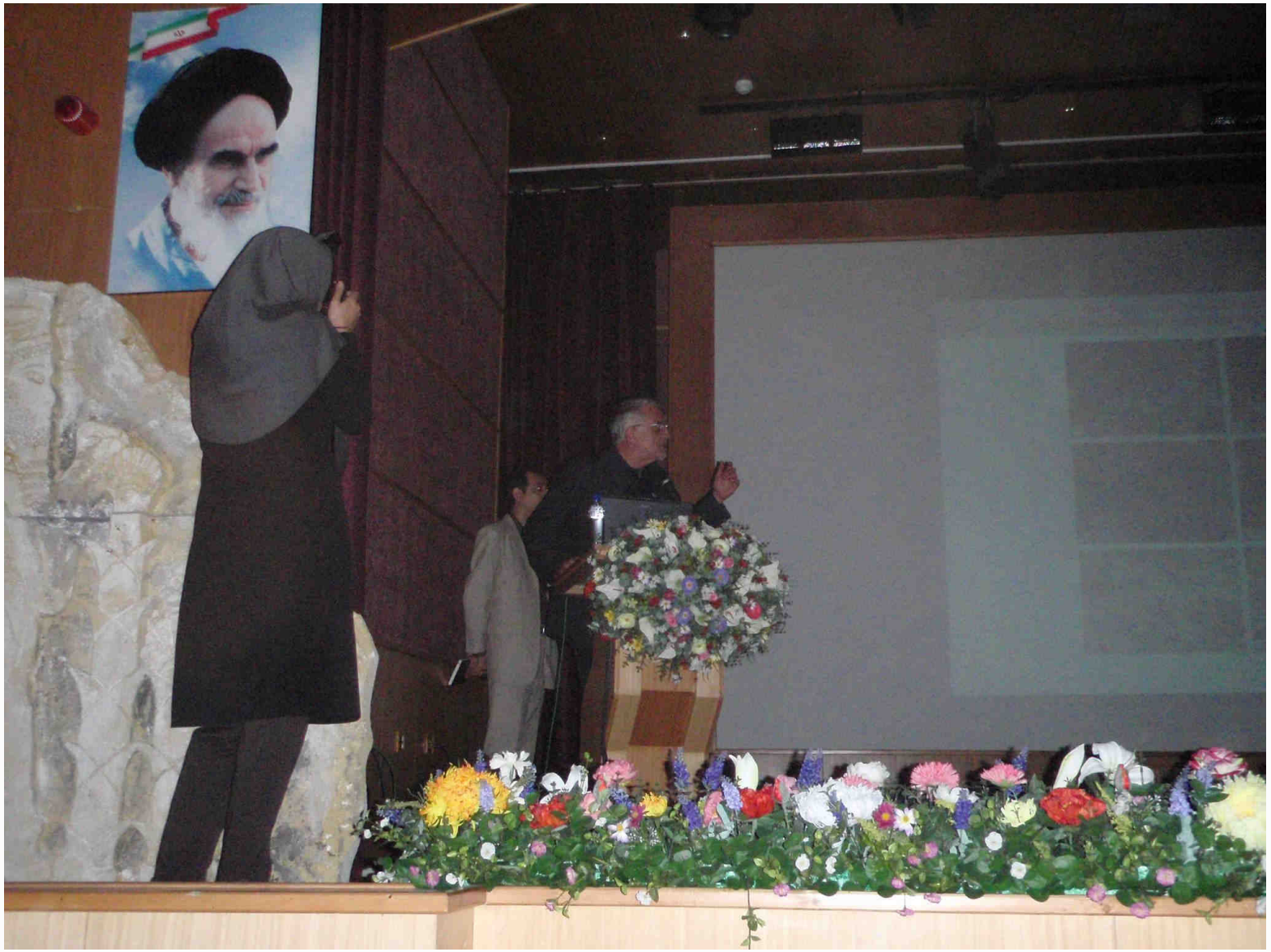
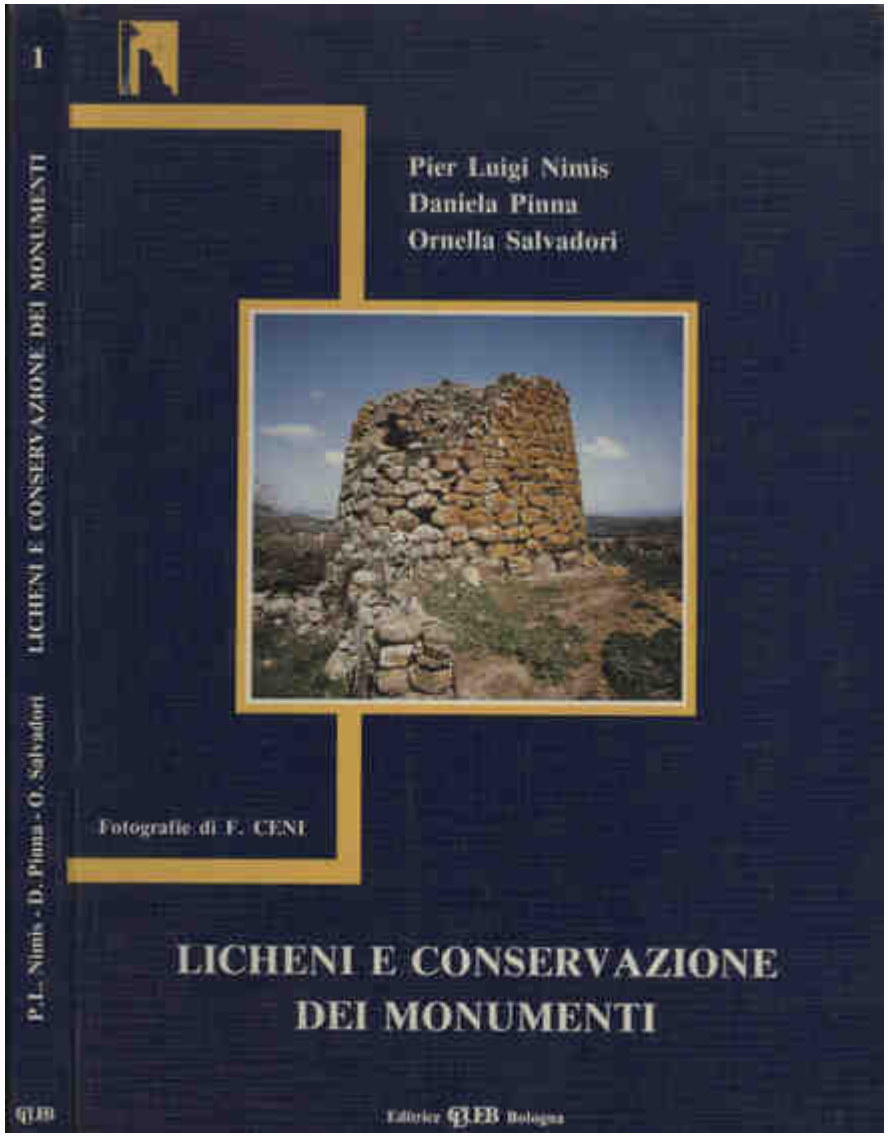
CORSO DI BOTANICA SISTEMATICA

