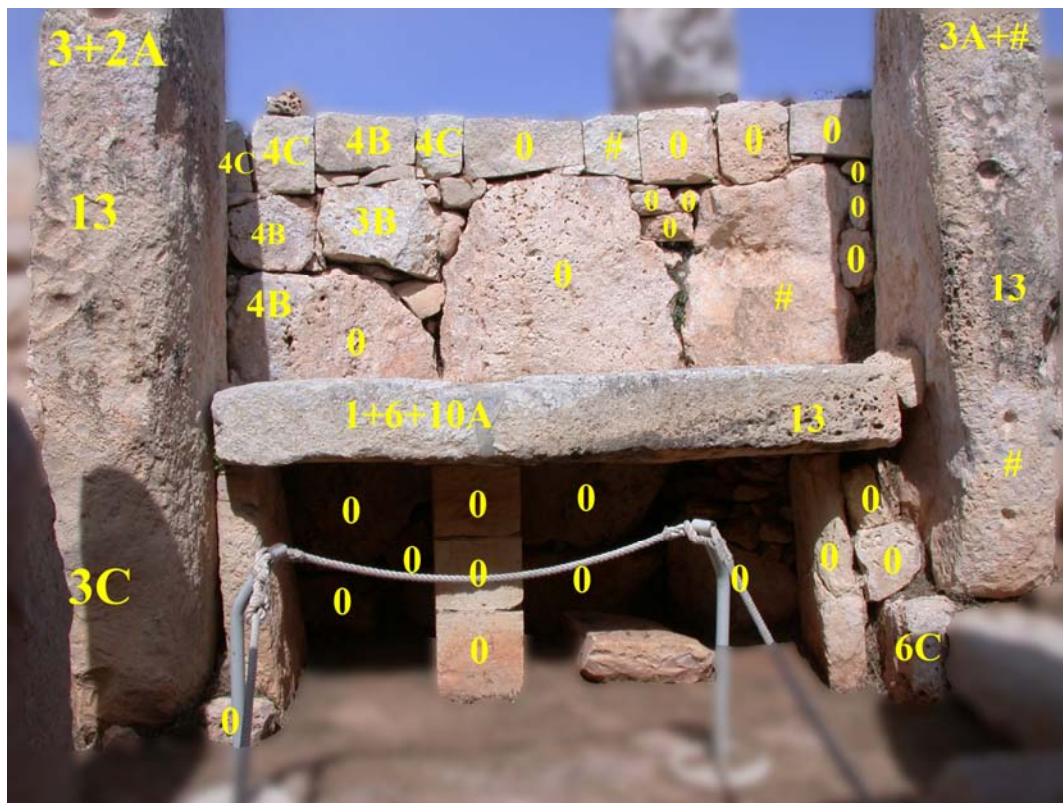
Colonization MN8.



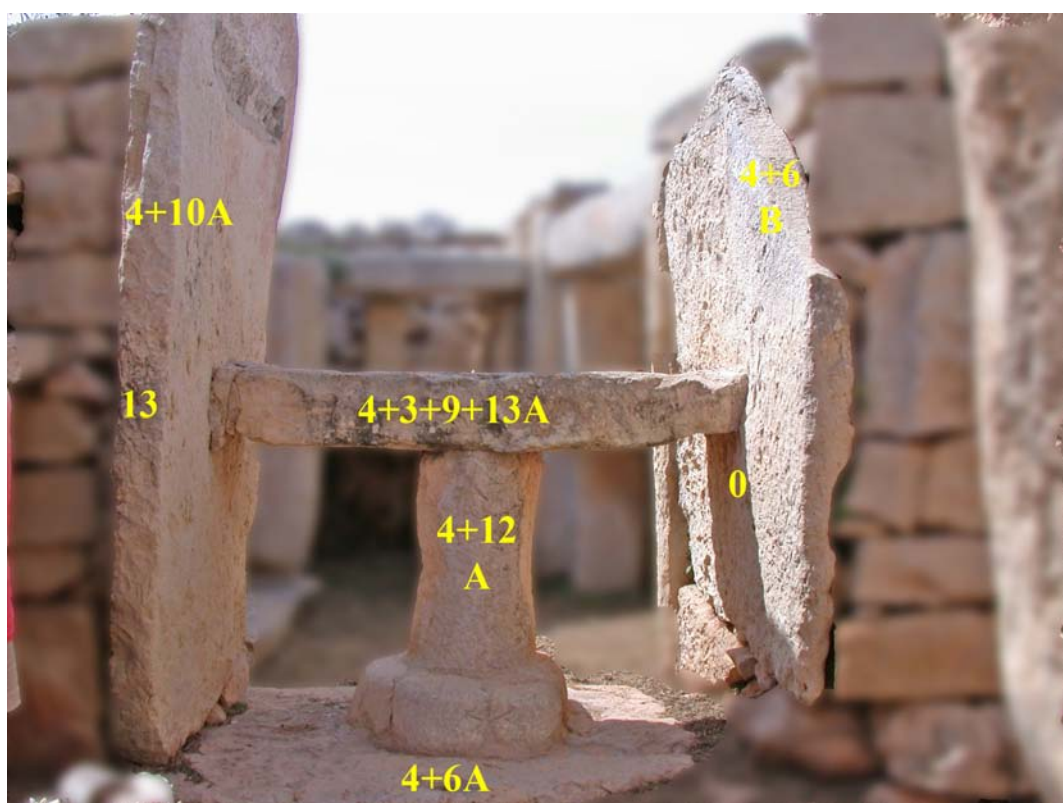
Colonization MN9. Room 1 right.



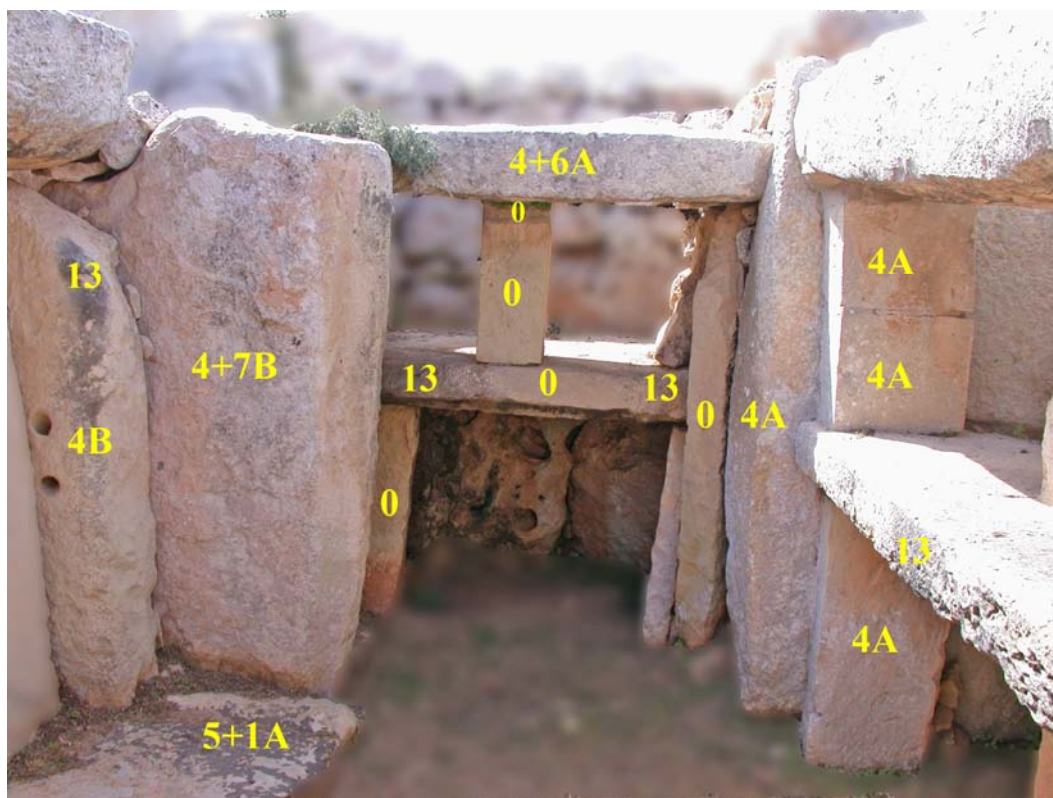
Colonization MN10. Room 1 left.



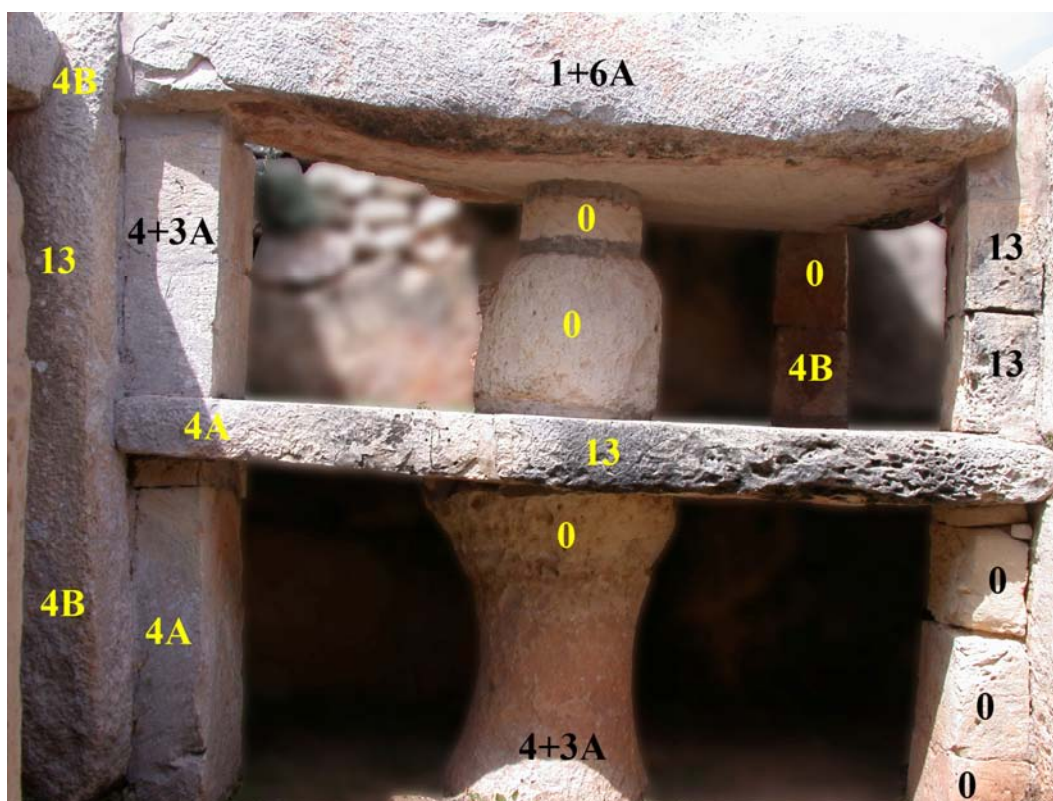
Colonization MN11. Room 2 ε.



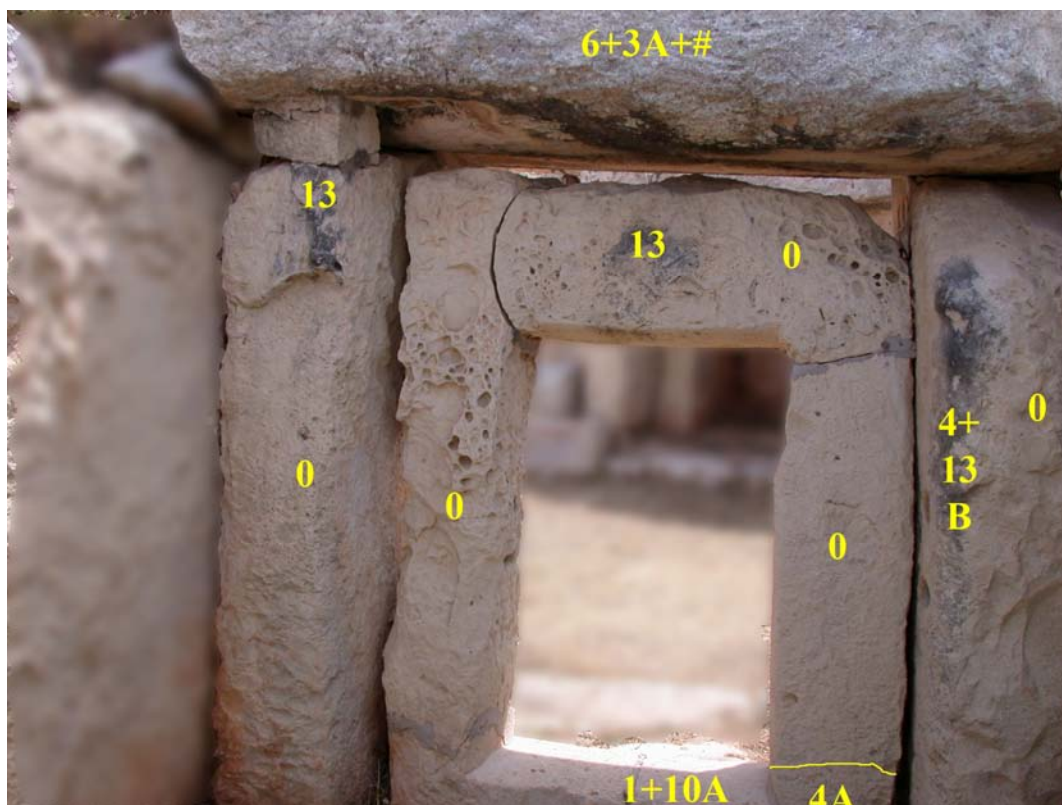
Colonization MN12. Room 2 δ.



Colonization MN13. Room 3 γ.



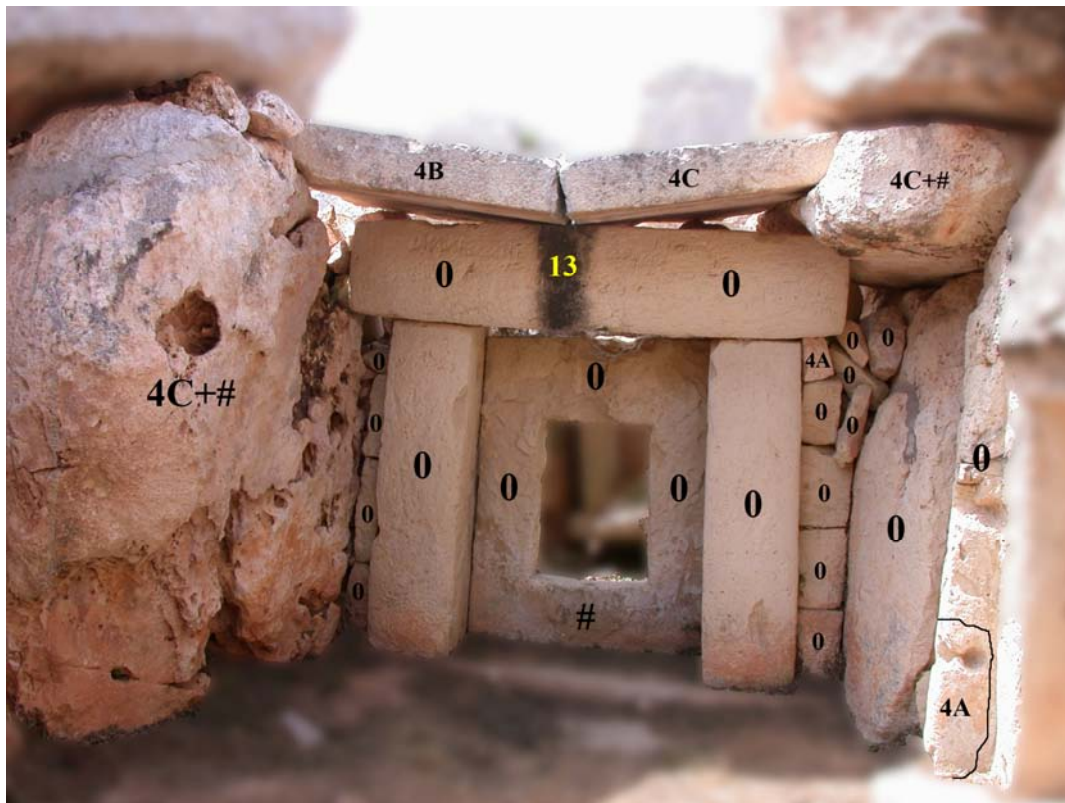
Colonization MN14. Room 3 β.



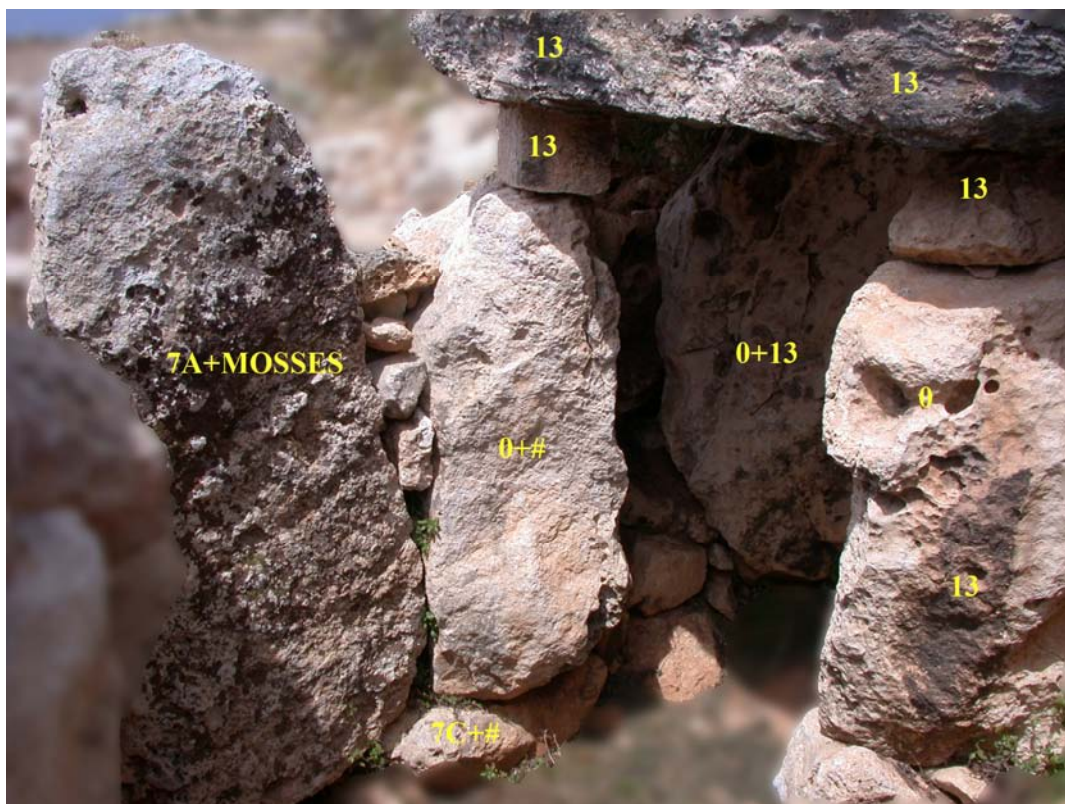
Colonization MN15. Room 3.



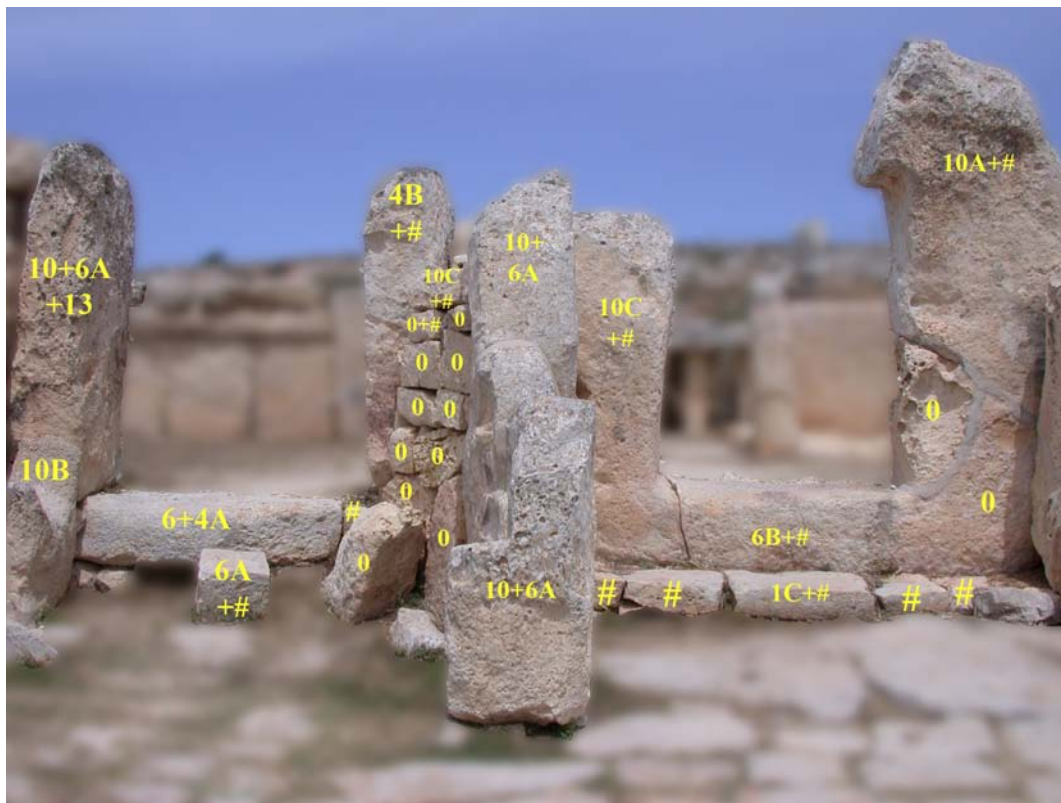
Colonization MN16. Room 4.



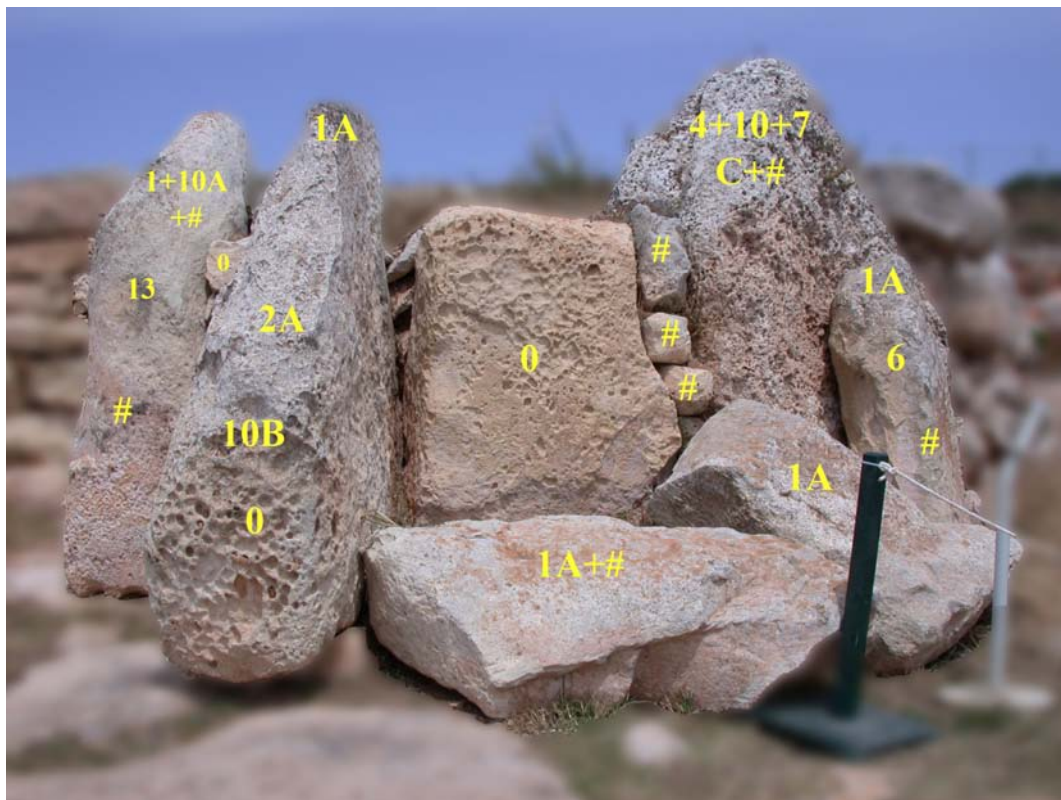
Colonization MN17. Room 5.



Colonization MN18. Room 6.



Colonization MN19.