LEZIONE 55

Licheni come agenti di biodeterioramento dei monumenti in pietra


اولین همایش بین المللی





CONSIGLIO NAZIONALE
DELLE RICERCHE
CENTRO DI STUDIO "CAUSE DI
DEPERIMENTO E METODI
DI CONSERVAZIONE DELLE OPERE
D'ARTE" - ROMA

DIPARTIMENTO DI BIOLOGIA
SEZIONE DI GEOBOTANICA
ED ECOLOGIA VEGETALE
UNIVERSITÀ DEGLI STUDI
TRIESTE

P.L. NIMIS, M. MONTE, M. TRETIACH

FLORA E VEGETAZIONE LICHENICA DI AREE ARCHEOLOGICHE DEL LAZIO

Trieste 1987

The First International Conference on
Biodeterioration of Historical and Cultural Heritage

Artistic and Historical Monuments: Threatened Ecosystems

PIER LUIGI NIMIS
Department of Biology
University of Trieste
Trieste, Italy

Italy has the largest heritage worldwide in historical monuments, ancient books, parchments, paintings, sculptures, ancient tapestries, and textiles. Some are kept outdoors, some indoors, and others even under water; their preservation is a responsibility of all Italians to mankind. These works of art are attacked by many organisms, and the biologist regards them as outright ecosystems. Open-air monuments mostly host photosynthetic organisms, such as cyanobacteria, algae, lichens, mosses, and higher plants, whereas those stored indoors are attacked by heterotrophic organisms, such as bacteria, fungi, and insects. Biology can help their conservation and restoration in that it can identify such organisms and the ecological conditions that allow their growth. This knowledge allows the biologist to judge the effectiveness of restoring treatments. Much has been done and much more still remains to be done.