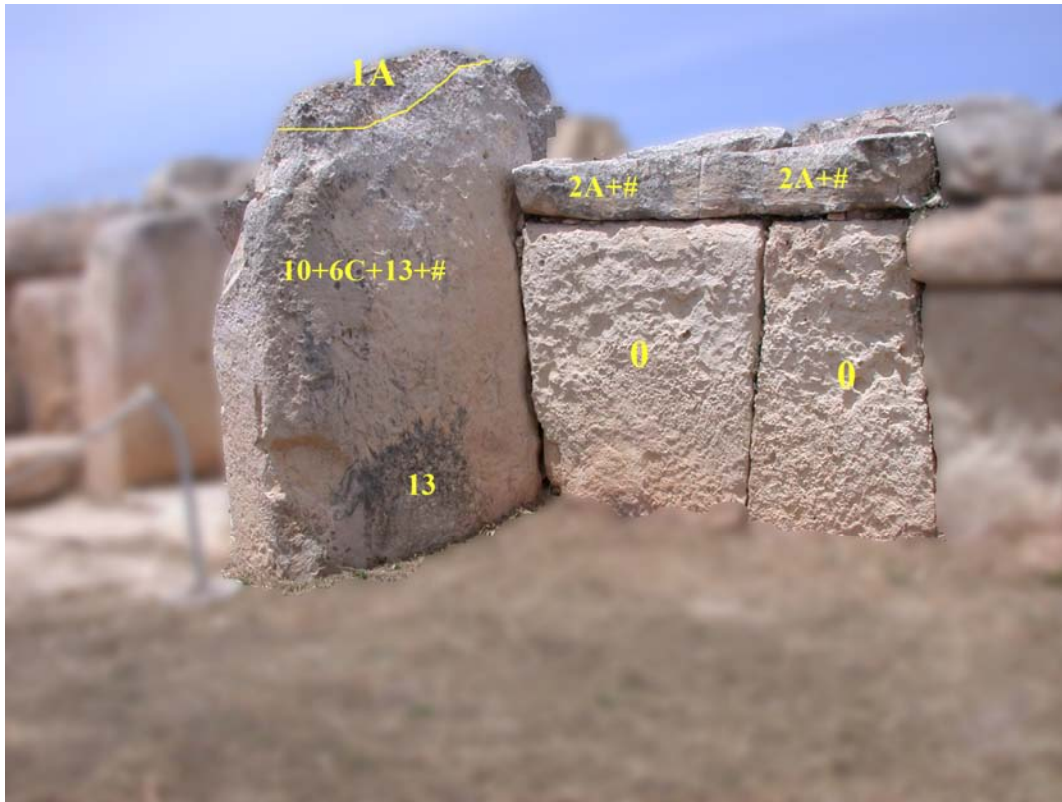
Colonization MN20.



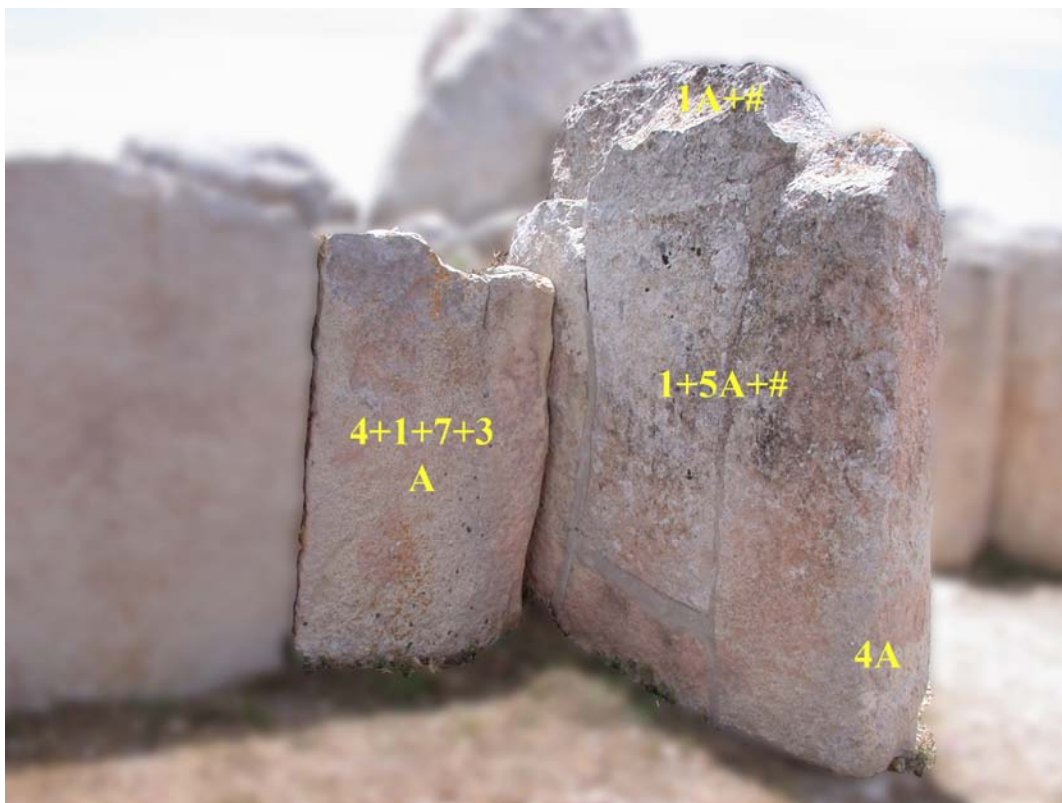
Colonization MN21. Room 7 right.



Colonization MN22. Room 7 right.



Colonization MN23. Room 7 right.



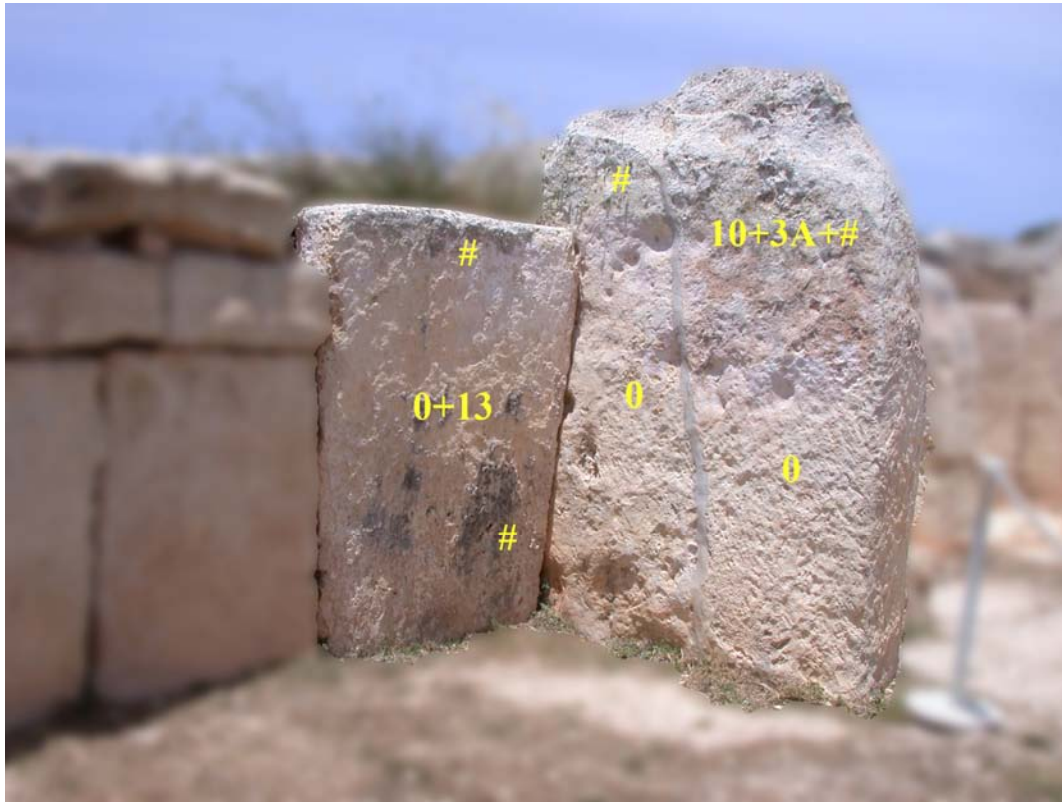
Colonization MN24. Room 7 right.



Colonization MN25. Room 7 left.



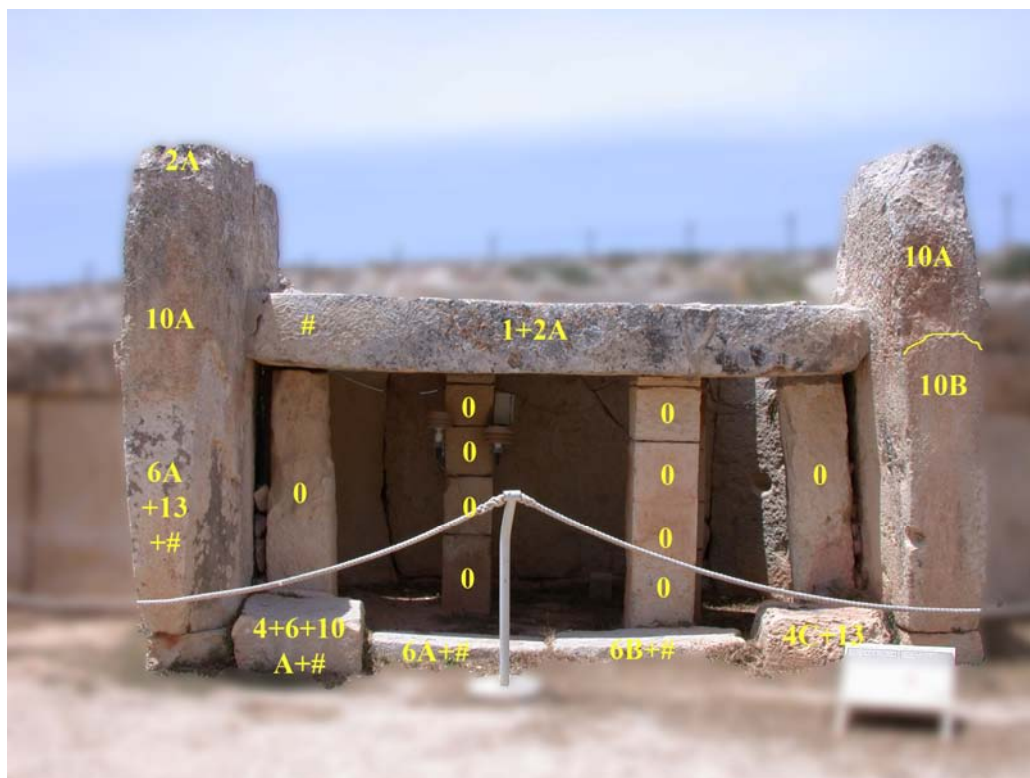
Colonization MN26. Room 7 left.



Colonization MN27. Room 7 left.



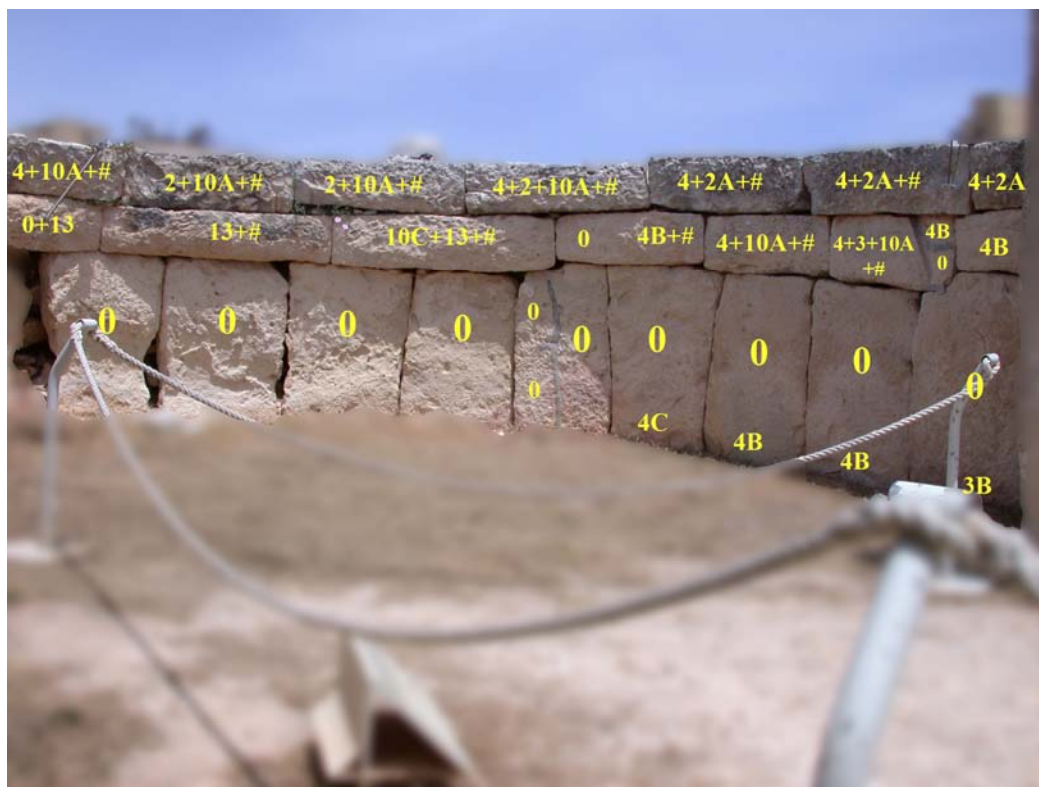
Colonization MN28. Room 7 central area.



Colonization MN29. Room 8 Θ.



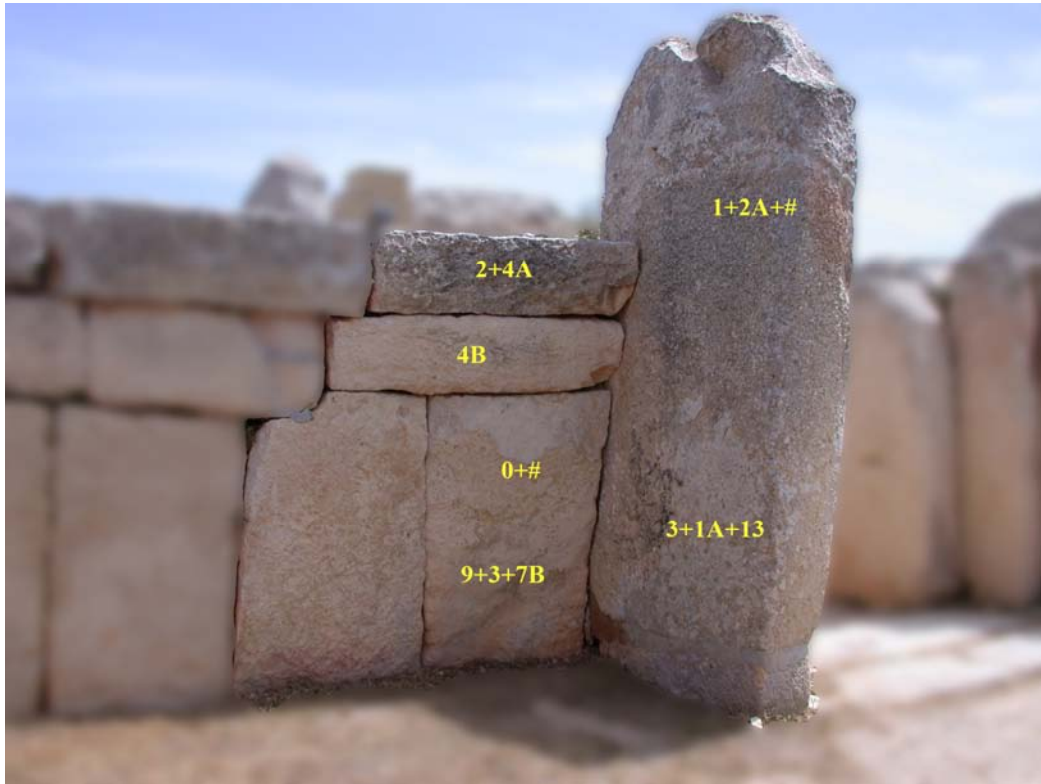
Colonization MN30. Room 8 right.



Colonization MN31. Room 8 right.



Colonization MN32. Room 8 right.



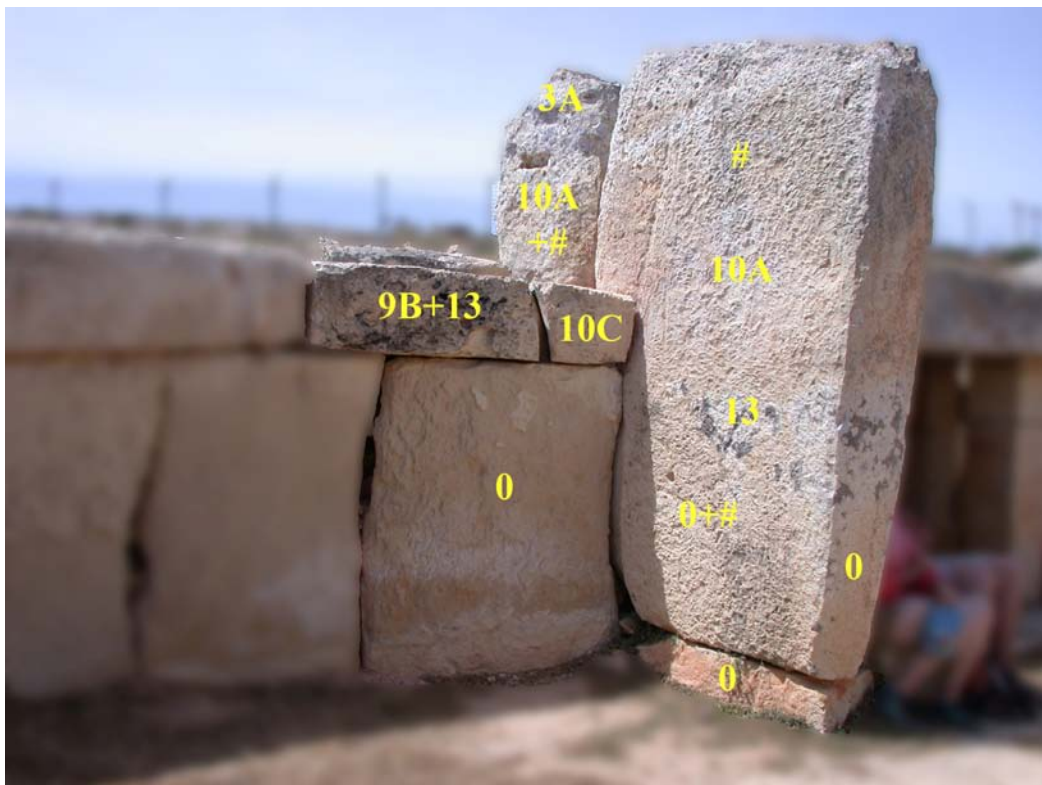
Colonization MN33. Room 8 right.



Colonization MN34. Room 8 left.



Colonization MN35. Room 8 left.



Colonization MN36. Room 8 left.



Colonization MN37. Room 8 left.

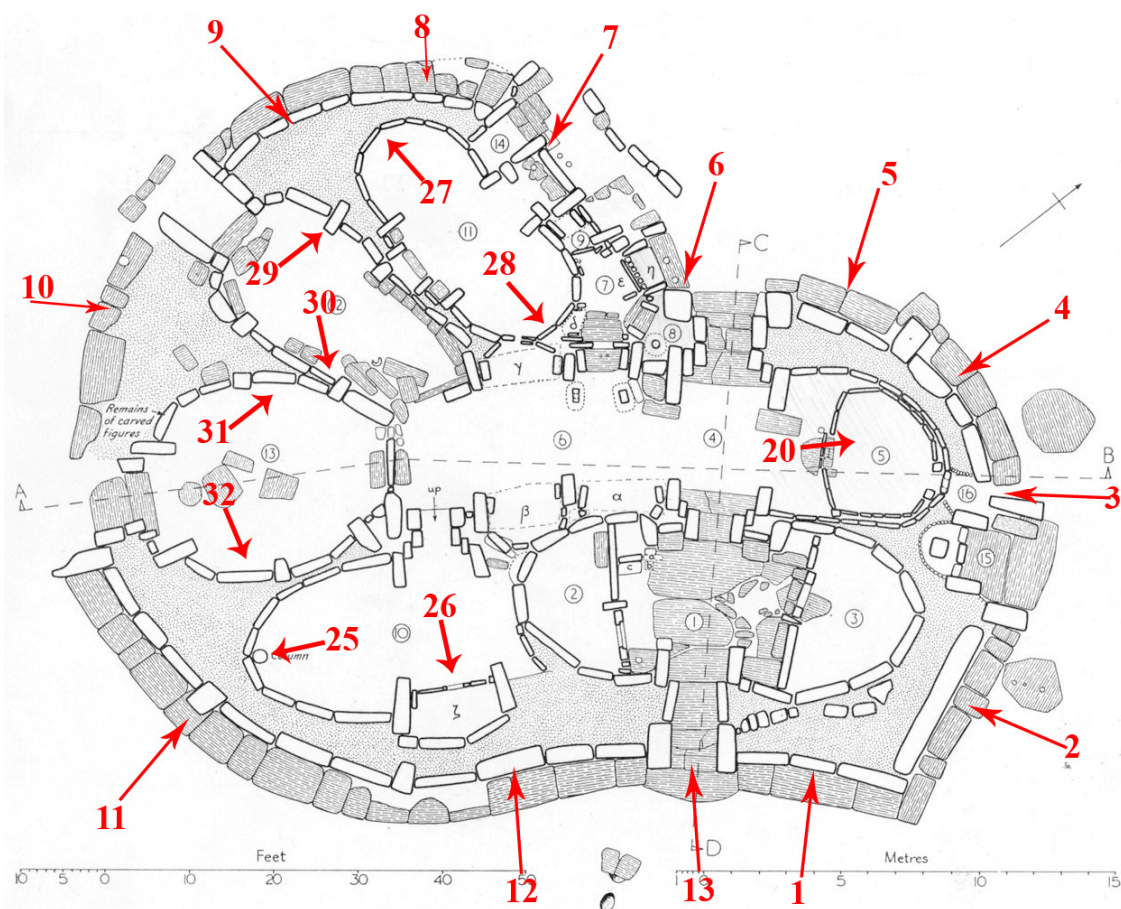


Colonization MN38. Small temple.



Colonization MN39. Small temple.

2.2. Haġar Qim

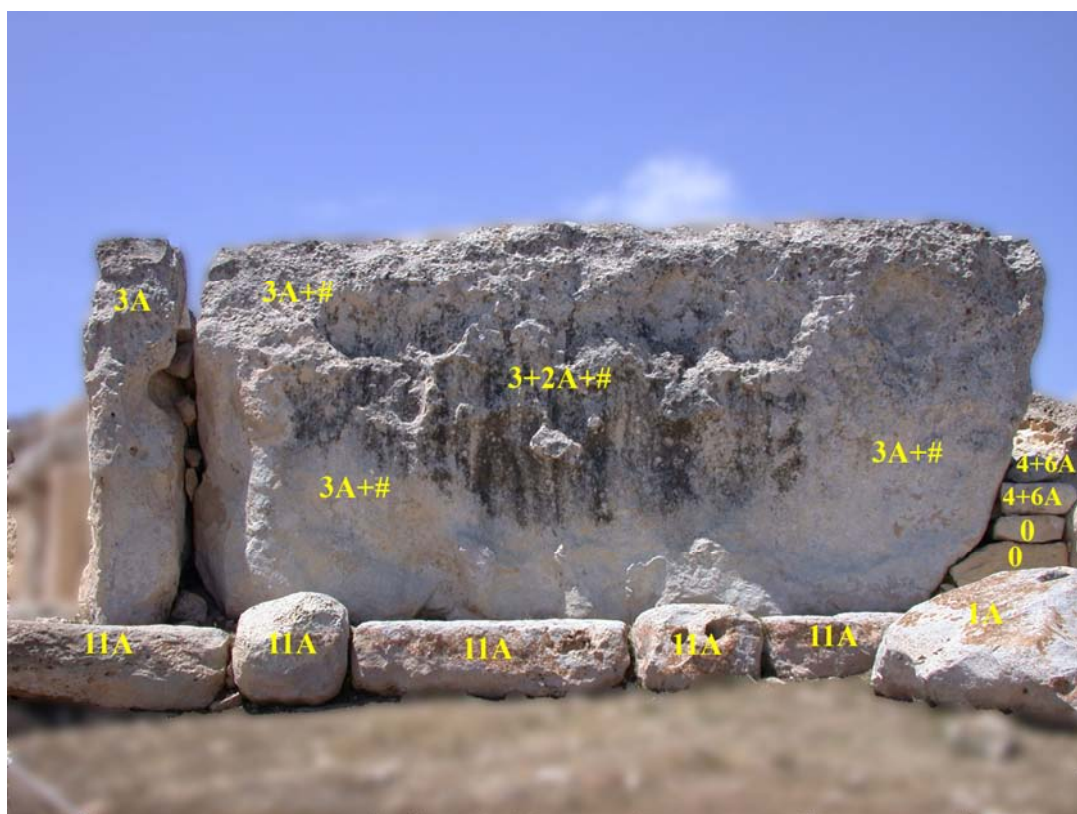


Plan r8A. Haġar Qim Temples: main building.