Opere d'arte e di storia: ecosistemi minacciati

di Pier Luigi Nimis* - Frontiere della Vita (1999)

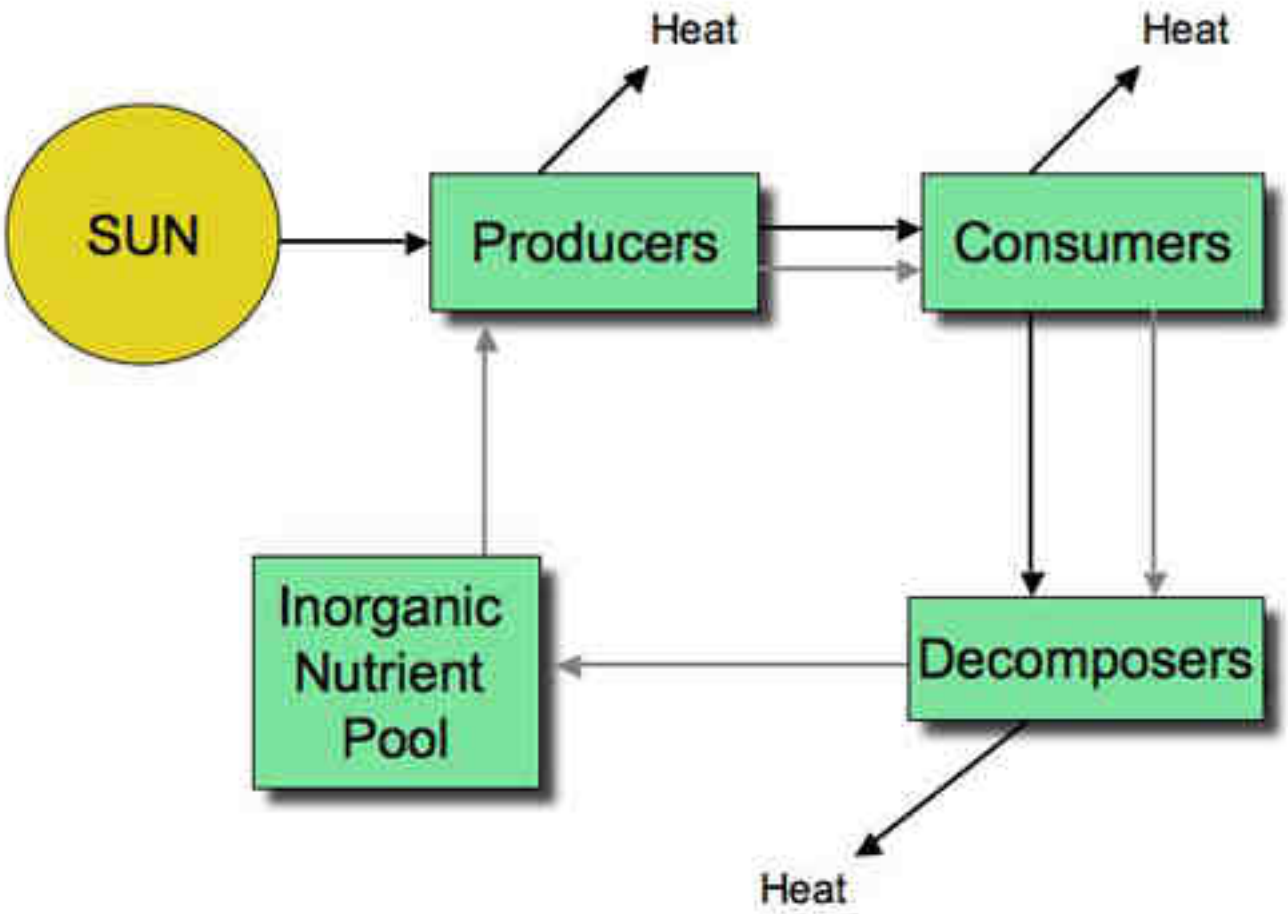
* Dipartimento di Biologia, Università di Trieste, Trieste, Italia

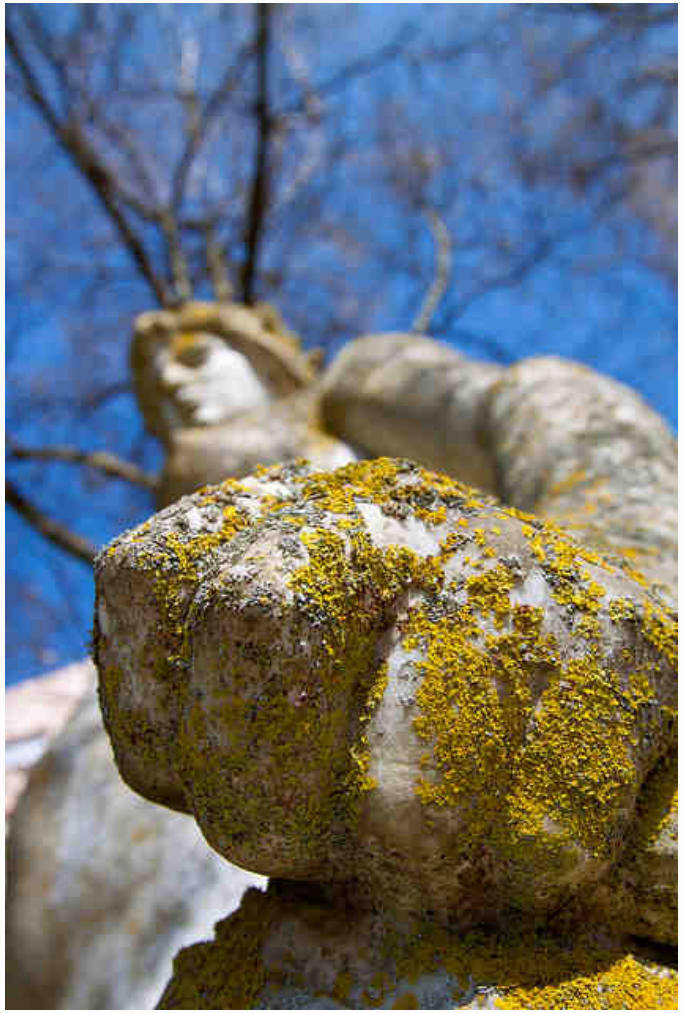
Opere d'arte e di storia: ecosistemi minacciati