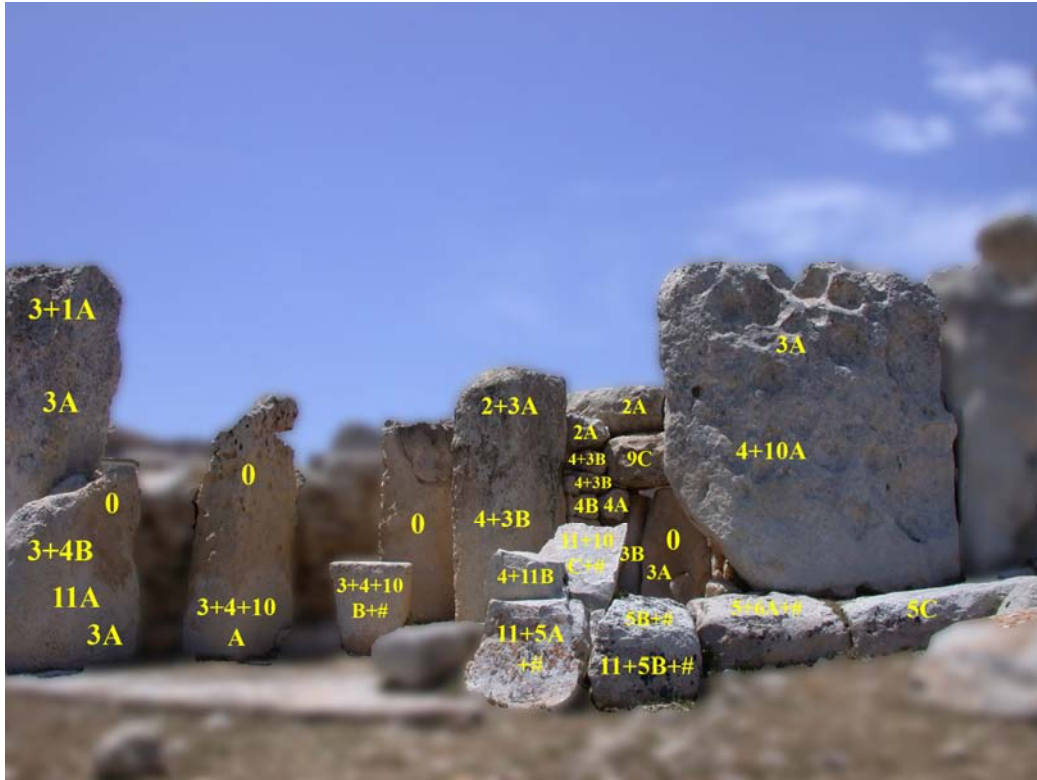
Numbers indicate the localization of pictures displayed below. Some pictures are not numbered in this plan, and their location is explained in the figure capture.



Colonization HQ1.



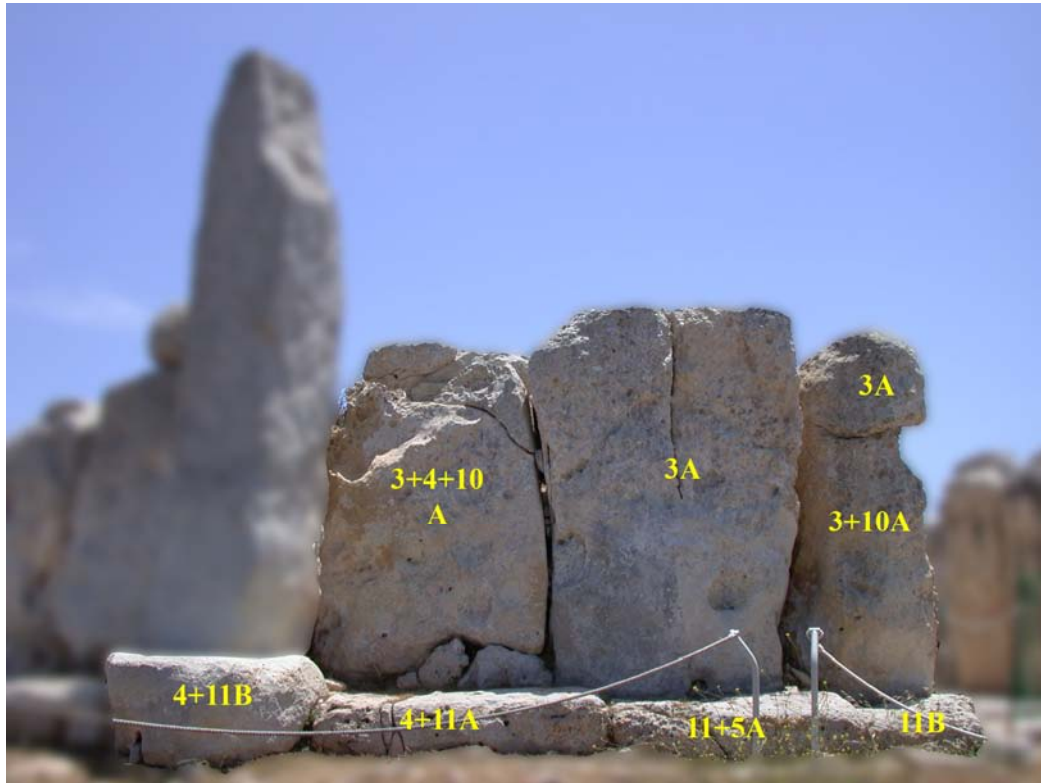
Colonization HQ2.



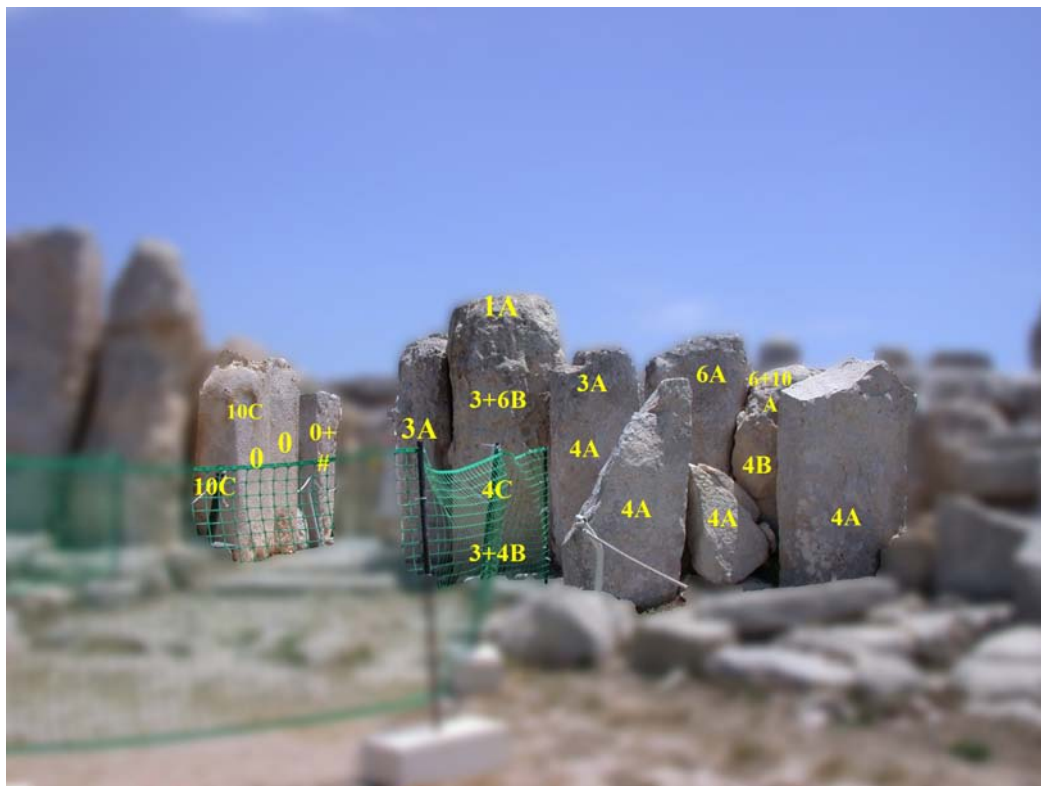
Colonization HQ3.



Colonization HQ4.



Colonization HQ5.



Colonization HQ6.



Colonization HQ7.



Colonization HQ8.

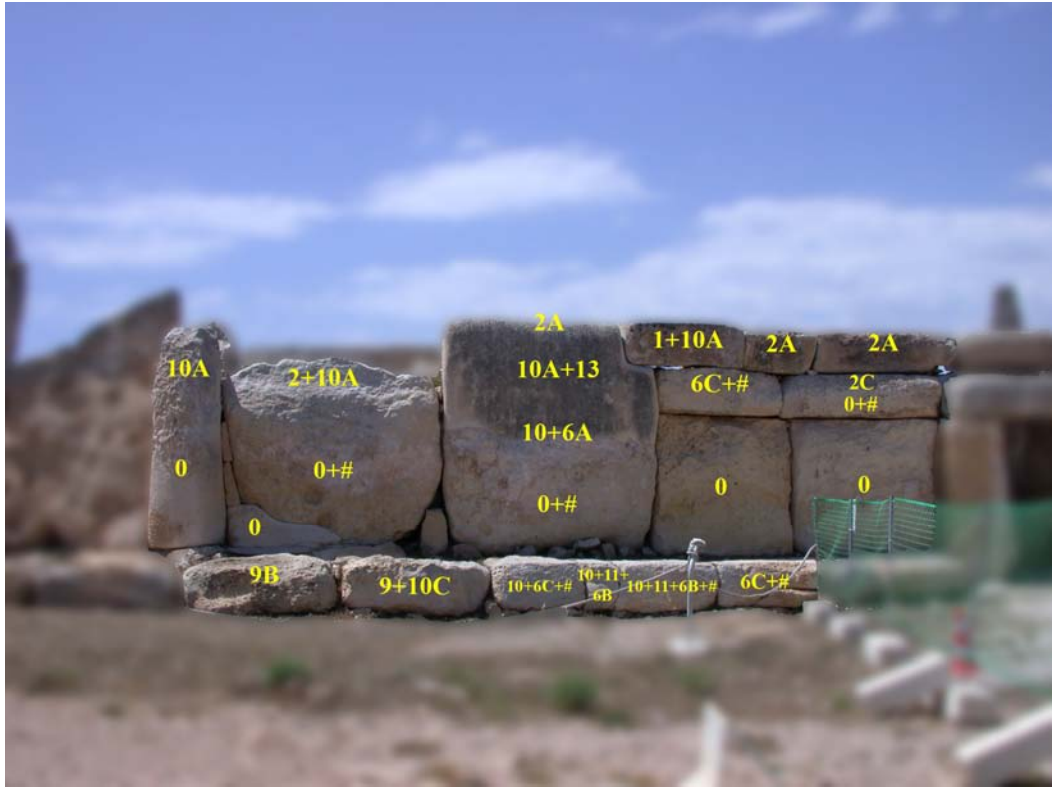


Colonization HQ9.



Colonization HQ10.

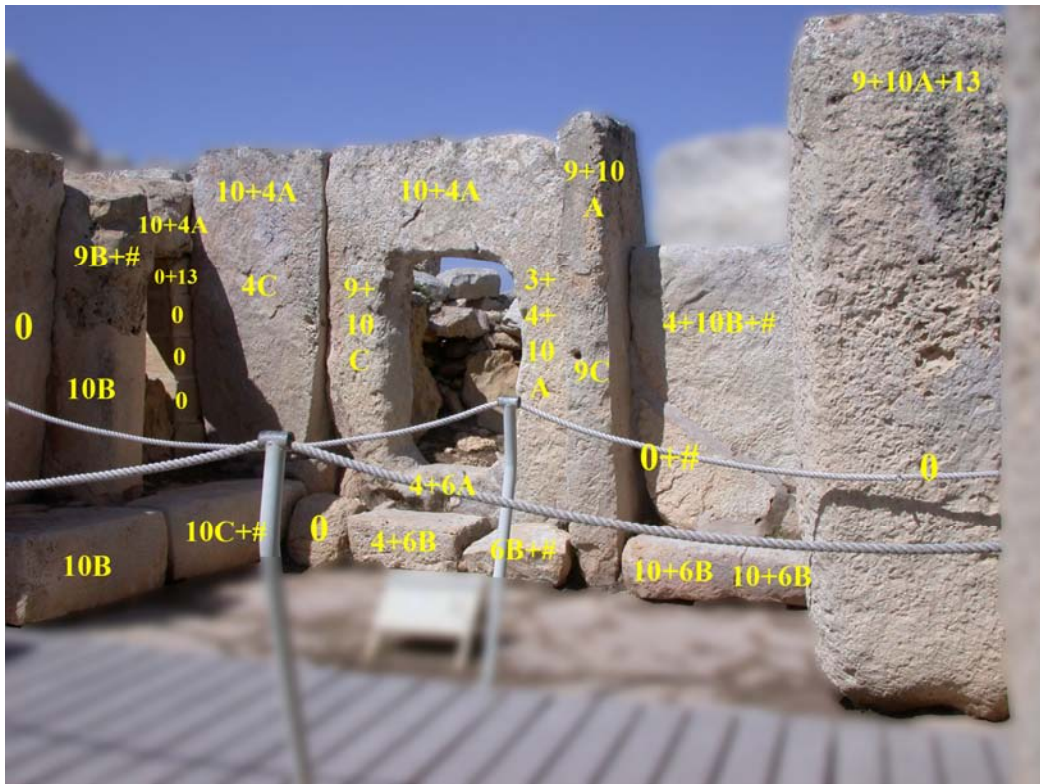
Colonization HQ11.



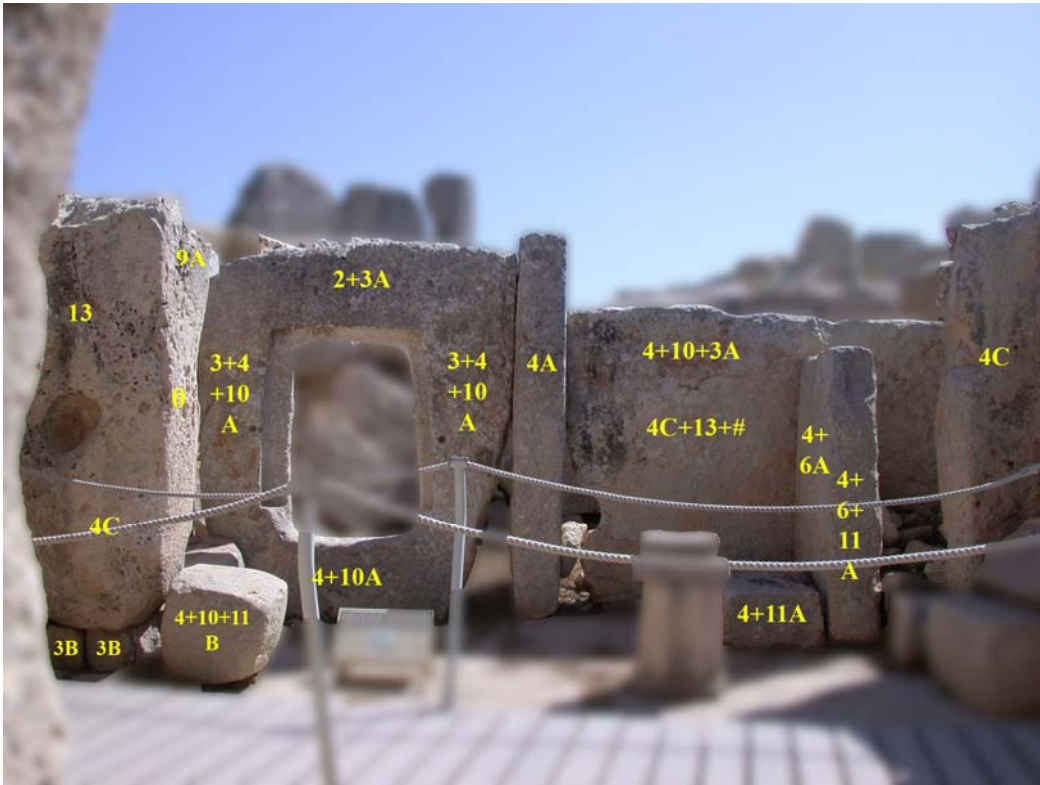
Colonization HQ12.



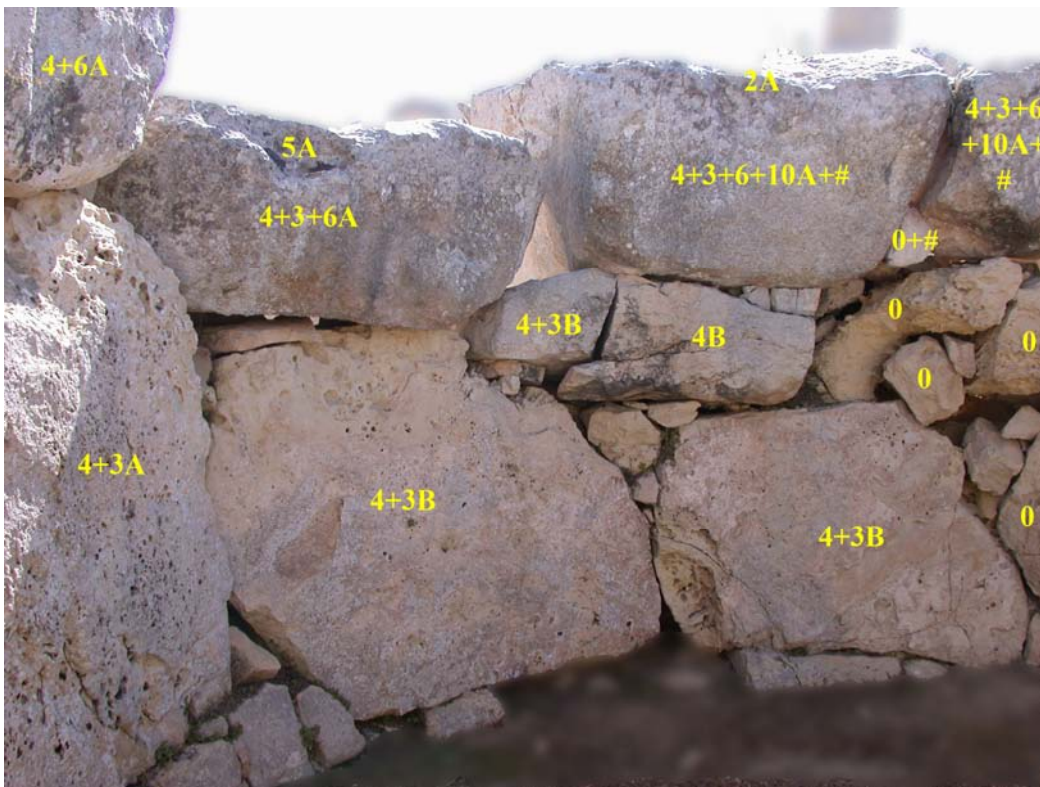
Colonization HQ13.



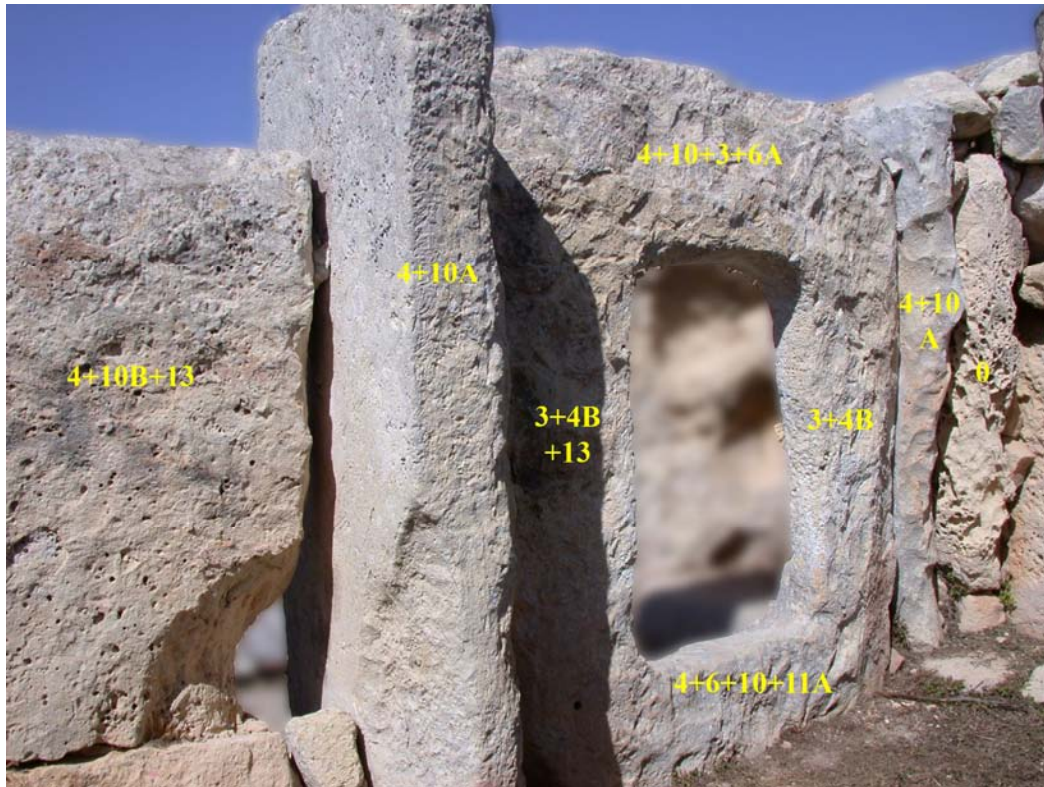
Colonization HQ14. Room 1 left.



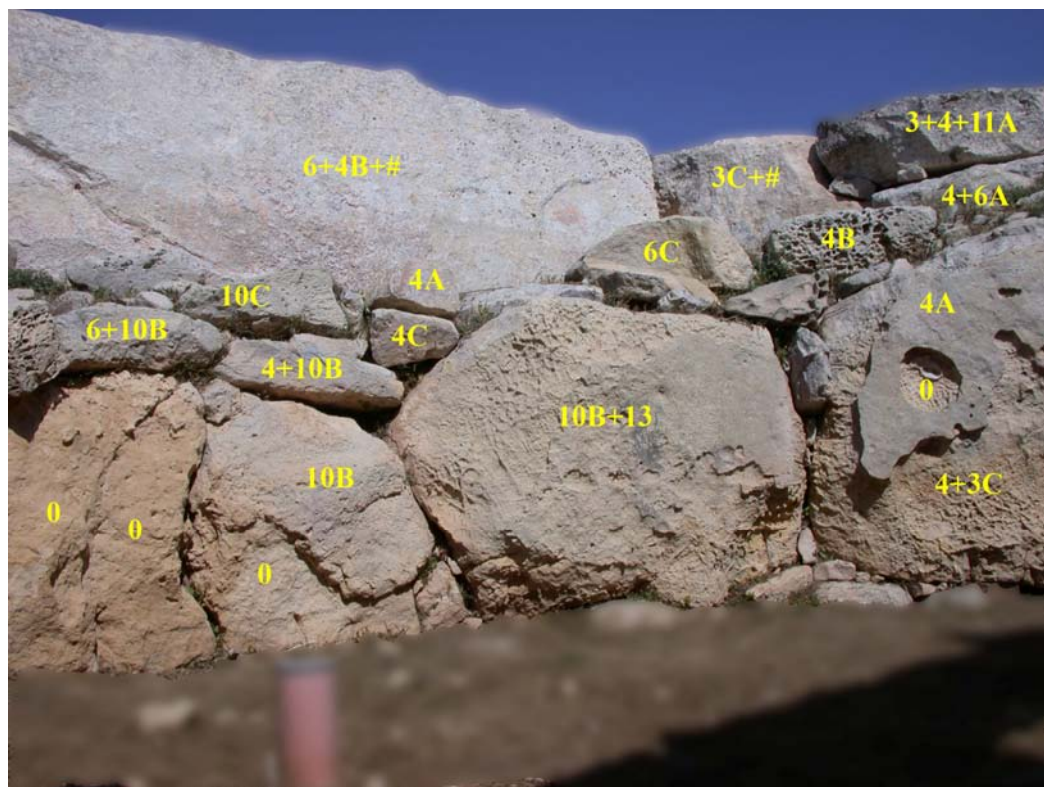
Colonization HQ15. Room 1 right.



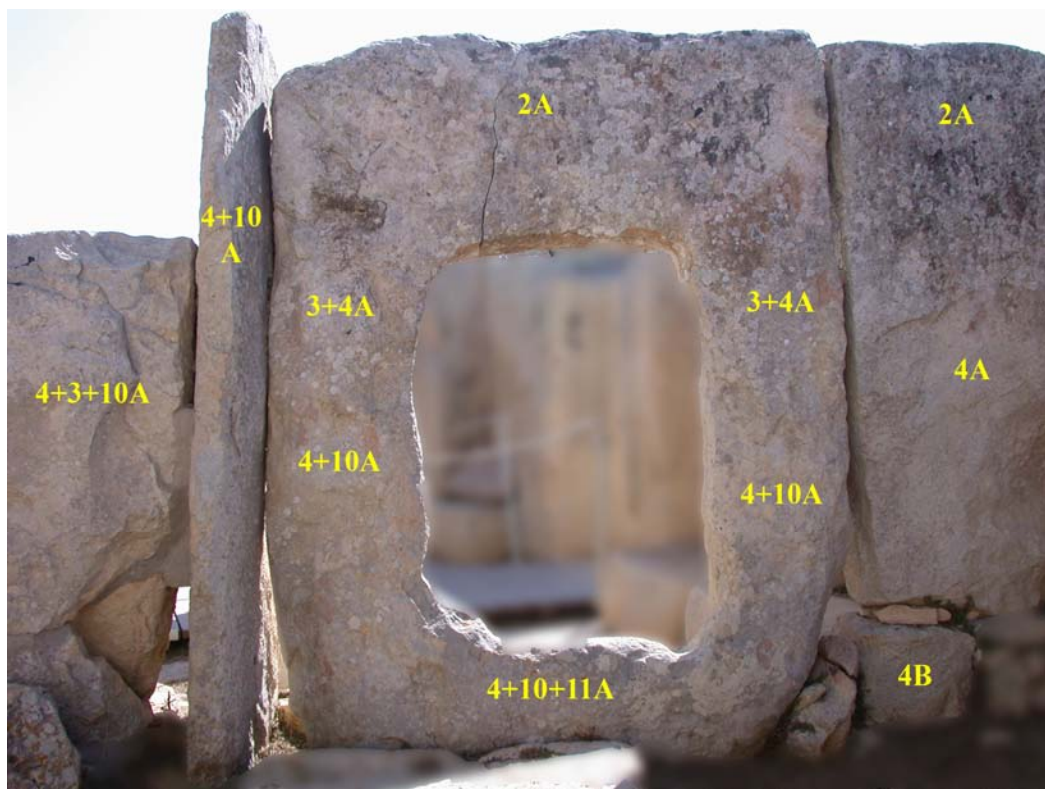
Colonization HQ16. Room 2.



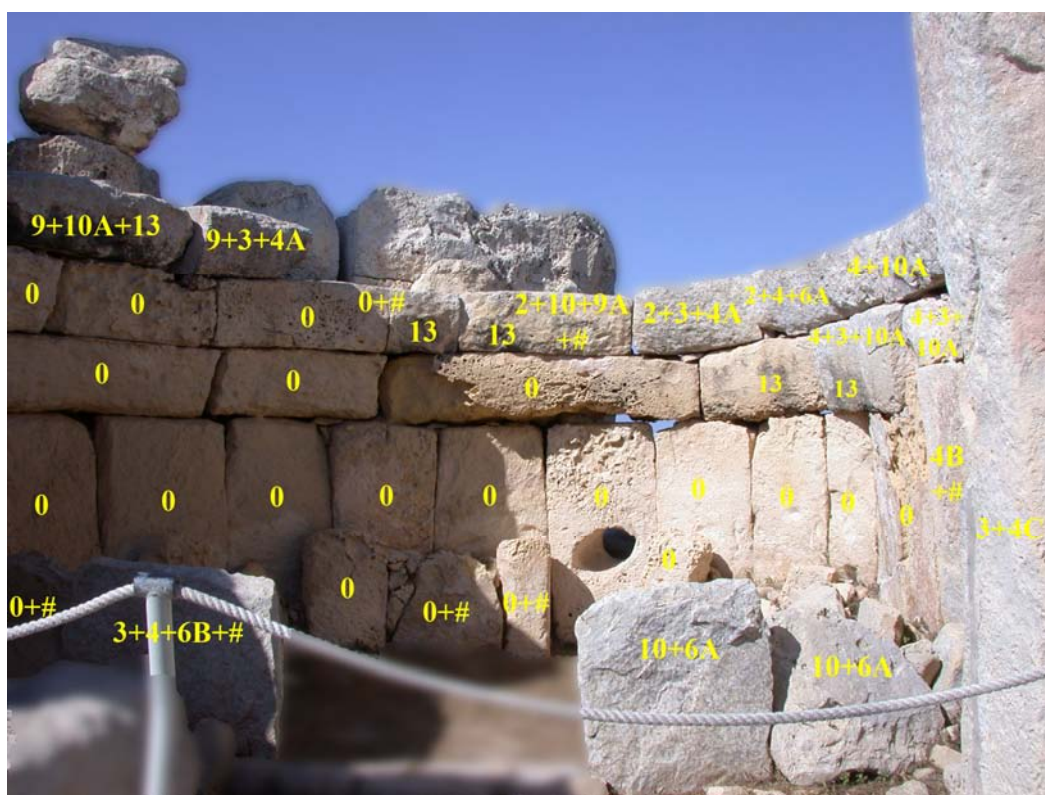
Colonization HQ17. Room 2.



Colonization HQ18. Room 3.



Colonization HQ19. Room 3.



Colonization HQ20. Room 5.



Colonization HQ21. Room 6 right side.



Colonization HQ22. Room 6 left side.



Colonization HQ23. Room 7.

Colonization HQ24. Room 8.





Colonization HQ25. Room 10.



Colonization HQ26. Room 10 ξ.



Colonization HQ27. Room 11, right side.



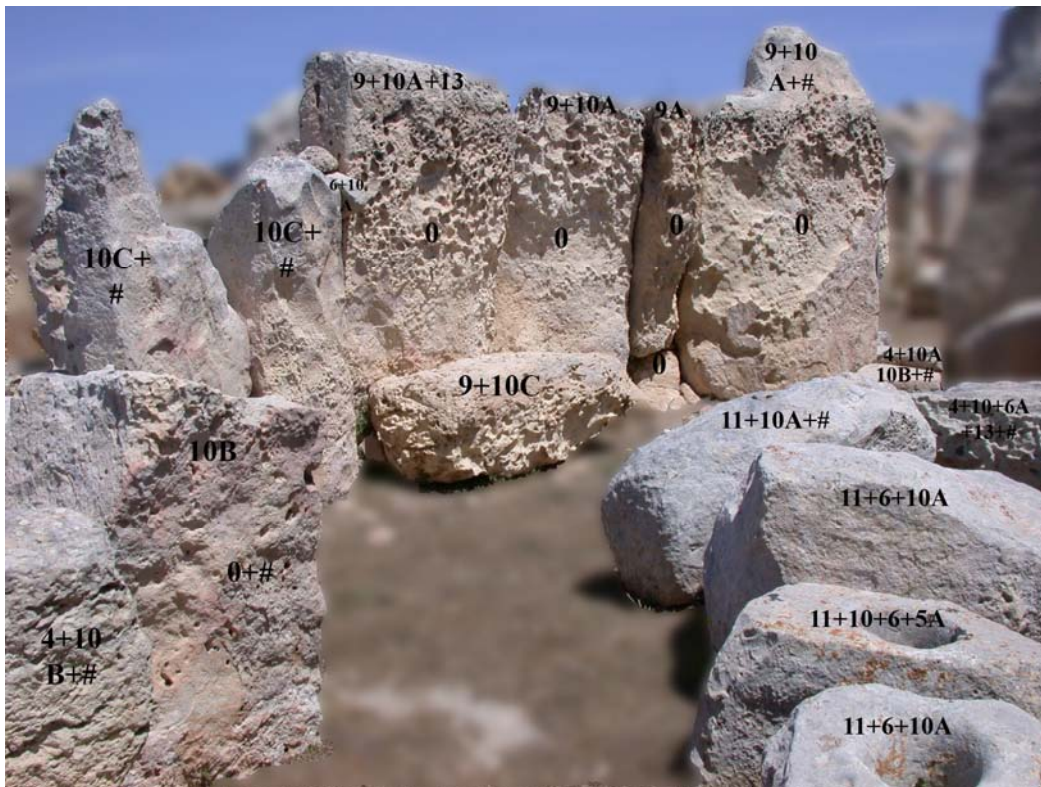
Colonization HQ28. Room 11, left side.



Colonization HQ29. Room 12, left side.



Colonization HQ30. Room 12, right side.



Colonization HQ31. Room 13, left side.



Colonization HQ32. Room 13, right side.



Environmental Monitoring at Haġar Qim and Mnajdra Temples

Final Report

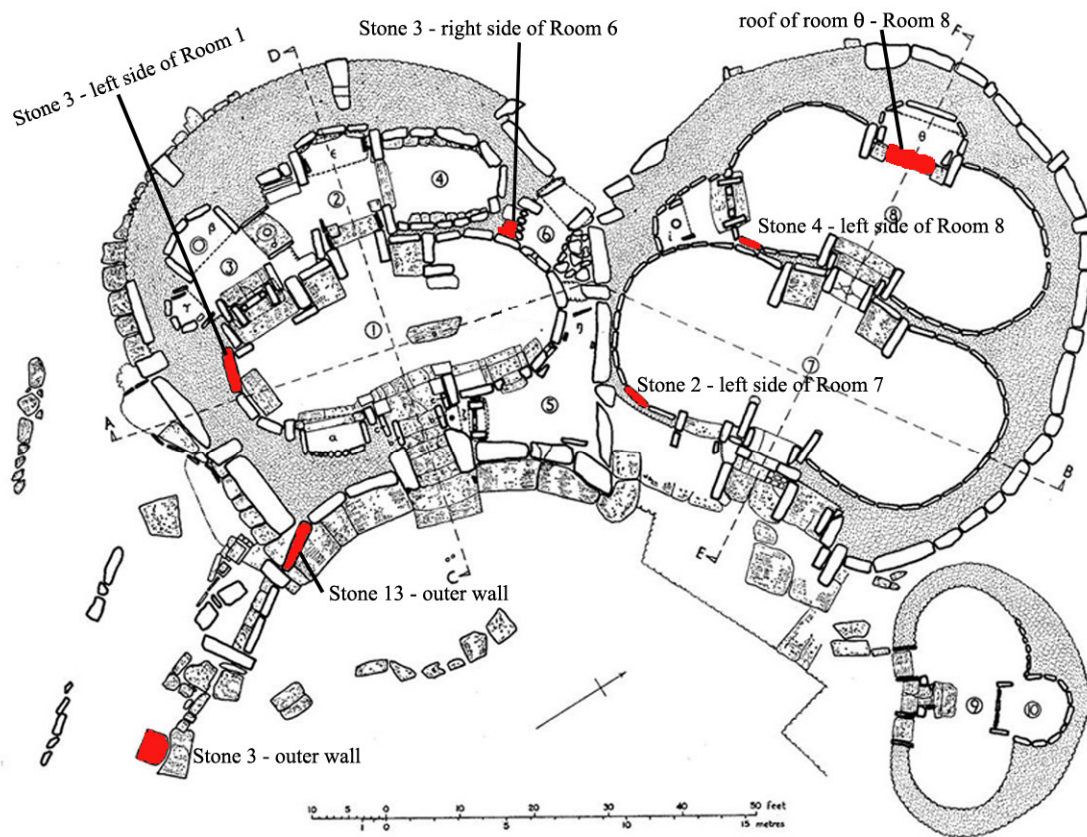
October 2008

Appendix III Controls

Contents

1. Mnajdra	2
2. Haġar Qim	23
3. Unsheltered controls	36

1. Mnajdra



Plan 20A. Mnajdra Temples.

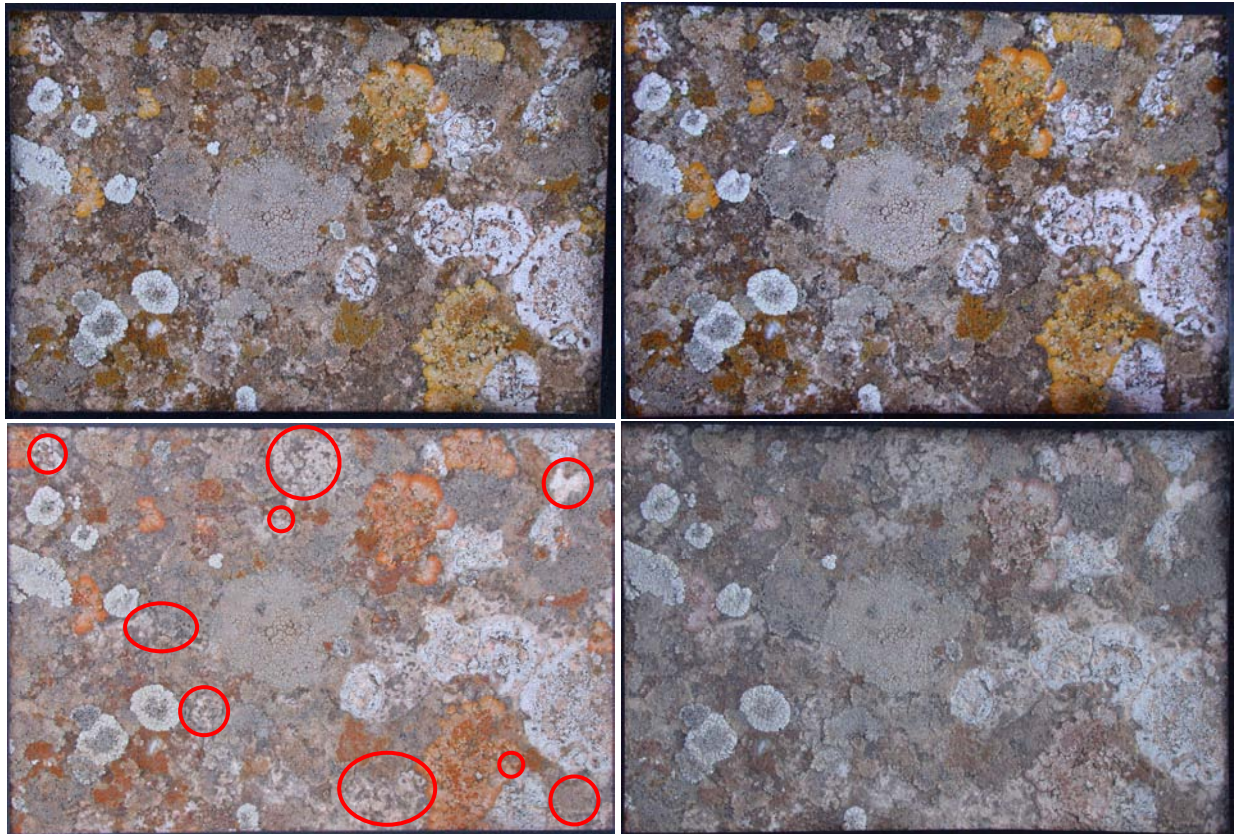
Situation of sampled stones for monitoring.

Community of *Caloplaca aurantia*

Stone 3 – outer wall



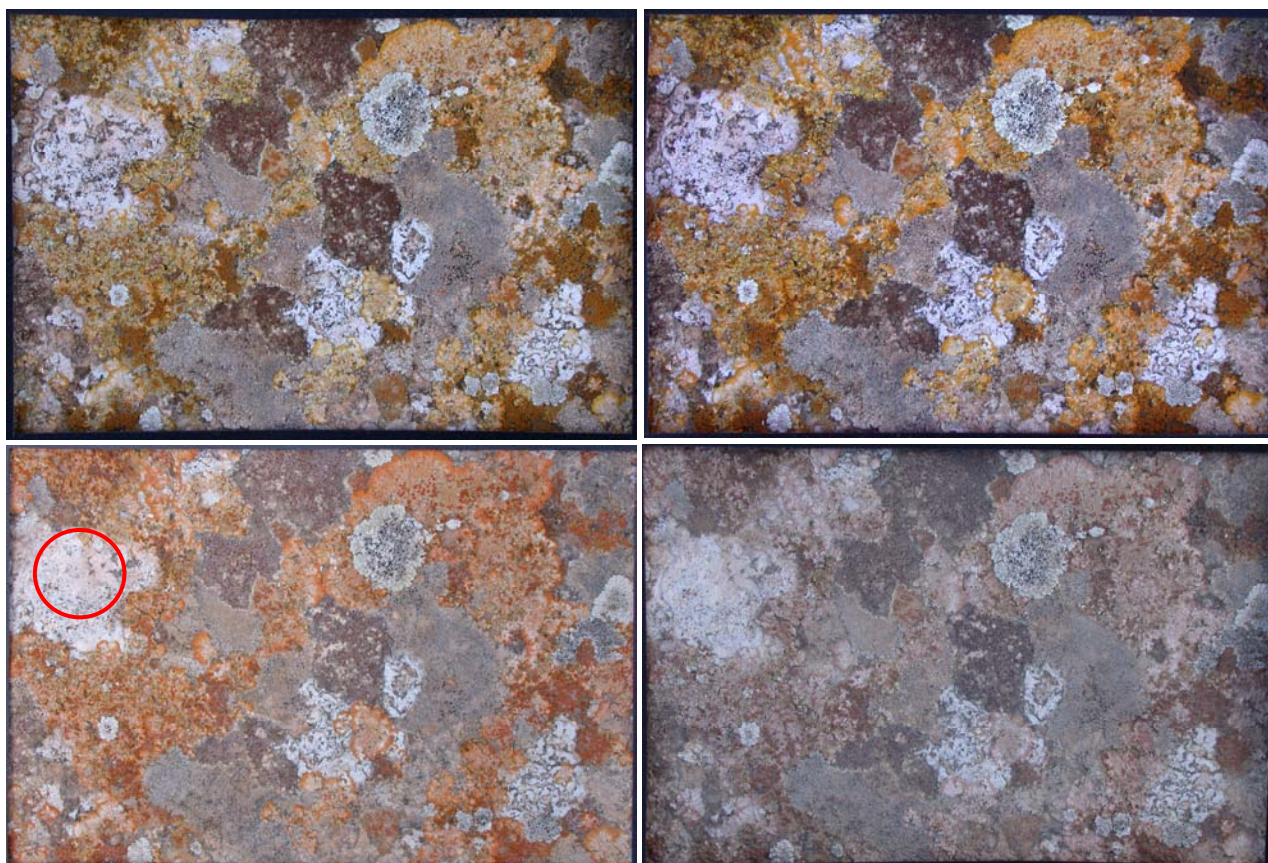
General view.



Sample MN-1. X = 40, Y = 37, 40°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN1

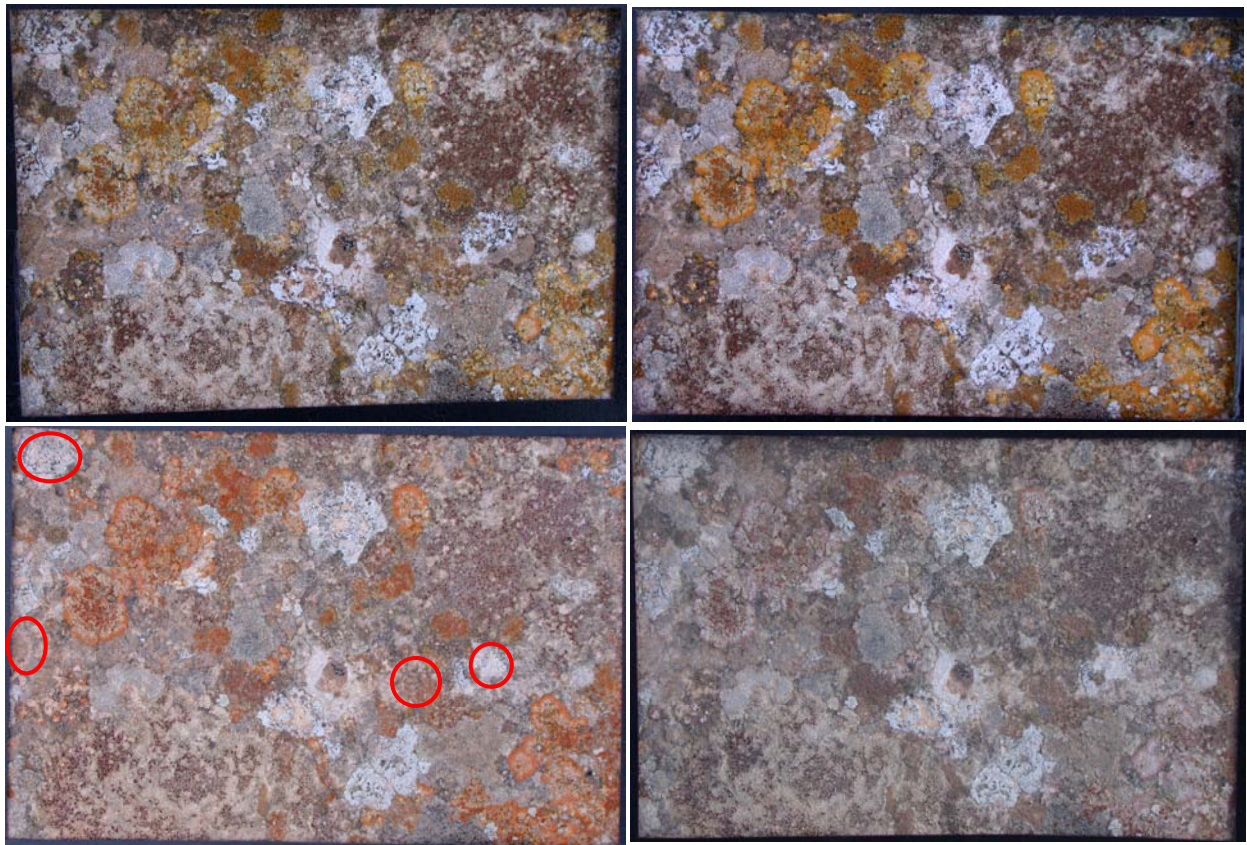
Exposure	horizontal	Species	% of cover	nº of thalli
Orientation		<i>Aspicilia hoffmanii</i>	5,38	2
Species richness	7	<i>Caloplaca aurantia</i>	9,57	15
% cover community	99,93	<i>Caloplaca citrina</i>	9,02	52
Total of thalli	107	<i>Caloplaca variabilis</i>	61,56	9
		<i>Lecanora albescens</i>	0,73	6
		<i>Protoparmeliopsis muralis</i>	3,16	9
		<i>Verrucaria calciseda</i>	10,59	14



Sample MN-2. X = 40, Y = 68, 42°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN2

Exposure	horizontal	Species	% of cover	nº of thalli
Orientation		<i>Aspicilia hoffmanii</i>	1,81	2
Species richness	10	<i>Caloplaca aurantia</i>	45,83	23
% cover community	99,34	<i>Caloplaca citrina</i>	5,86	17
Total of thalli	112	<i>Caloplaca aff. subochracea</i>	10,57	5
		<i>Caloplaca navasiana</i>	1,15	5
		<i>Caloplaca variabilis</i>	19,26	26
		<i>Lecanora albescens</i>	1,37	12
		<i>Protoparmeliopsis muralis</i>	2,58	10
		<i>Toninia aromatica</i>	0,09	1
		<i>Verrucaria calciseda</i>	11,47	11



Sample MN-3. X = 20, Y = 52, 40°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