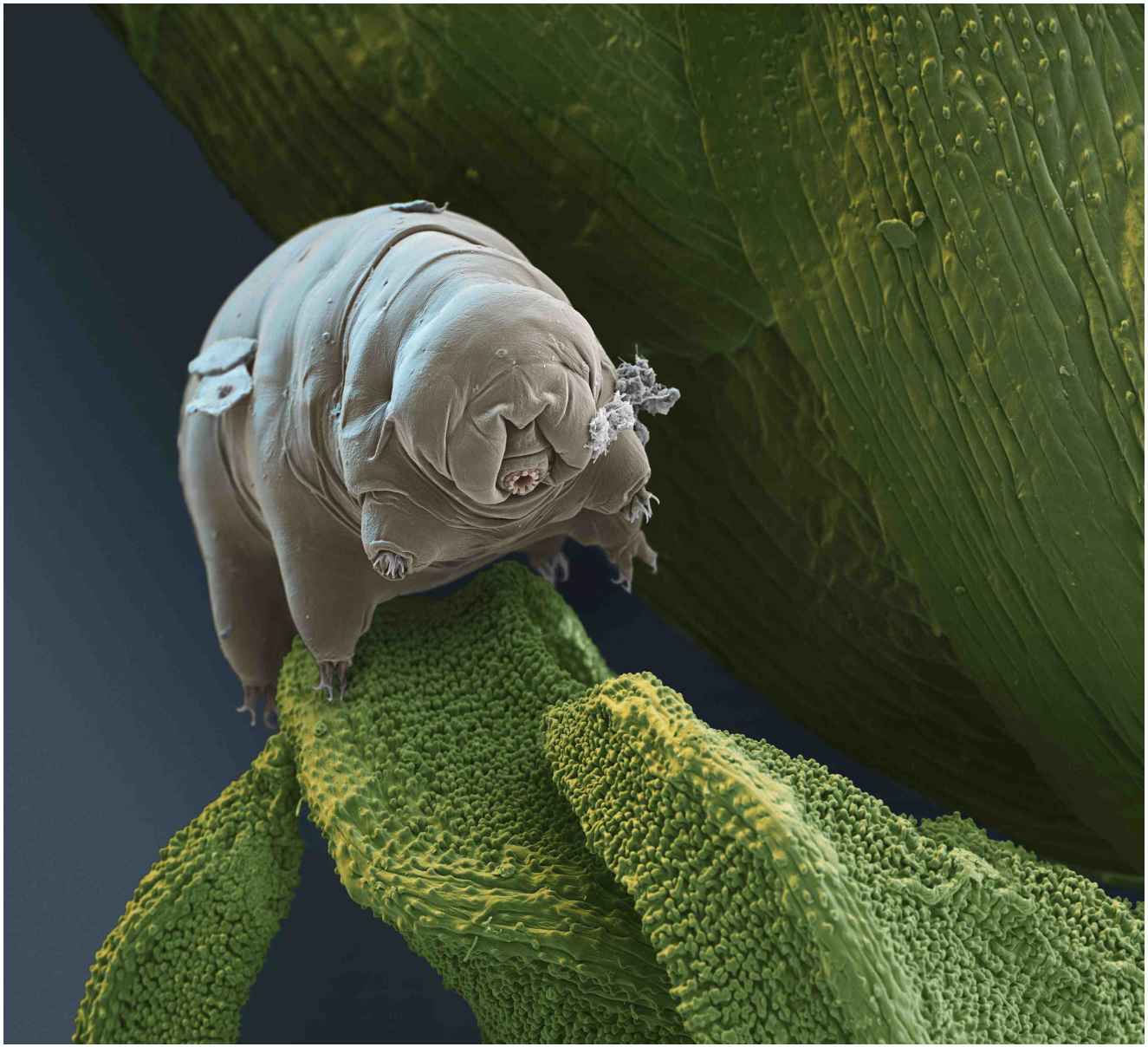
Lichens and monuments: an overview

Pier Luigi Nimis

Dept. of Life Sciences, University of Trieste


Heat
Heat
SUN
Producers
Consumers
Inorganic
Nutrient
Pool
Decomposers
Heat

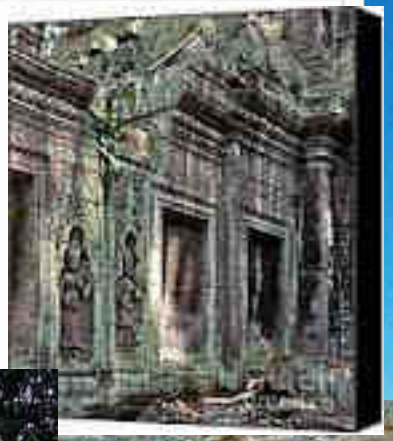




I licheni possono sopravvivere nello spazio!
Lo ha dimostrato un esperimento dell'**Agenzia Spaziale Europea** condotto dal prof. Leopoldo Sancho, dell'*Universidad Complutense* di Madrid, membro onorario della Società Lichenologica Italiana.

Nel corso dell'esperimento due specie licheniche (*Xanthoria elegans* e *Rhizocarpon geographicum*) sono state sigillate in una capsula e lanciate in orbita attorno alla terra il 31 maggio 2005, a bordo di un razzo Sojuz.