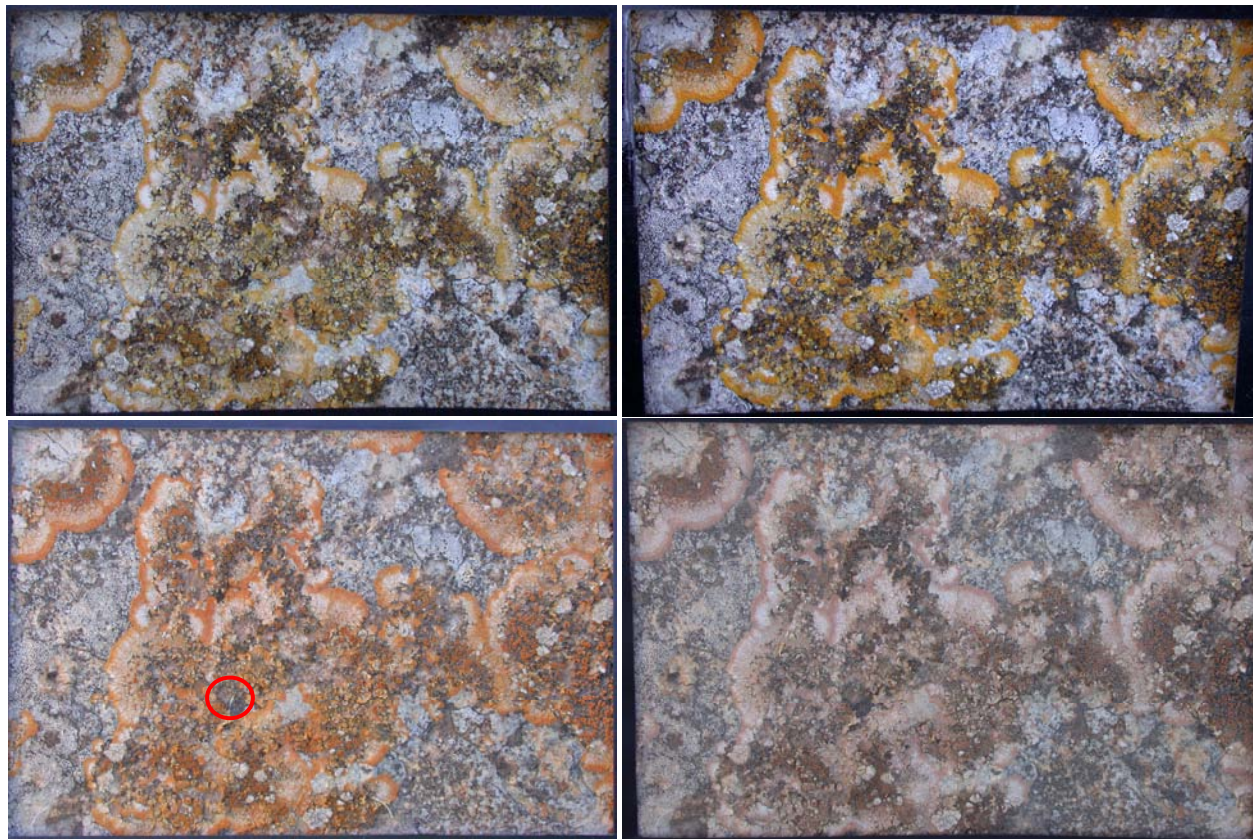
MN3

Exposure	horizontal	Species	% of cover	nº of thalli
Orientation		<i>Caloplaca aurantia</i>	12,15	39
Species richness	10	<i>Caloplaca citrina</i>	14,00	36
% cover community	81,61	<i>Caloplaca aff. subochracea</i>	38,06	9
total of thalli	117	<i>Caloplaca navasiana</i>	1,06	3
		<i>Caloplaca variabilis</i>	22,30	11
		<i>Diplotomma epipolium</i>	4,07	7
		<i>Lecania turicensis</i>	0,04	1
		<i>Lecanora albescens</i>	0,12	1
		<i>Toninia aromatica</i>	0,12	1
		<i>Verrucaria macrostoma</i>	8,08	9

Exposed roof of space 0 - Room 8



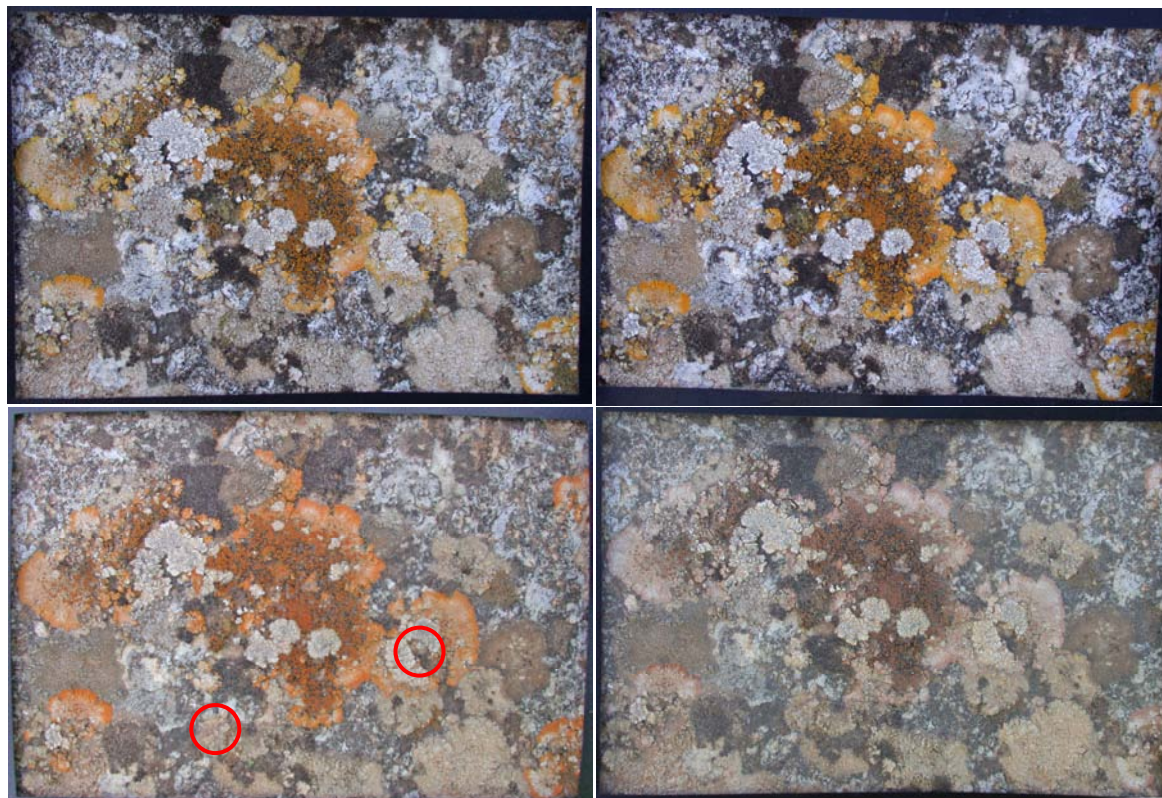
General view.



Sample MN-4. X = 55, Y = 21, 315°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN4

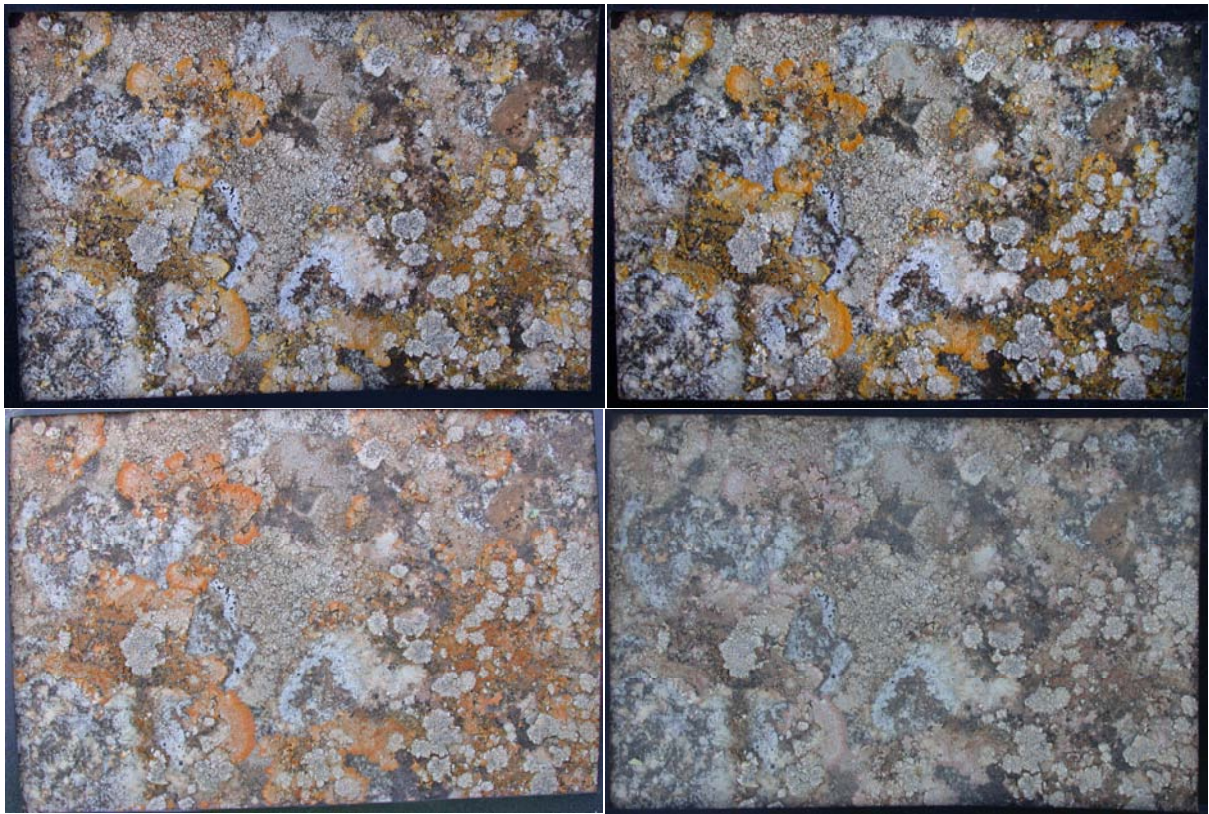
Exposure	horizontal	Species	% of cover	nº of thalli
Orientation		<i>Caloplaca aurantia</i>	54,97	9
Species richness	3	<i>Diplotomma epipolium</i>	0,71	8
% cover community	100	<i>Verrucaria calciseda</i>	44,32	3
Total of thalli	20			



Sample MN-5. X = 85, Y = 19, 314°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN5

Exposure MN5	horizontal	Species	% of cover	nº of thalli
Orientation MN5		<i>Aspicilia calcarea</i>	17,53	16
Species richness	7	<i>Caloplaca aurantia</i>	22,06	12
% cover community	100	<i>Caloplaca citrina</i>	1,29	6
Total of thalli	86	<i>Caloplaca variabilis</i>	2,97	15
		<i>Diplotomma epipolium</i>	2,99	2
		<i>Verrucaria calciseda</i>	49,00	25
		<i>Verrucaria nigrescens</i>	4,16	10



Sample MN-6. X = 133, Y = 22, 316°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN6

Exposure	horizontal	Species	% of cover	n° of thalli
Orientation		<i>Aspicilia calcarea</i>	14,64	8
Species richness	6	<i>Caloplaca aurantia</i>	25,24	29
% cover community	99,46	<i>Caloplaca citrina</i>	0,43	1
Total of thalli	91	<i>Diplotomma epipolium</i>	6,50	43
		<i>Caloplaca variabilis</i>	0,88	1
		<i>Verrucaria calciseda</i>	52,30	8

Community of *Dirina massiliensis* (recent colonization)

Stone 2 – left side of Room 7



General view.



Sample MN-7. X = 75, Y = 92. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN7

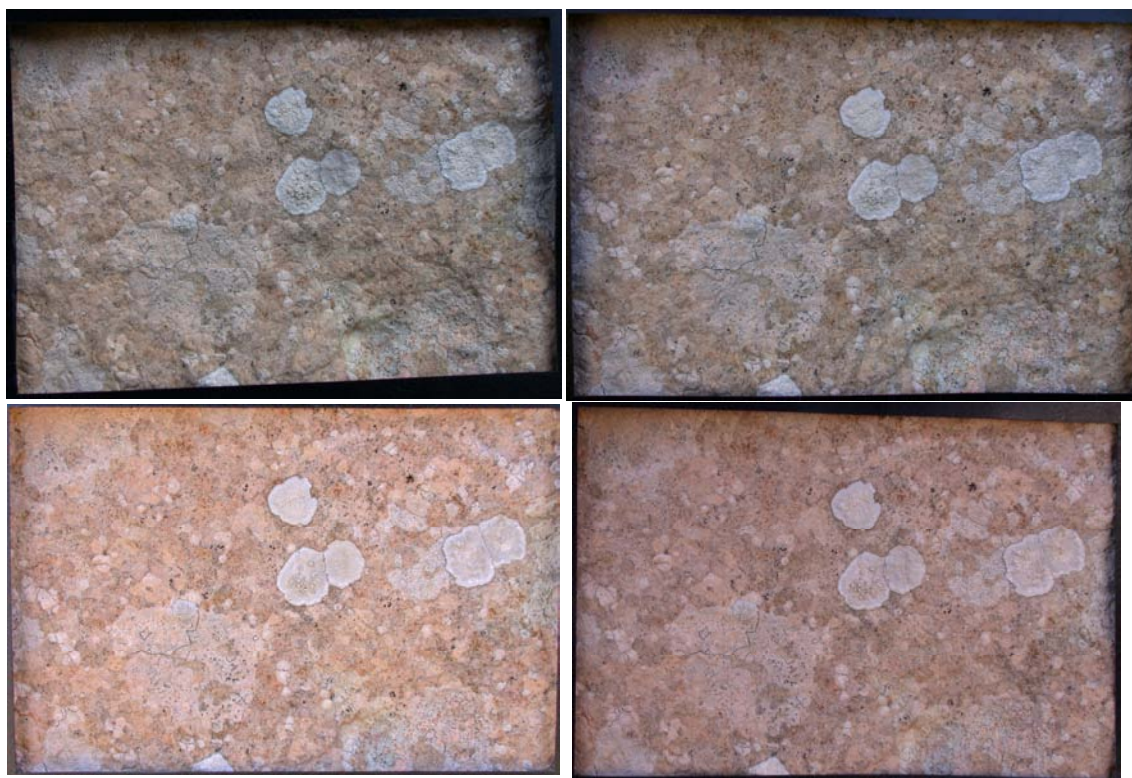
Exposure	vertical	Species	% of cover	nº of thalli
Orientation	338°N	<i>Caloplaca navasiana</i>	57,56	20
Species richness	5	<i>Caloplaca variabilis</i>	15,96	1
% cover community	100	<i>Dirina massiliensis</i>	2,29	7
Total of thalli	440	<i>Opegrapha calcarea</i>	5,80	83
		<i>Verrucaria calciseda</i>	18,39	329



Sample MN-8. X = 56, Y = 78. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN8

Exposure	vertical	Species	% of cover	nº of thalli
Orientation	338°N	<i>Caloplaca citrina</i>	1,17	8
Species richness	6	<i>Caloplaca navasiana</i>	70,94	4
% cover comun.	100	<i>Caloplaca flavescens</i>	0,06	1
Total of thalli	279	<i>Dirina massiliensis</i>	3,63	16
		<i>Opegrapha calcarea</i>	7,31	67
		<i>Verrucaria calciseda</i>	16,89	183



Sample MN-9. X = 39, Y = 75. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN9

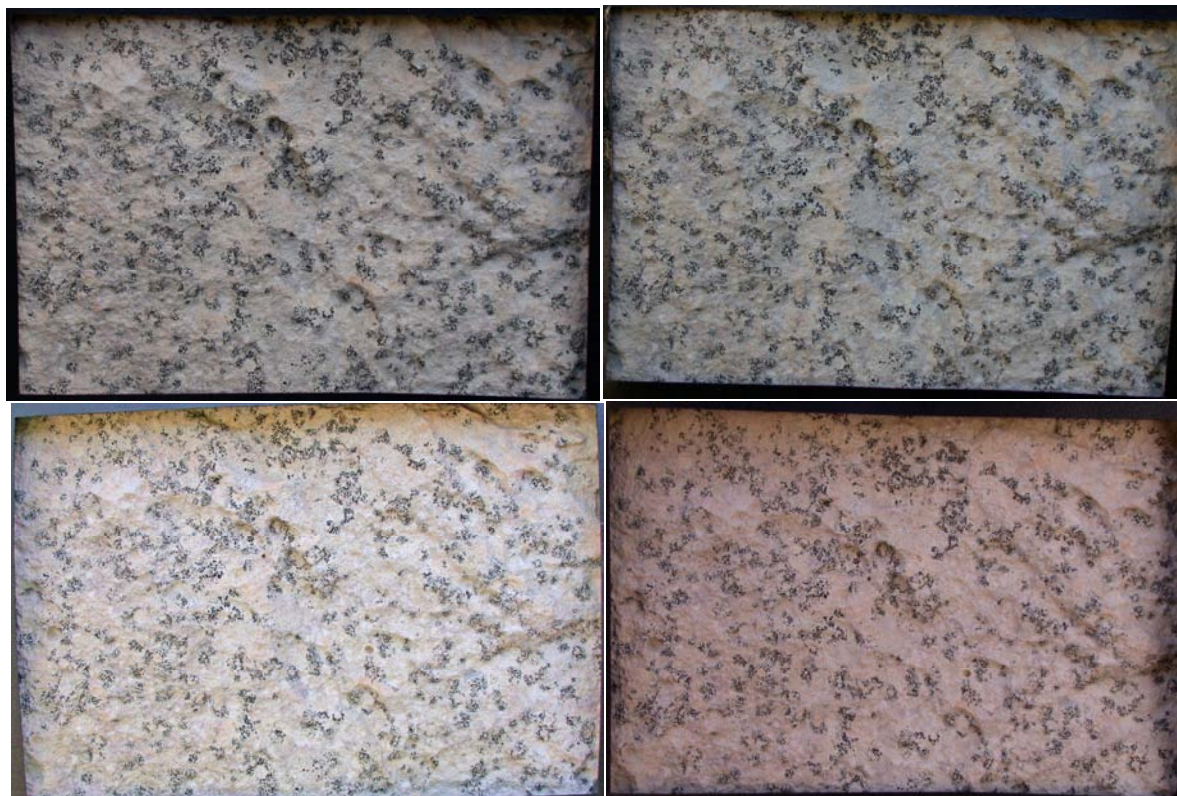
Exposure	vertical	Species	% of cover	n° of thalli
Orientation	338°N	<i>Caloplaca navasiana</i>	55,72	1
Species richness	5	<i>Caloplaca variabilis</i>	13,93	1
% cover community	99,91	<i>Dirina massiliensis</i>	5,02	7
Total of thalli	160	<i>Opegrapha calcarea</i>	4,58	37
		<i>Verrucaria calciseda</i>	20,75	114

Community of *Opegrapha calcarea*

Stone 4 – left side of Room 8



General view.



Sample MN-10. X = 24, Y = 88. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN10

Exposure	vertical	Species	% of cover	n° of thalli
Orientation	317°N	<i>Opegrapha calcarea</i>	98,44	311
Species richness	2	<i>Verrucaria calciseda</i>	1,56	1
% cover community	20,02			
Total of thalli	312			



Sample MN-11. X = 31, Y = 74. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN11

Exposure	vertical	Species	% of cover	n° of thalli
Orientation	317°N	<i>Opegrapha calcarea</i>	100	315
Species richness	1			
% cover comun.	15,06			
Total of thalli	315			



Sample MN-12. X = 56, Y = 63. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN12

Exposure	vertical	Species	% of cover	n° of thalli
Orientation	317°N	<i>Opegrapha calcarea</i>	100	150
Species richness	1			
% cover community	6,47			
Total of thalli	151			

Community of *Dirina massiliensis* (well developed)

Stone 3 – left side of Room 1



General view.



Sample MN-13. X = 29, Y = 136. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN13

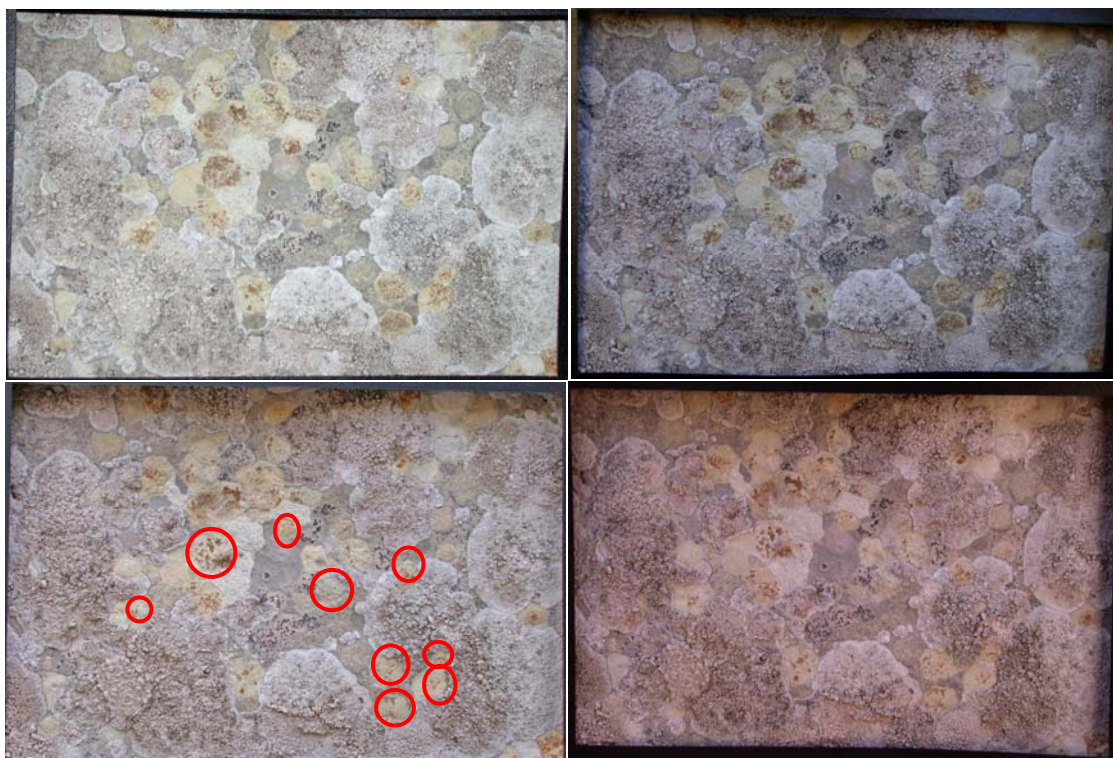
Exposure	vertical	Species	% of cover	nº of thalli
Orientation	9°N	<i>Calopaca variabilis</i>	0,38	2
Species richness	6	<i>Dirina massiliensis</i>	14,73	18
% cover community	98,99	<i>Caloplaca navasiana</i>	61,00	34
Total of thalli	96	<i>Opegrapha calcarea</i>	5,74	12
		<i>Opegrapha durieui</i>	13,47	14
		<i>Verrucaria calciseda</i>	4,69	16



Sample MN-14. X = 51, Y = 100. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN14

Exposure	vertical	Species	% of cover	nº of thalli
Orientation	9°N	<i>Dirina massiliensis</i>	35,39	14
Species richness	6	<i>Caloplaca navasiana</i>	37,83	12
% cover comun.	99,04	<i>Opegrapha calcarea</i>	5,20	18
Total of thalli	109	<i>Opegrapha durieui</i>	1,91	10
		<i>Verrucaria calciseda</i>	19,68	55



Sample MN-15. X = 42, Y = 68. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN15

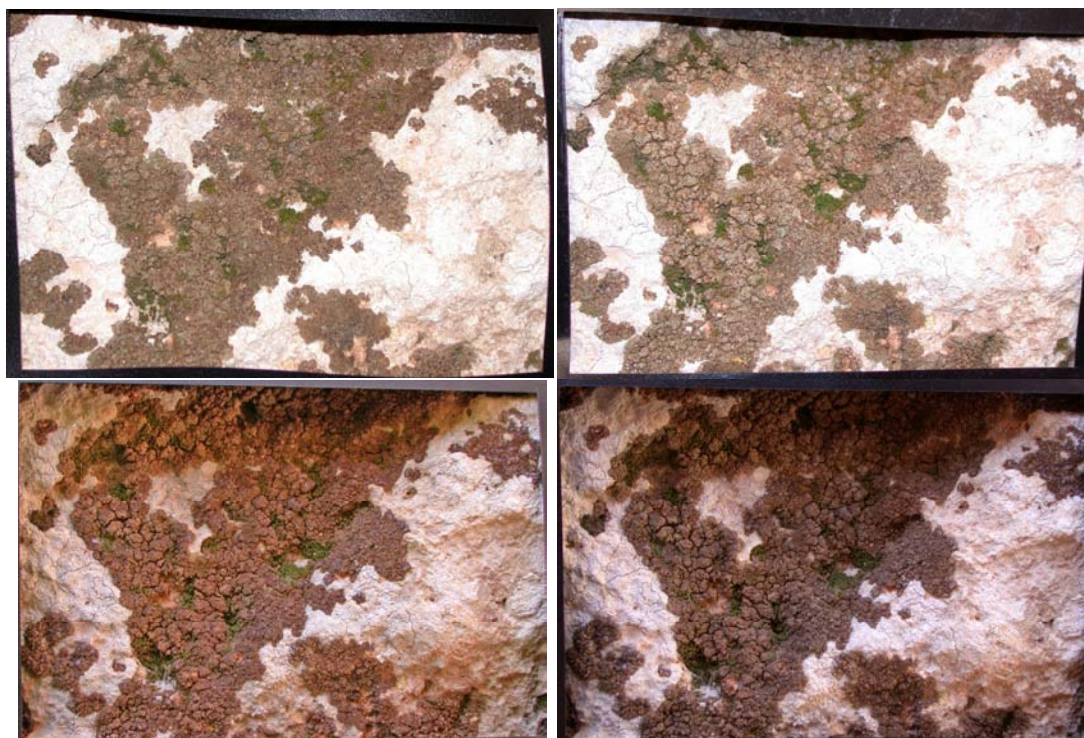
Exposure	vertical	Species	% of cover	nº of thalli
Orientation	9°N	<i>Caloplaca navasiana</i>	14,30	16
Species richness	5	<i>Dirina massiliensis</i>	62,31	22
% cover community	100	<i>Opegrapha calcarea</i>	15,30	11
Total of thalli	72	<i>Opegrapha durieui</i>	3,52	8
		<i>Verrucaria calciseda</i>	4,57	15

Community of *Lecania spadicea*

Stone 2 – left side of Room 6



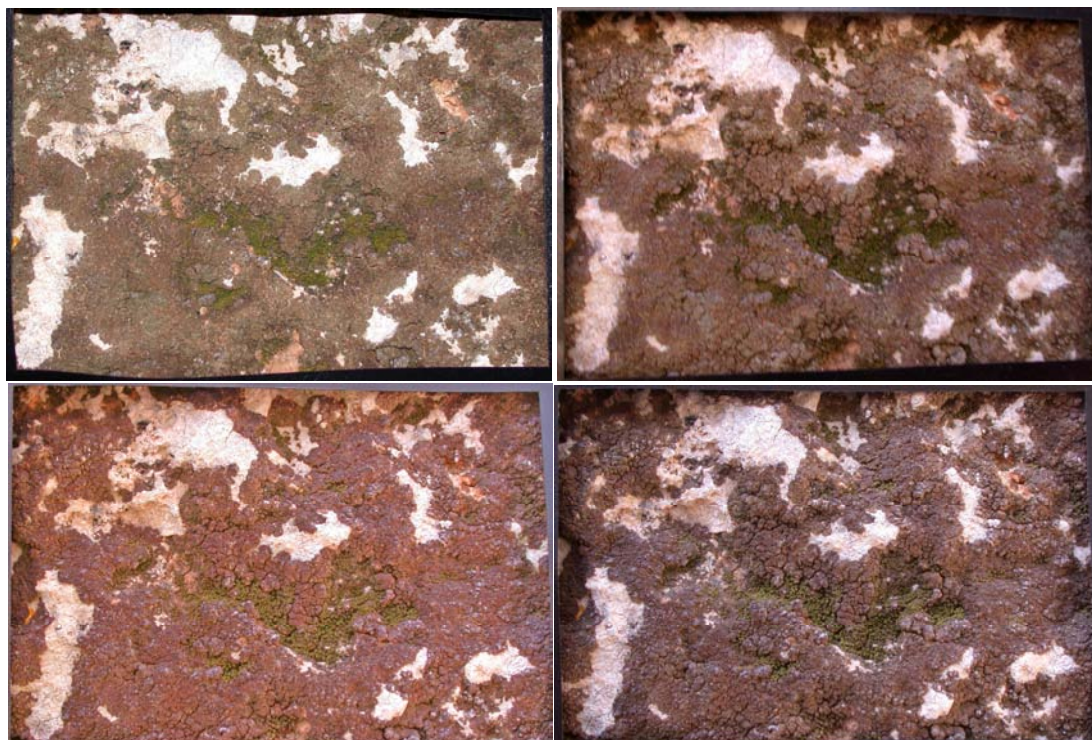
General view.



Sample MN-16. X = 28, Y = 109. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN16

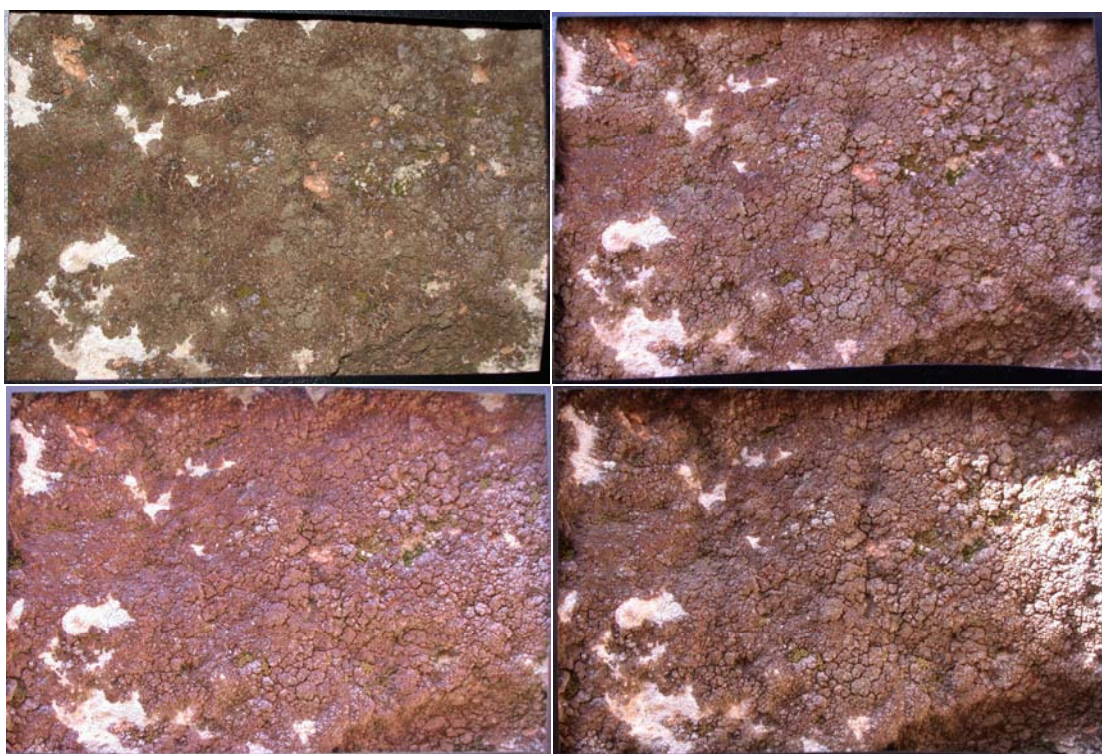
Exposure	vertical	Species	% of cover	n° of thalli
Orientation	42°N	<i>Aloina aloides</i>	3,13	17
Species richness	3	<i>Lecania spadicea</i>	51,88	9
% cover community	100	<i>Verrucaria calciseda</i>	44,98	5
Total of thalli	31			



Sample MN-17. X = 43, Y = 148. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN17

Exposure	vertical	Species	% of cover	n° of thalli
Orientation	42°N	<i>Aloina aloides</i>	5,34	6
Species richness	3	<i>Lecania spadicea</i>	79,90	1
% cover community	100	<i>Verrucaria calciseda</i>	14,76	15
Total of thalli	22			



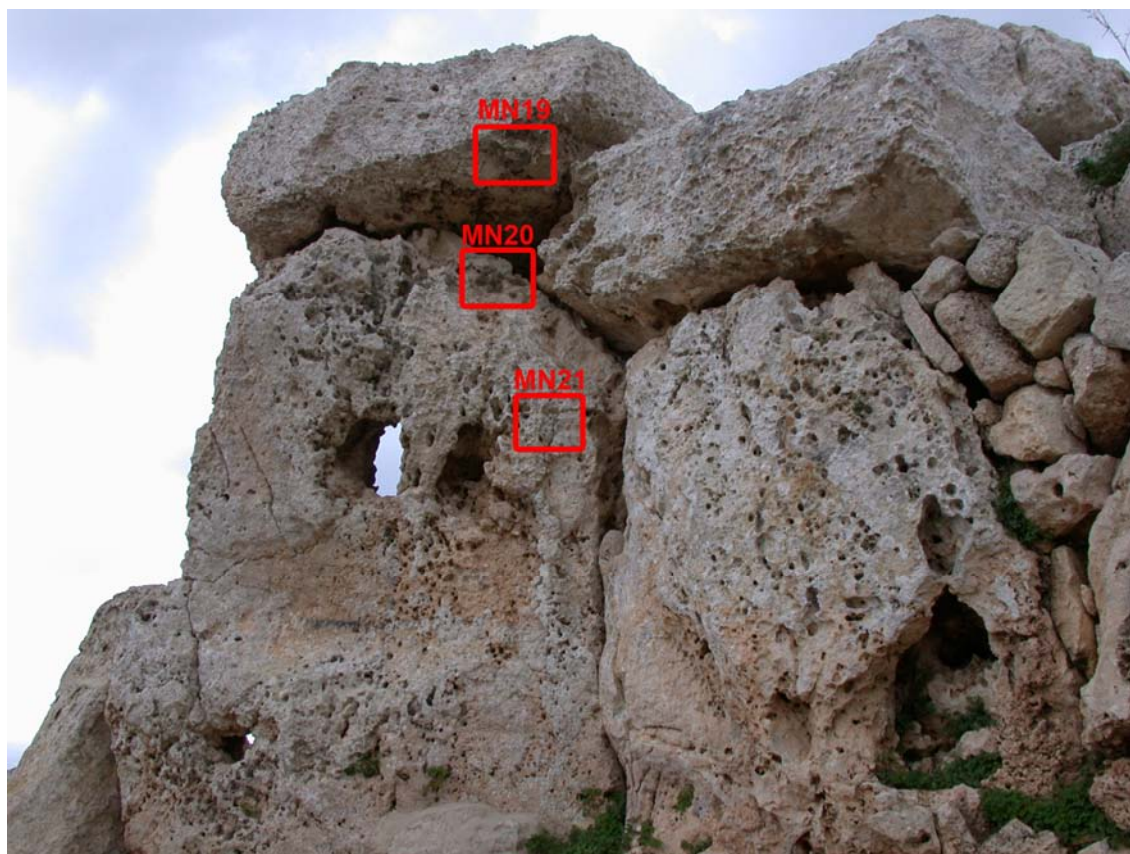
Sample MN-18. X = 54, Y = 145. Autumn (up left), winter (up right), spring (down left) and summer (down right).

MN18

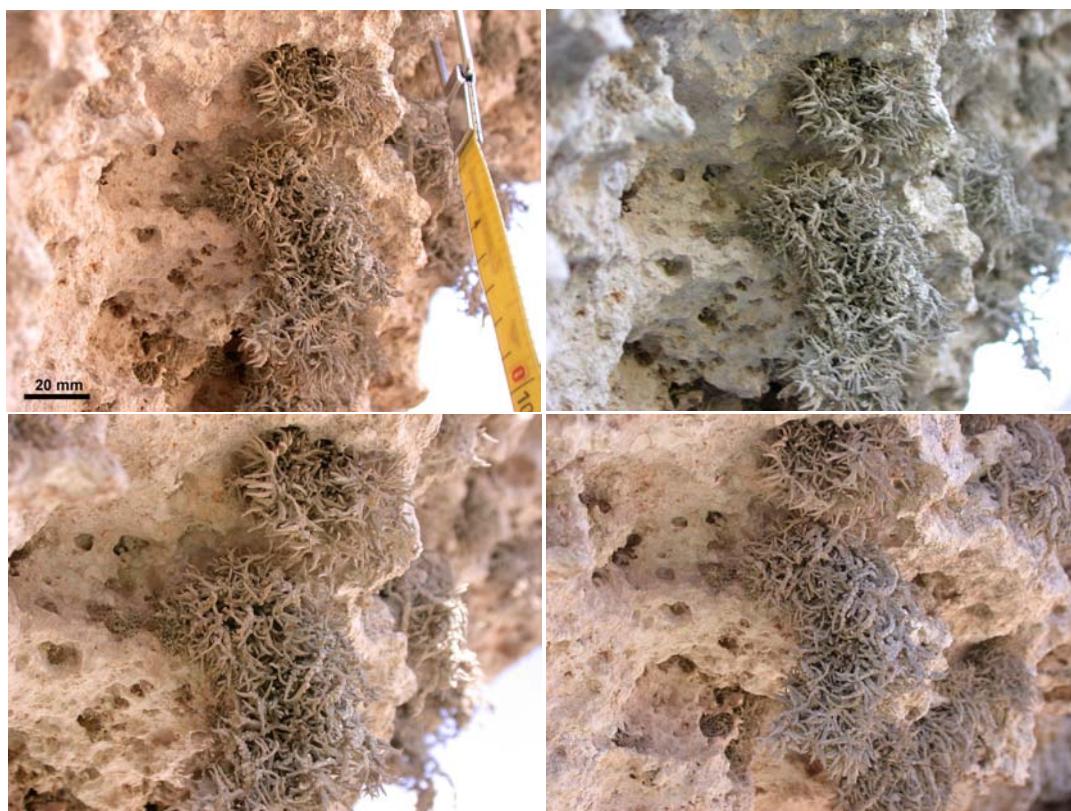
Exposure	vertical	Species	% of cover	n° of thalli
Orientation	42°N	<i>Aloina aloides</i>	1,18	7
Species richness	3	<i>Lecania spadicea</i>	95,42	1
% cover community	100	<i>Verrucaria calciseda</i>	3,40	12
Total of thalli	20			

Community of *Roccella phycopsis*

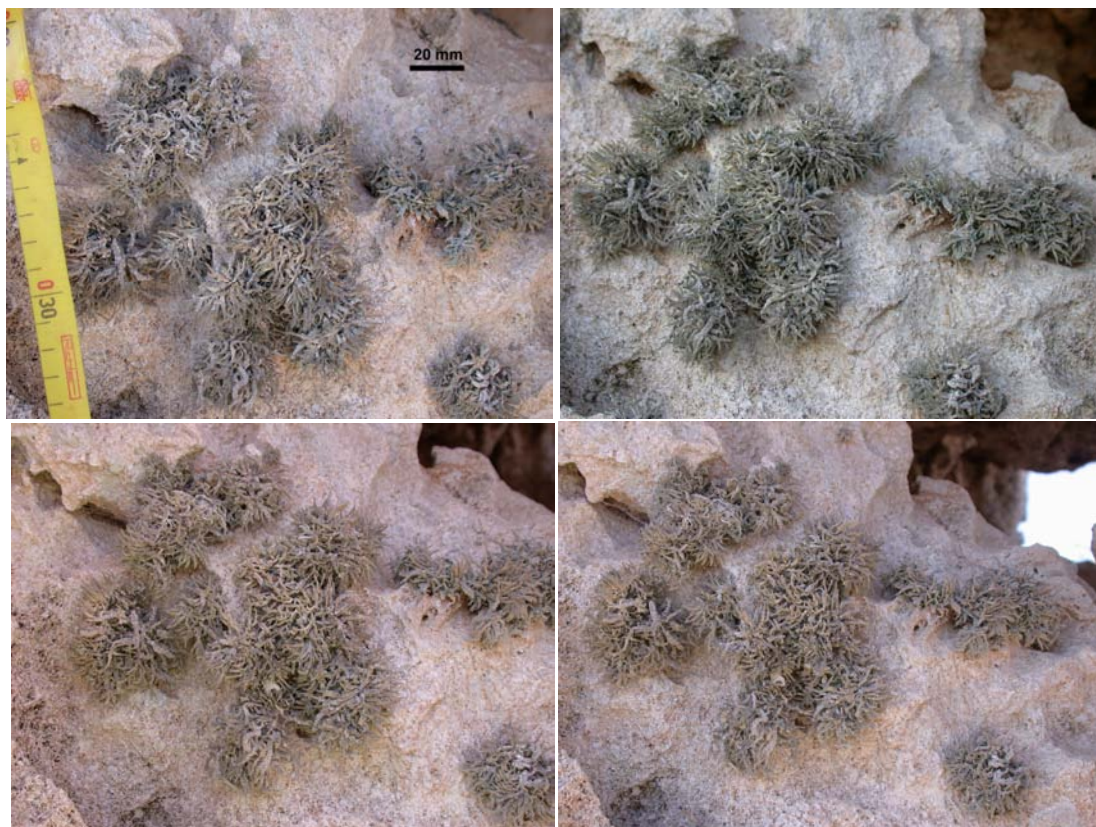
Stone 13 – outer wall



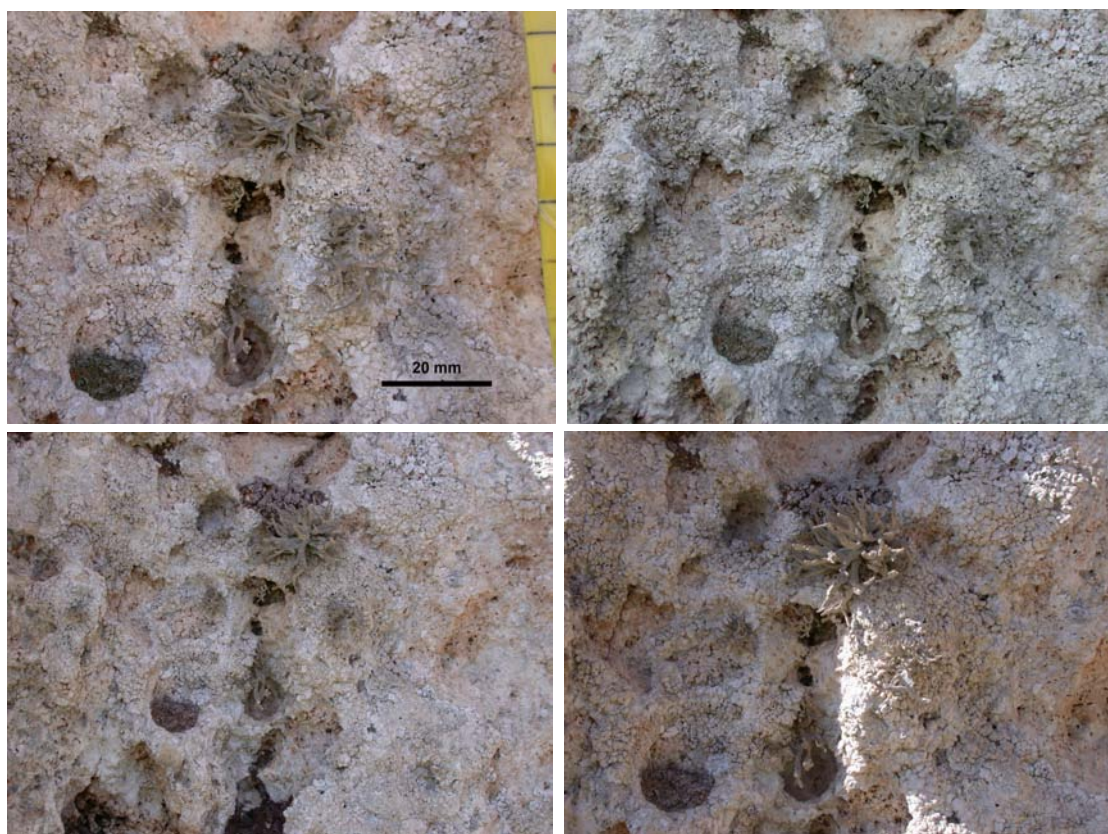
General view.



Sample MN-19. Thalli show a good vitality. Autumn (up left), winter (up right), spring (down left) and summer (down right).

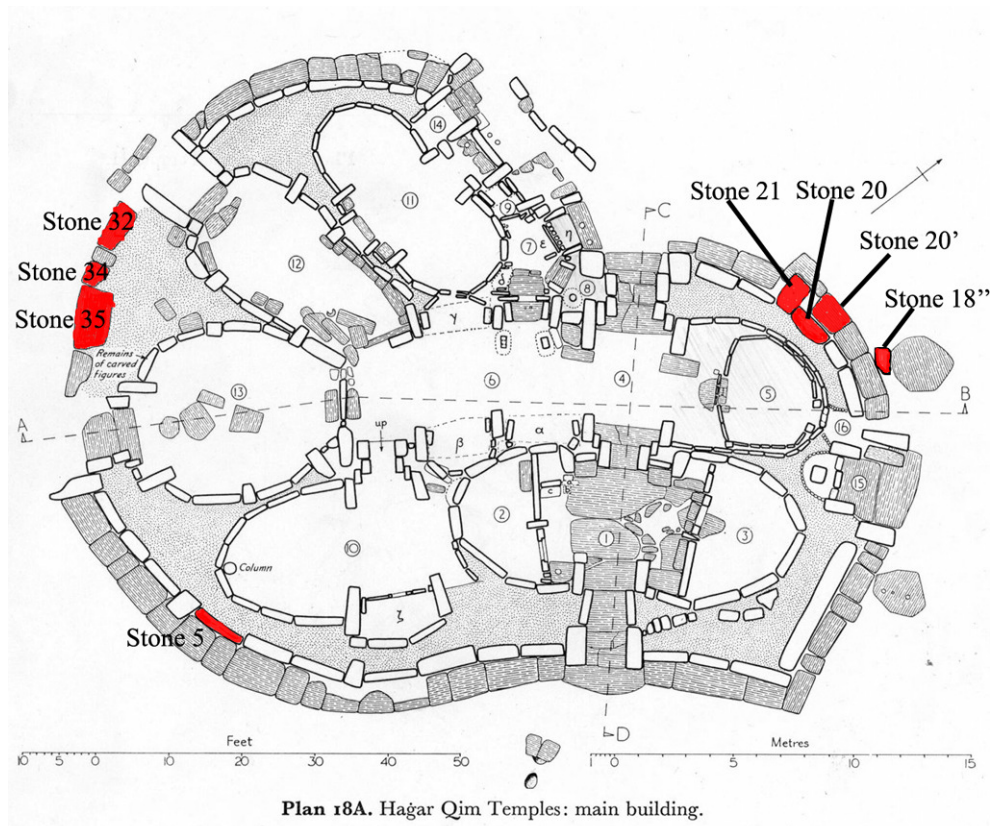


Sample MN-20. Thalli show a good vitality. Autumn (up left), winter (up right), spring (down left) and summer (down right).



Sample MN-21. Thalli show a good vitality. Autumn (up left), winter (up right), spring (down left) and summer (down right).

2. Haġar Qim



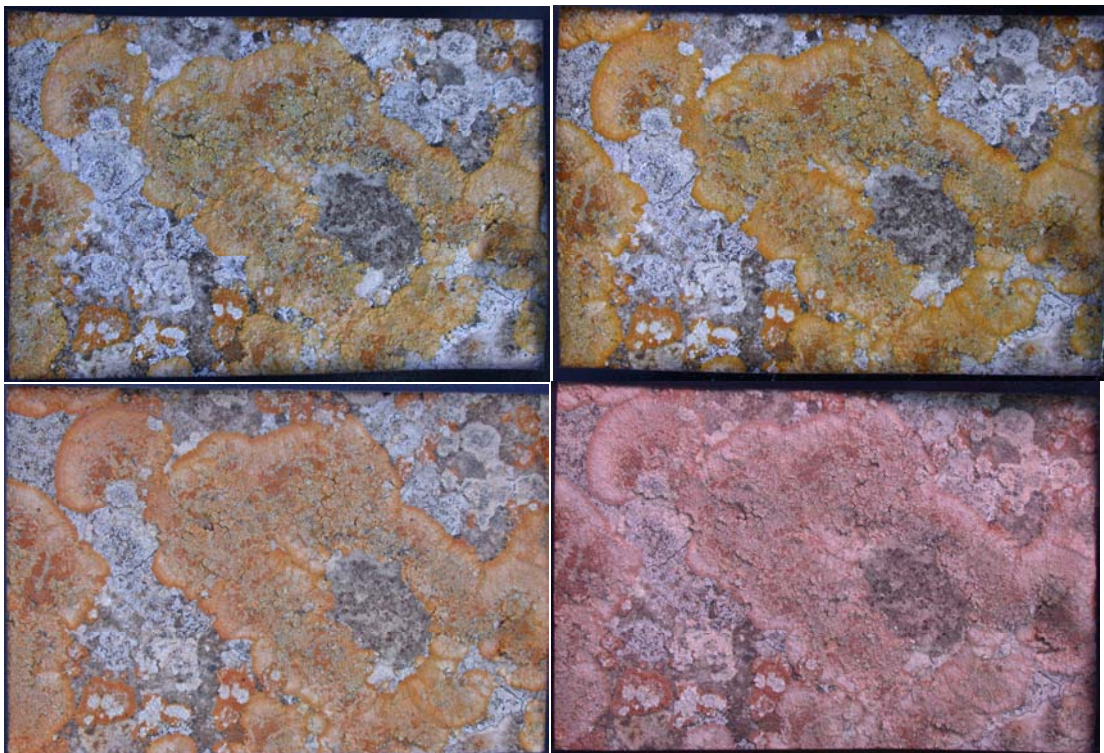
Situation of sampled stones for monitoring.