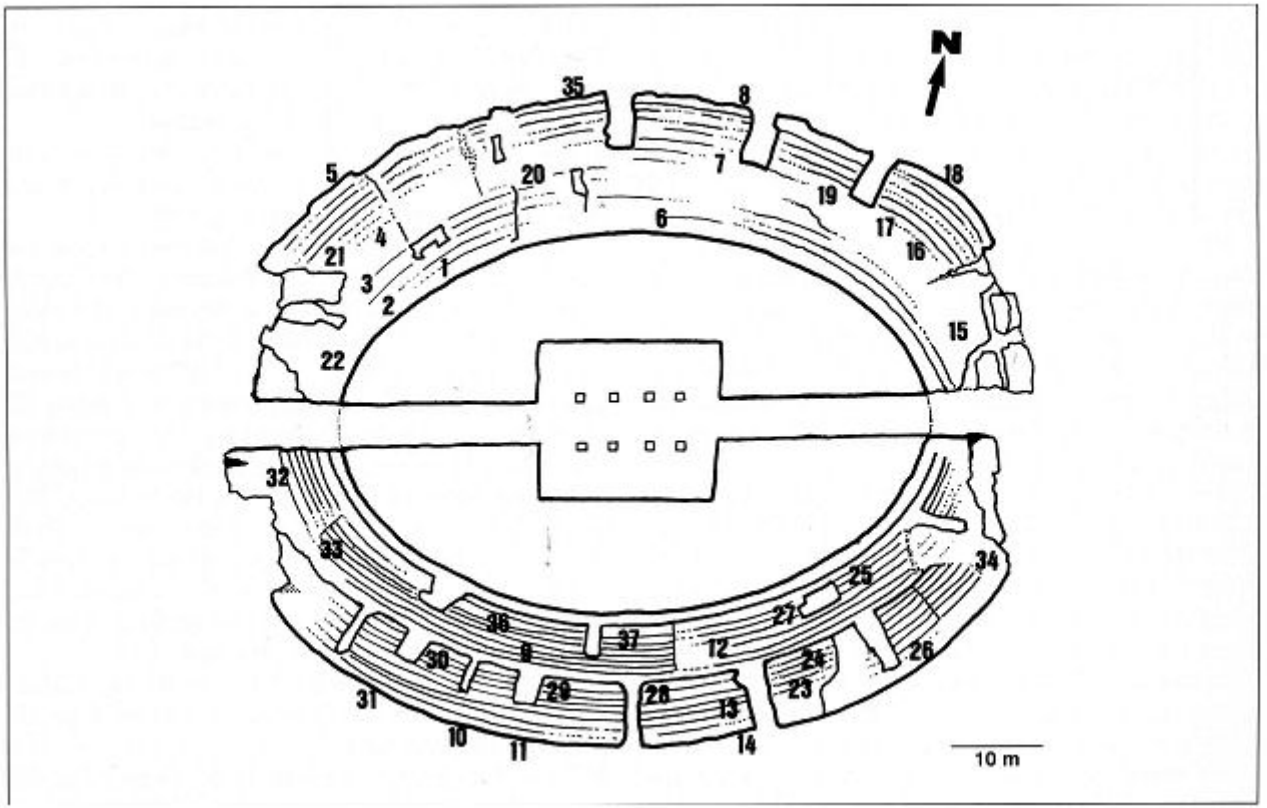
The First International Conference on Biodeterioration of Historical and Cultural Heritage