Community of *Caloplaca aurantia*

Stones 32/34/35 – outer wall



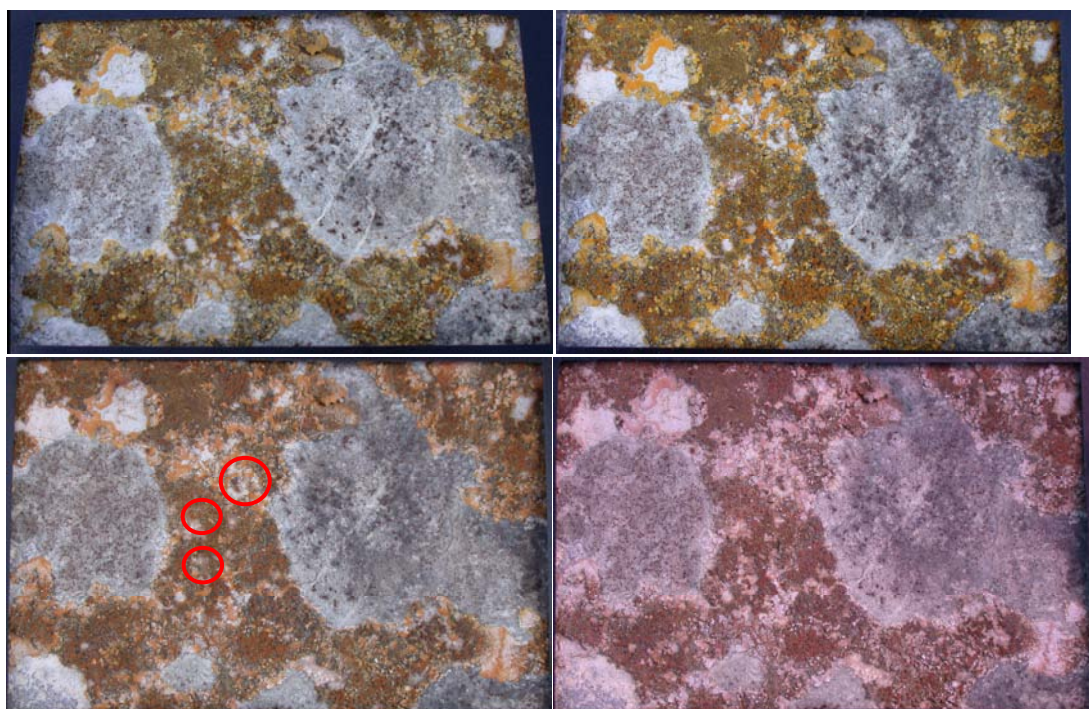
General view.



Sample HQ-1. X = 67, Y = 77, 60°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ1

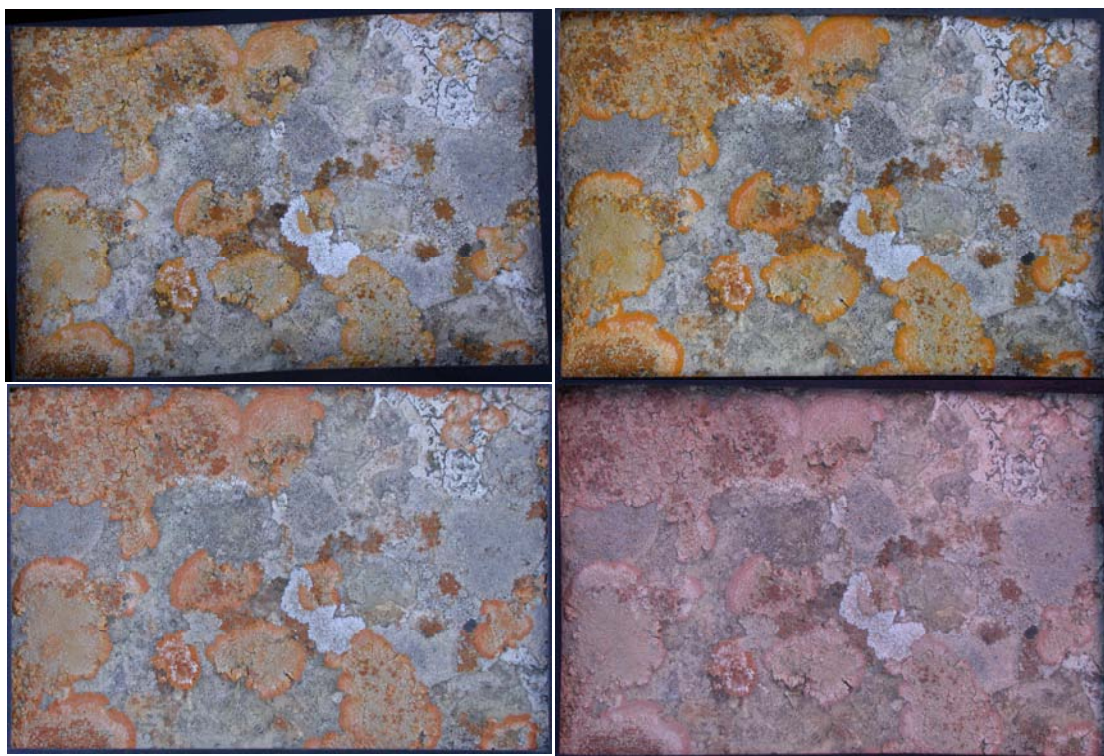
Exposure	horizontal	Species	% of cover	nº of thalli
Orientation		<i>Caloplaca aurantia</i>	59,08	7
Species richness	7	<i>Caloplaca</i> aff. <i>subochracea</i>	4,47	1
% cover community	98,83	<i>Caloplaca flavescens</i>	4,75	32
Total of thalli	80	<i>Caloplaca navasiana</i>	3,59	8
		<i>Caloplaca variabilis</i>	0,29	1
		<i>Diplotomma epipolium</i>	5,11	20
		<i>Verrucaria calciseda</i>	22,72	11



Sample HQ-2. X = 35, Y = 64, 58°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ2

Exposure	horizontal	Species	% of cover	nº of thalli
Orientation		<i>Caloplaca aurantia</i>	78,48	4
Species richness	4	<i>Caloplaca citrina</i>	0,24	2
% cover community	71,03	<i>Caloplaca</i> aff. <i>subochracea</i>	16,10	6
Total of thalli	22	<i>Verrucaria calciseda</i>	5,17	10



Sample HQ-3. X = 85, Y = 29, 46°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ3

Exposure	horizontal	Species	% of cover	n° of thalli
Orientation	0	<i>Caloplaca aurantia</i>	43,58	17
Species richness	9	<i>Caloplaca citrina</i>	5,10	12
% cover community	99,70	<i>Caloplaca</i> aff. <i>subochracea</i>	1,66	4
Total of thalli	91	<i>Caloplaca flavescens</i>	0,89	1
		<i>Caloplaca variabilis</i>	19,13	13
		<i>Coscinocladium gaditanum</i>	1,23	1
		<i>Diplotomma epipolium</i>	0,09	1
		<i>Verrucaria calciseda</i>	22,39	21
		<i>Verrucaria nigrescens</i>	4,86	16
		Lichenicolous fungi	1,07	5

Community of *Dirina massiliensis*

Stones 20/21 – outer wall



General view.



Sample HQ-4. X = 43, Y = 164. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ4

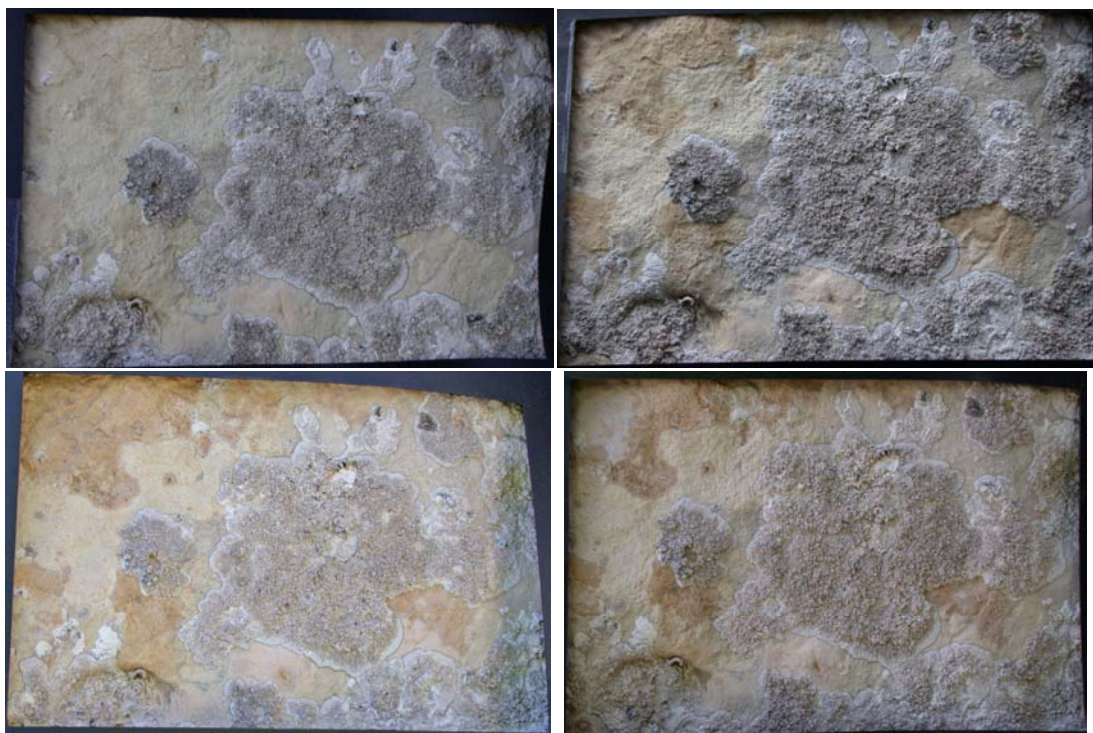
Exposure	vertical	Species	% of cover	n° of thalli
Orientation	351°N	<i>Caloplaca marmorata</i>	5,45	13
Species richness	5	<i>Dirina massiliensis</i>	64,08	16
% cover community	100	<i>Opegrapha calcarea</i>	1,70	2
Total of thalli	40	<i>Opegrapha durieui</i>	0,57	2
		<i>Verrucaria calciseda</i>	28,19	7



Sample HQ-5. X = 65, Y = 145. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ5

Exposure	vertical	Species	% of cover	n° of thalli
Orientation	65°N	<i>Caloplaca marmorata</i>	22,00	17
Species richness	6	<i>Dirina massiliensis</i>	26,95	13
% cover community	99,55	<i>Dirina massiliensis</i> f. <i>sorediata</i>	11,81	6
Total of thalli	71	<i>Opegrapha calcarea</i>	8,12	15
		<i>Opegrapha durieui</i>	6,55	14
		<i>Verrucaria calciseda</i>	24,58	6



Sample HQ-6. X = 146, Y = 118. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ6

Exposure	vertical	Species	% of cover	n° of thalli
Orientation	65°N	<i>Caloplaca navasiana</i>	12,44	1
Species richness	4	<i>Dirina massiliensis</i>	86,12	7
% cover community	70,15	<i>Lecanographa grumulosa</i>	0,12	1
Total of thalli	14	<i>Opegrapha durieui</i>	1,32	5

Community of *Verrucaria nigrescens*

Stones 18''/20' – outer wall



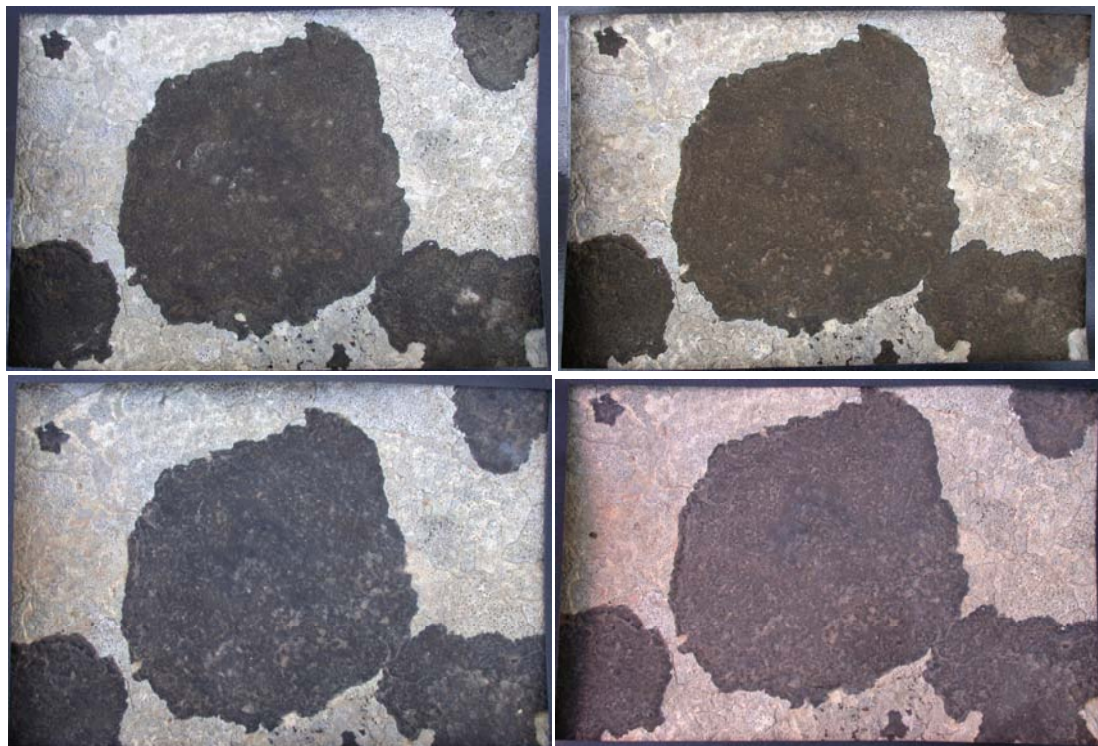
General view.



Sample HQ-7. X = 20, Y = 17, 309°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ7

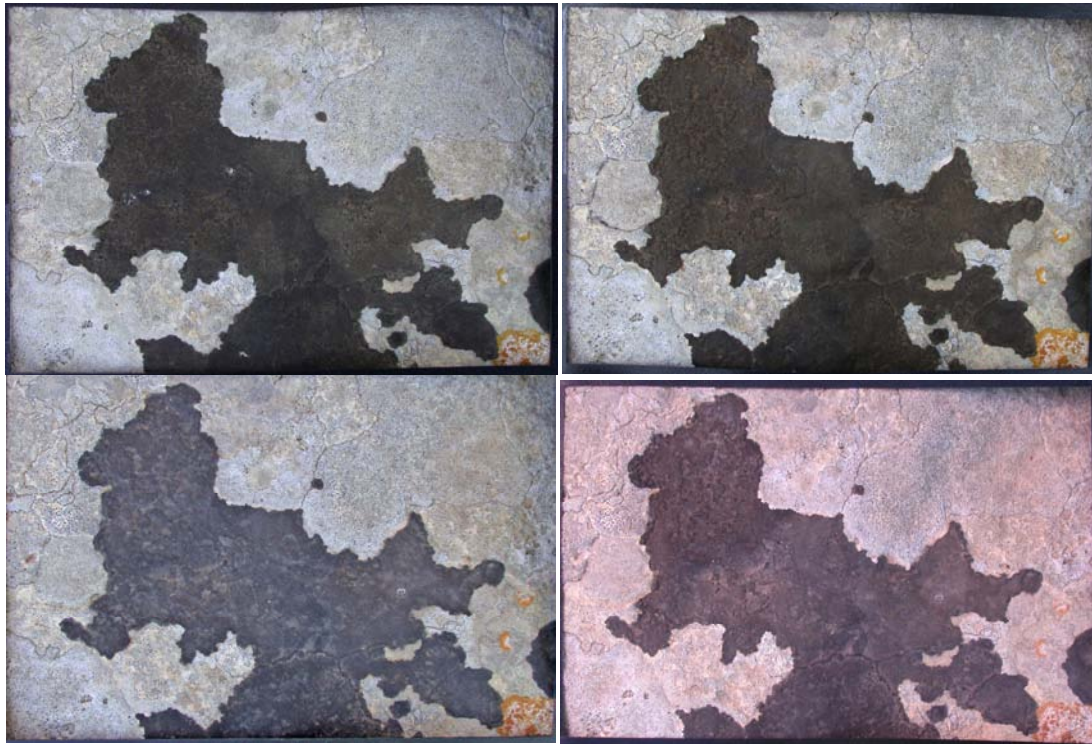
Exposure	horizontal	Species	% of cover	n° of thalli
Orientation		<i>Caloplaca flavescens</i>	0,48	4
Species richness	2	<i>Verrucaria nigrescens</i>	99,52	1
% cover community	97,51			
Total of thalli	5			



Sample HQ-8. X = 103, Y = 40, 178°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ8

Exposure	horizontal	Species	% of cover	n° of thalli
Orientation		<i>Clauzadea immersa</i>	0,17	3
Species richness	4	<i>Verrucaria calciseda</i>	44,20	1
% cover community	100	<i>Verrucaria nigrescens</i>	55,40	6
Total of thalli	34	lichenicolous fungi	0,23	24



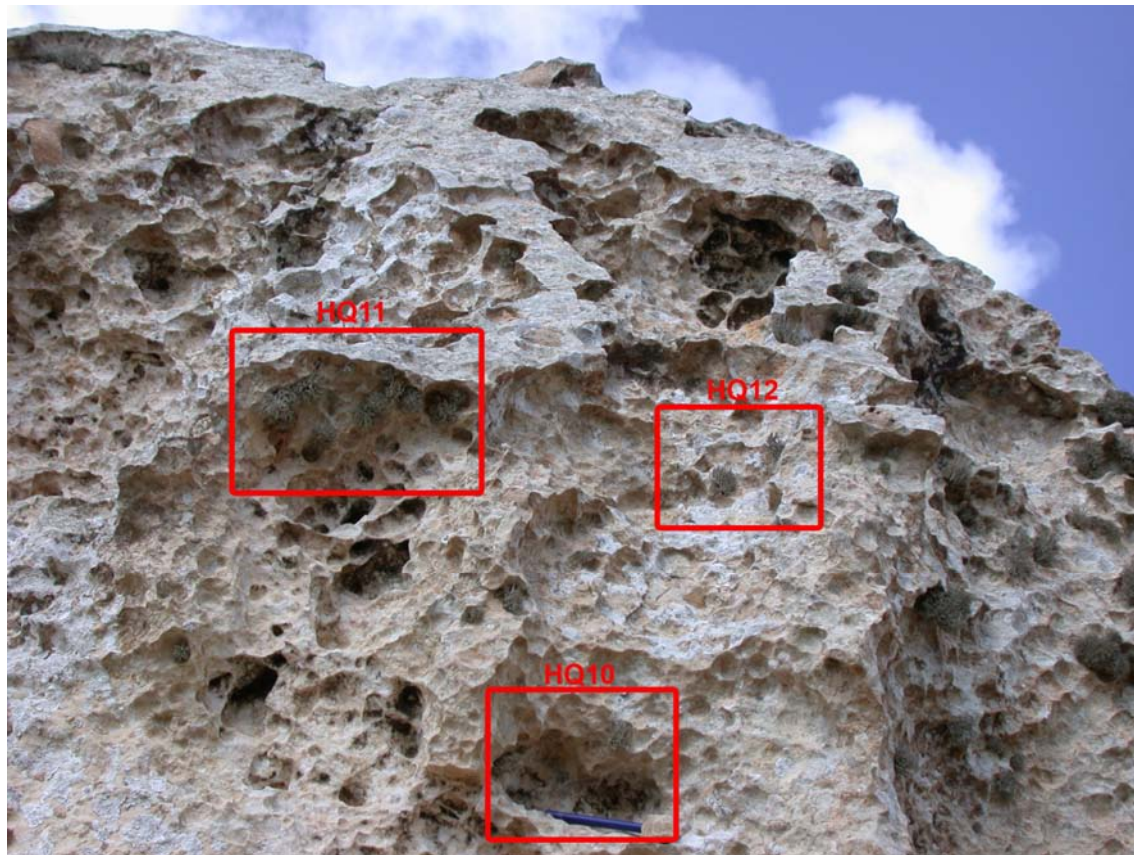
Sample HQ-9. X = 120, Y = 23, 180°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ9

Exposure	horizontal	Species	% of cover	nº of thalli
Orientation		<i>Caloplaca flavescens</i>	0,86	3
Species richness	5	<i>Clauzadea immersa</i>	2,23	2
% cover community	99,77	<i>Verrucaria calciseda</i>	57,13	3
Total of thalli	16	<i>Verrucaria nigrescens</i>	39,63	4
		lichenicolous fungi	0,14	4

Community of *Rocella phycopsis*

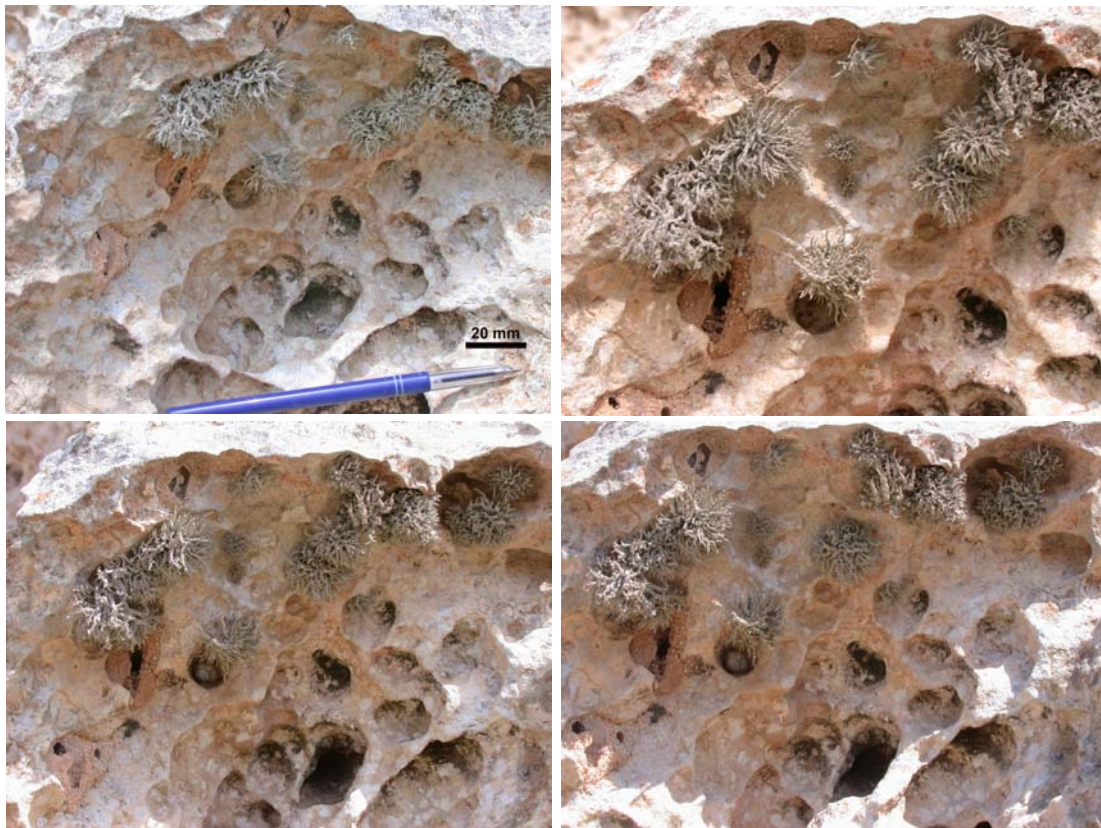
Stone 5 – outer wall



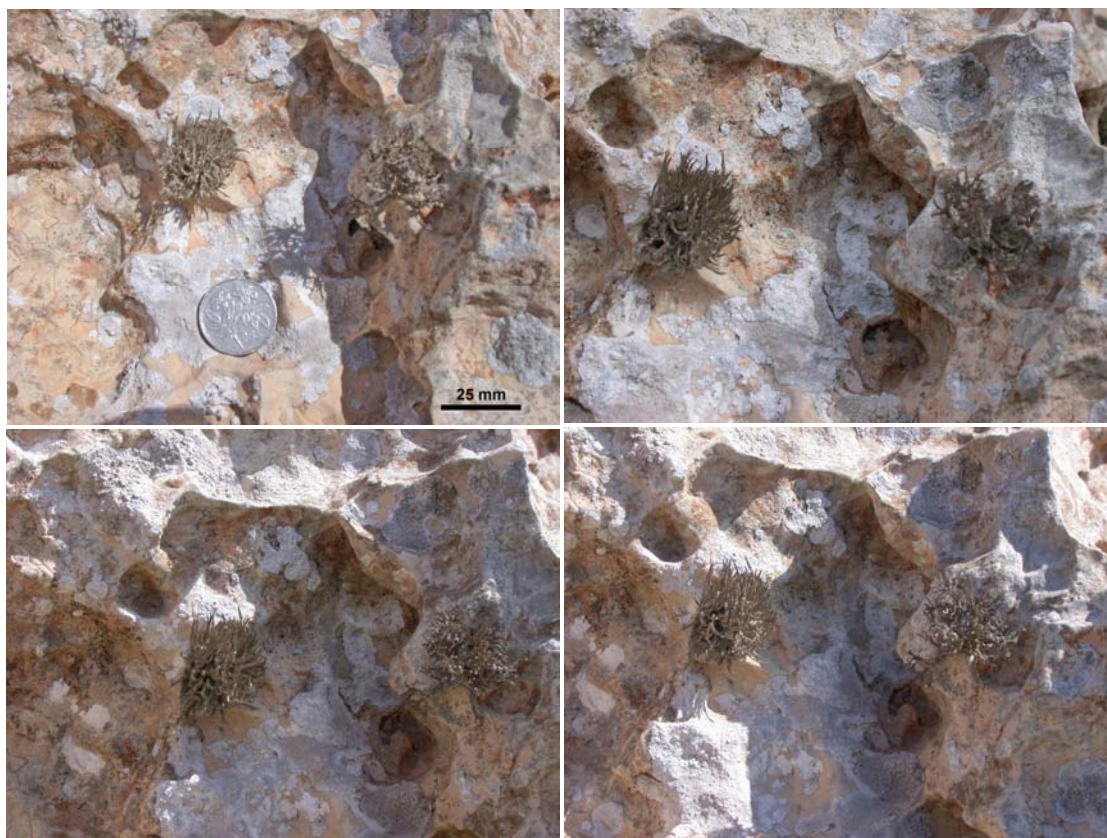
General view.



Sample HQ-10. Thalli show a good vitality. Autumn (up left), winter (up right), spring (down left) and summer (down right).

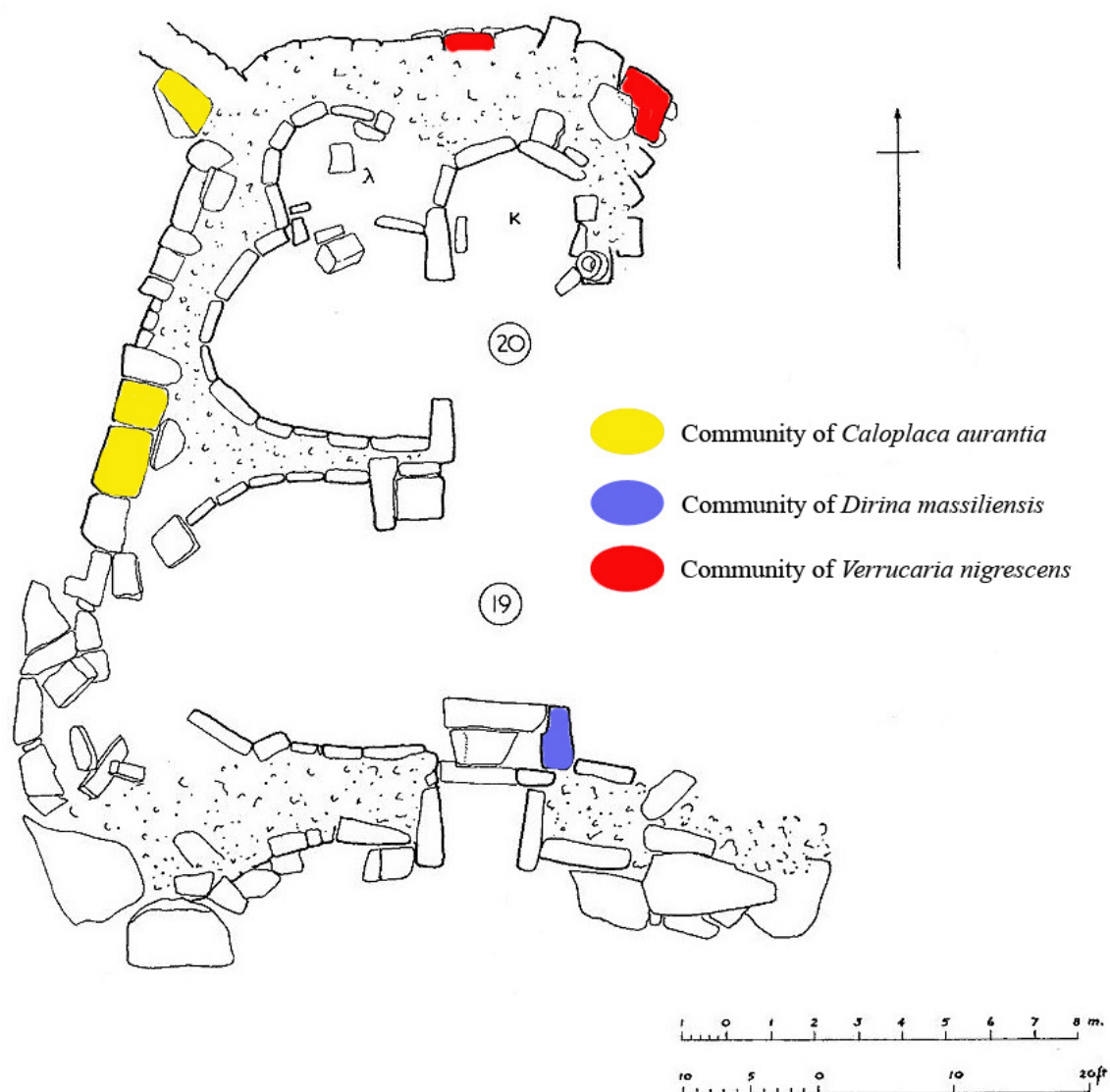


Sample HQ-11. Thalli show a good vitality. Autumn (up left), winter (up right), spring (down left) and summer (down right).



Sample HQ-12. Thalli show a good vitality. Autumn (up left), winter (up right), spring (down left) and summer (down right).

3. Unsheltered controls

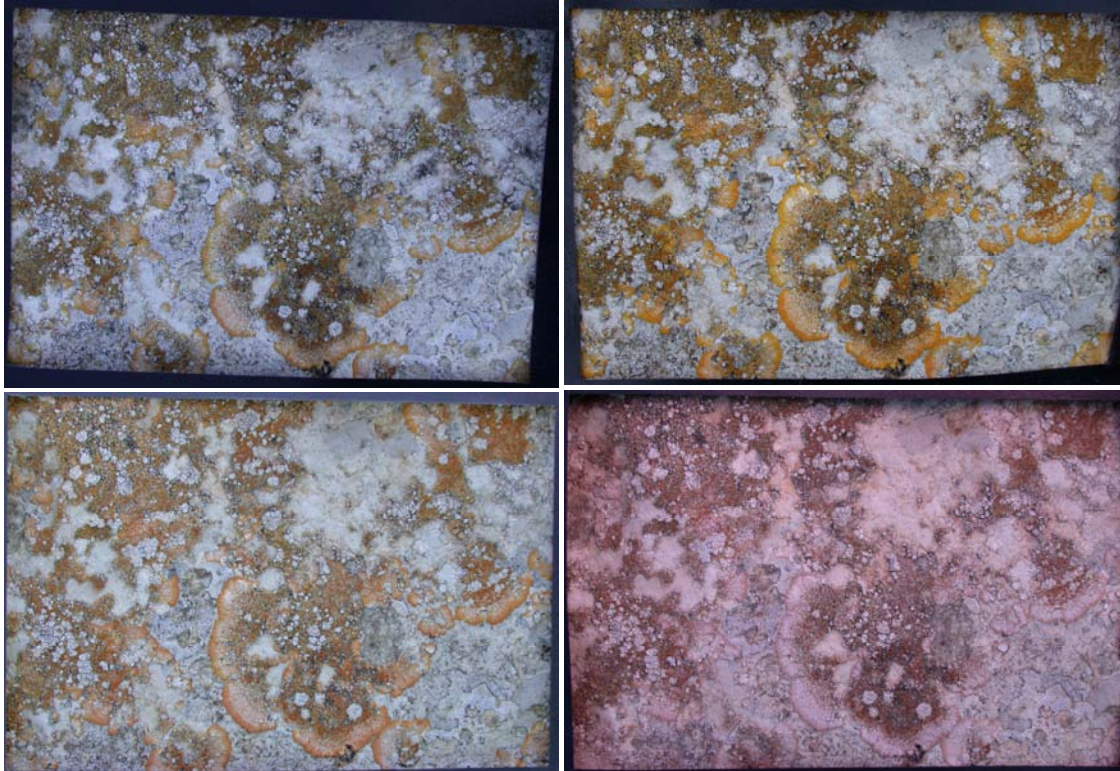


Situation of control communities for monitoring.

Community of *Caloplaca aurantia*



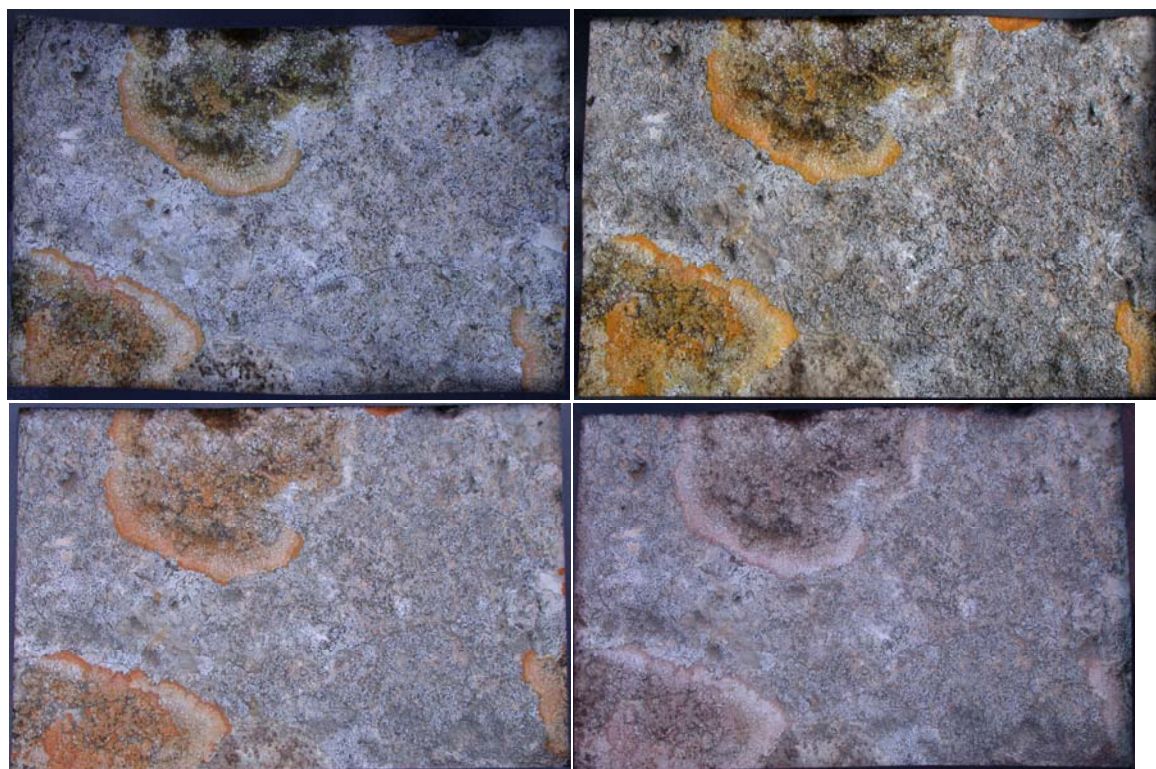
General view.



Sample HQ-13. X = 110, Y = 41, 50°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ13

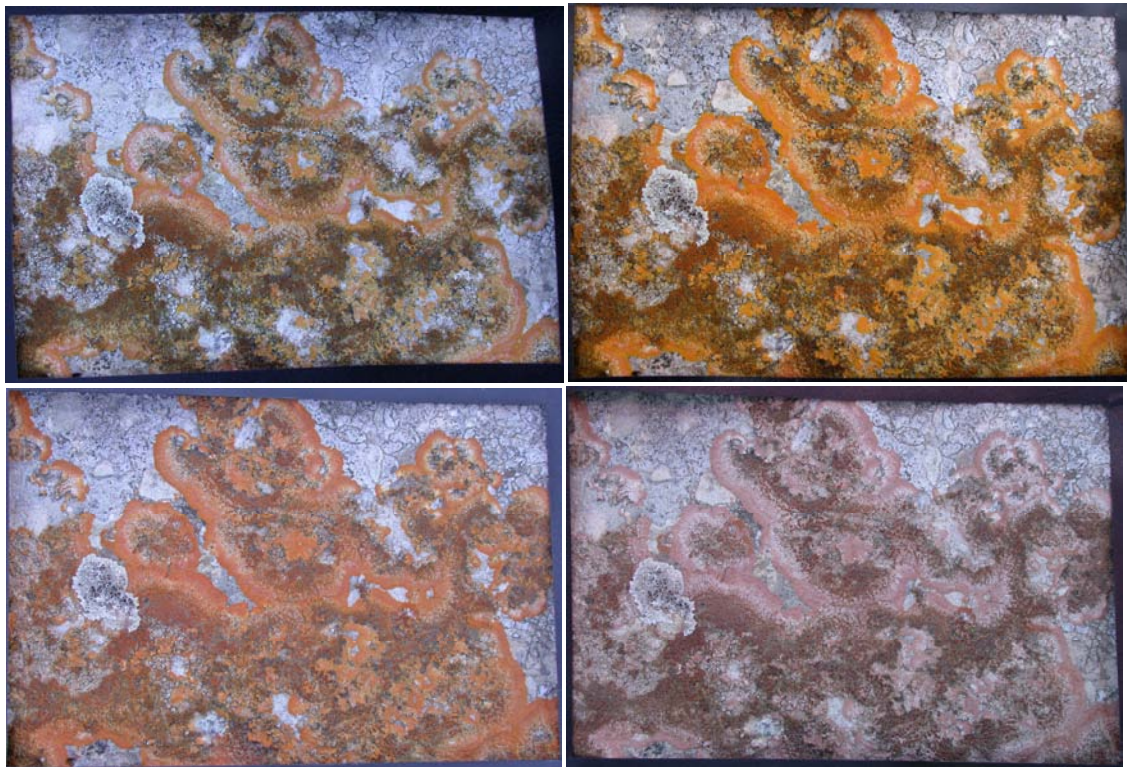
Exposure	horizontal	Species	% of cover	n° of thalli
Orientation		<i>Caloplaca aurantia</i>	43,40	32
Species richness	5	<i>Caloplaca</i> aff. <i>subochracea</i>	0,84	1
% cover community	95,70	<i>Caloplaca navasiana</i>	0,36	1
Total of thalli	132	<i>Diplotomma epipolium</i>	7,08	94
		<i>Verrucaria calciseda</i> (dead)	48,32	4



Sample HQ-14. X = 36, Y = 25, 110°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ14

Exposure	horizontal	Species	% of cover	n° of thalli
Orientation		<i>Caloplaca aurantia</i>	27,81	6
Species richness	7	<i>Caloplaca</i> aff. <i>subochracea</i>	2,37	1
% cover community	99,81	<i>Caloplaca flavescens</i>	0,06	1
Total of thalli	21	<i>Caloplaca variabilis</i>	0,95	3
		<i>Clauzadea immersa</i>	1,76	8
		<i>Opegrapha calcarea</i>	0,36	1
		<i>Verrucaria calciseda</i>	66,68	1



Sample HQ-15. X = 63, Y = 37. 105°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ15

Exposure	horizontal	Species	% of cover	nº of thalli
Orientation		<i>Caloplaca aurantia</i>	75,66	8
Species richness	7	<i>Caloplaca marmorata</i>	0,07	1
% cover community	91,53	<i>Caloplaca navasiana</i>	0,31	3
Total of thalli	25	<i>Caloplaca variabilis</i>	1,18	2
		<i>Catillaria detractula</i>	0,14	1
		<i>Protoparmeliopsis muralis</i>	1,57	1
		<i>Verrucaria calciseda</i>	21,06	9

Community of *Dirina massiliensis*



General view.



Sample HQ-16. X = 106, Y = 170. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ16

Exposure	vertical	Species	% of cover	n° of thalli
Orientation	95°N	<i>Caloplaca</i> aff. <i>subochracea</i>	30,38	5
Species richness	5	<i>Caloplaca navasiana</i>	1,02	2
% cover community	97,35	<i>Dirina massiliensis</i>	59,76	4
Total of thalli	20	<i>Lecanographa grumulosa</i>	2,84	7
		<i>Verrucaria calciseda</i>	6,00	2



Sample HQ-17. X = 45, Y = 177. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ17

Exposure	vertical	Species	% of cover	n° of thalli
Orientation	95°N	<i>Caloplaca</i> aff. <i>subochracea</i>	13,01	2
Species richness	3	<i>Caloplaca navasiana</i>	5,43	4
% cover community	78,70	<i>Dirina massiliensis</i>	81,56	31
Total of thalli	37			



Sample HQ-18. X = 99, Y = 114. Autumn (up left), winter (up right), spring (down left) and summer (down right).

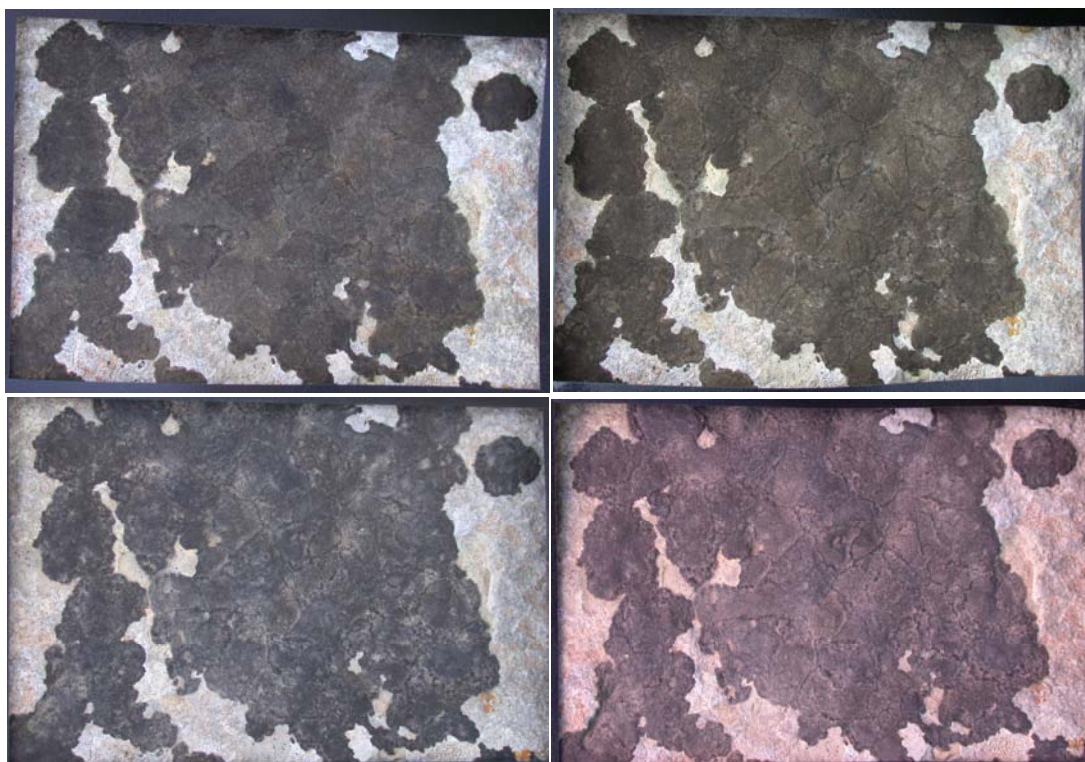
HQ18

Exposure	vertical	Species	% of cover	n° of thalli
Orientation	95°N	<i>Caloplaca marmorata</i>	12,15	8
Species richness	4	<i>Caloplaca navasiana</i>	0,99	3
% cover community	84,51	<i>Dirina massiliensis</i>	71,97	8
Total of thalli	24	<i>Lecanographa grumulosa</i>	14,88	5

Community of *Verrucaria nigrescens*



General view.



Sample HQ-19. X = 67, Y = 57, 210°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ19

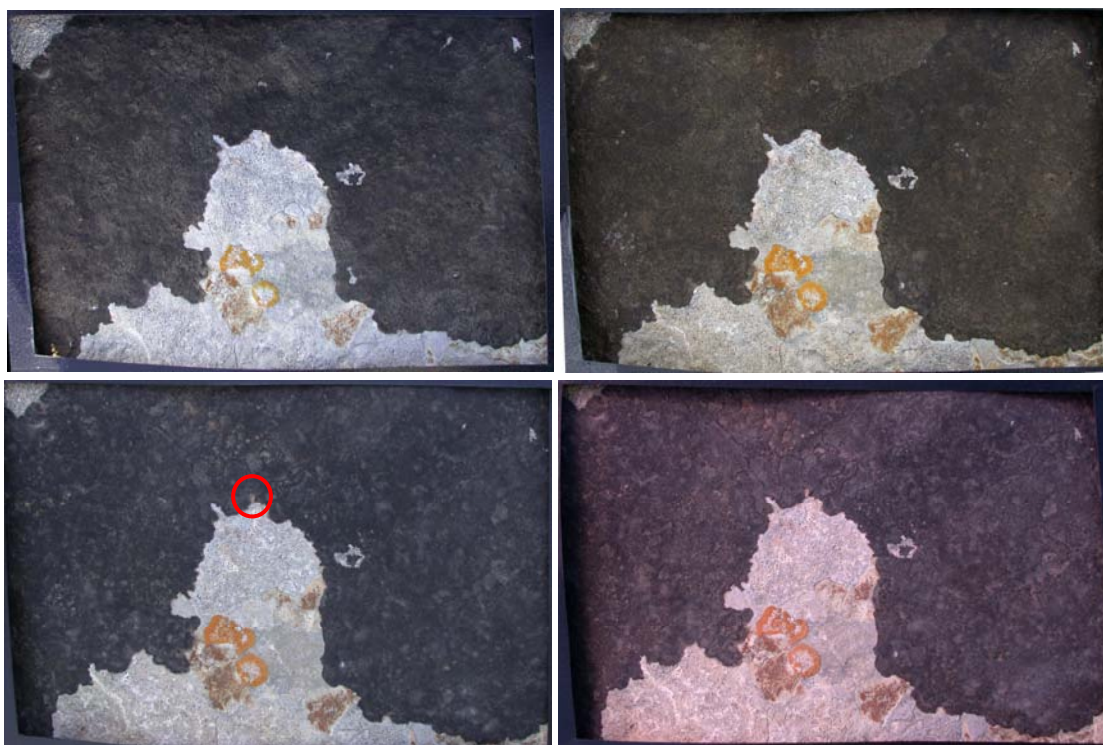
Exposure	horizontal	Species	% of cover	nº of thalli
Orientation		<i>Caloplaca flavescens</i>	0,07	1
Species richness	4	<i>Clauzadea immersa</i>	1,85	6
% cover community	95,16	<i>Verrucaria calciseda</i>	19,77	7
Total of thalli	18	<i>Verrucaria nigrescens</i>	78,30	4



Sample HQ-20. X = 38, Y = 42, 216°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ20

Exposure	horizontal	Species	% of cover	nº of thalli
Orientation		<i>Caloplaca marmorata</i>	15,95	5
Species richness	5	<i>Caloplaca navasiana</i>	1,39	4
% cover community	99,42	<i>Caloplaca flavescens</i>	0,58	16
Total of thalli	36	<i>Clauzadea immersa</i>	12,70	8
		<i>Verrucaria nigrescens</i>	69,38	3



Sample HQ-21. X = 25, Y = 14, 182°N. Autumn (up left), winter (up right), spring (down left) and summer (down right).

HQ21

Exposure	horizontal	Species	% of cover	nº of thalli
Orientation		<i>Caloplaca navasiana</i>	7,92	7
Species richness	4	<i>Caloplaca flavescens</i>	0,79	2
% cover community	99,94	<i>Clauzadea immersa</i>	13,08	7
Total of thalli	18	<i>Verrucaria nigrescens</i>	78,21	2