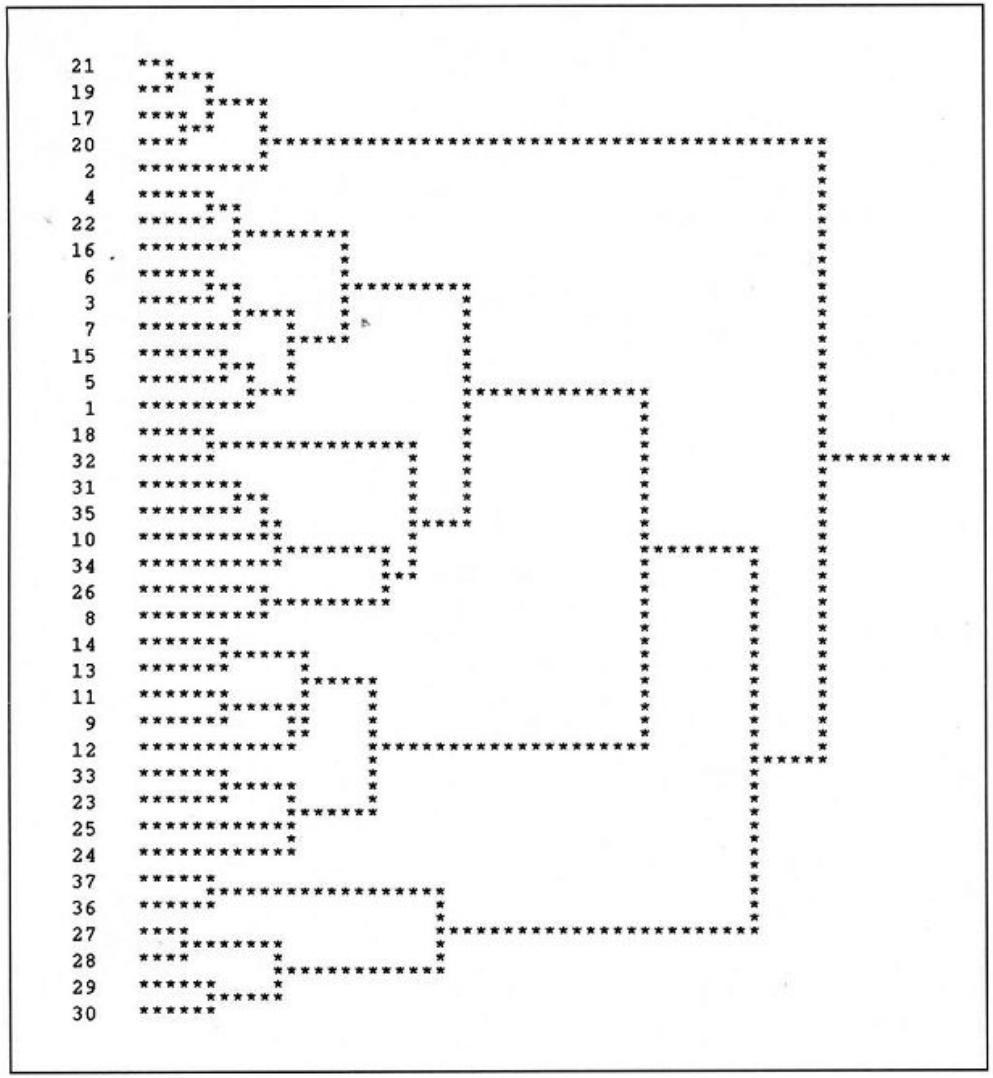



a
b


© Klaus Pommerenke
www.bears-and-more.de


NORMAL - 1/88
ALTERAZIONI MACROSCOPICHE DEI MATERIALI LAPIDEI: LESSICO
Gruppi:
NORMAL - B Metodologie Biologiche
NORMAL - C Metodologie Chimiche
NORMAL - P Metodologie Petrografiche


N
35
8
7
5
20
18
19
6
17
21
4
16
3
1
2
15
22
32
33
34
25
27
38
37
12
24
26
30
8
23
31
29
28
13
10
11
14
10 m


21
19
17
20
2
4
22
16
6
3
7
15
5
1
18
32
31
35
10
34
26
8
14
13
11
9
12
33
23
25
24
37
36
27
28
29
30

Cluster Nr.	1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3 3 3 3 3 4 4 4 4 4 4 4 5 5 5 5 5
Rilievo Nr.	2 1 1 1 1 2 1 1 2 1 3 2 2 2 2 2 2 2 2 1 1 1 2 1 1 9 3 2 5 6 7 5 4 0 2 1 3 3 8 0 5 0 1 9 6 8 4 7 4 7 6 2 9 8
Pendenza	- - / - 1 / / / 1 / 1 1 / - - - - - / 1 1 1 1 1 1 / / 1 / 1
Caloplaca flavescens	+ 1 + + 1 1 1 1 1 1 + 1 1 2 1 1 2 2 1 1 1
Caloplaca teicholyta	2 + +
Verrucaria macrostoma	+ 2
Lecania erysibe	2 2 + +
Bagliettoa parmigera	1 1 5 3 2 2 1 2
Verrucaria tectorum	1 + + + 1 1 2 3 2 1 2 4
Lecania turicensis	1 + 2 1 + 1 2 2 1
Phaeophyscia chloantha	+ + + + +
Catillaria lenticularis	+ + +
Rinodina sp.	+ + + +
Caloplaca holocarpa	+ +
Candelaria concolor	+ + +
Caloplaca inconnexa	+ +
Protoblastenia rupestris	+
Caloplaca saxicola	+
Aspicilia calcarea	+
Caloplaca lithophila	+
Physcia adscendens	+ + 1 + 1
Phaeophyscia orbicularis	+ 1 1 2 + +
Candelariella medians	5 5 4 3 + 1 1 1
Caloplaca aurantia	+ + 2 + 3 4 3 3 3 3 4 5 3 1 1
Lecanora albescens	1 + 1 + 3 4 5 + + + 1 + + 1 + + +
Candelariella aurella	+ + + + + +
Caloplaca citrina	+ + + + + + + + + 3 +
Verrucaria nigrescens	2 1 + + + 2 1 1 1 2 2 2 1
Aspicilia hoffmannii	+ 1 1 1 1 + + 1 1 4 + +
Aspicilia radiosa	2 4 1 + 1 + + + 5 1 +
Phaeophyscia hirsuta	+ + 3 ++ +
Caloplaca flavescens	+ 1 + + 1 1 1 1 1 1 + 1 1 2 1 1 2 2 1 1 1
Caloplaca teicholyta	2 + +
Verrucaria macrostoma	+ 2
Lecania erysibe	2 2 + +
Bagliettoa parmigera	1 1 5 3 2 2 1 2
Verrucaria tectorum	1 + + + 1 1 2 3 2 1 2 4
Lecania turicensis	1 + 2 1 + 1 2 2 1
Phaeophyscia chloantha	+ + + + +
Catillaria lenticularis	+ + +
Rinodina sp.	+ + + +
Caloplaca holocarpa	+ +
Candelaria concolor	+ + +
Caloplaca inconnexa	+ +
Protoblastenia rupestris	+
Caloplaca saxicola	+
Aspicilia calcarea	+
Caloplaca lithophila	+

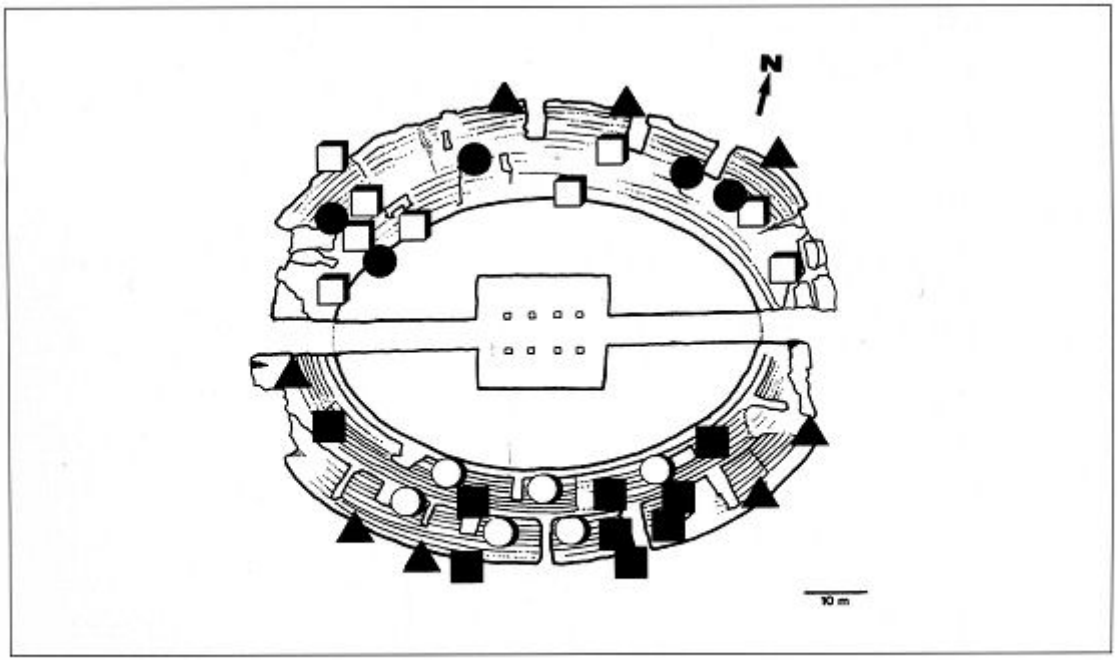
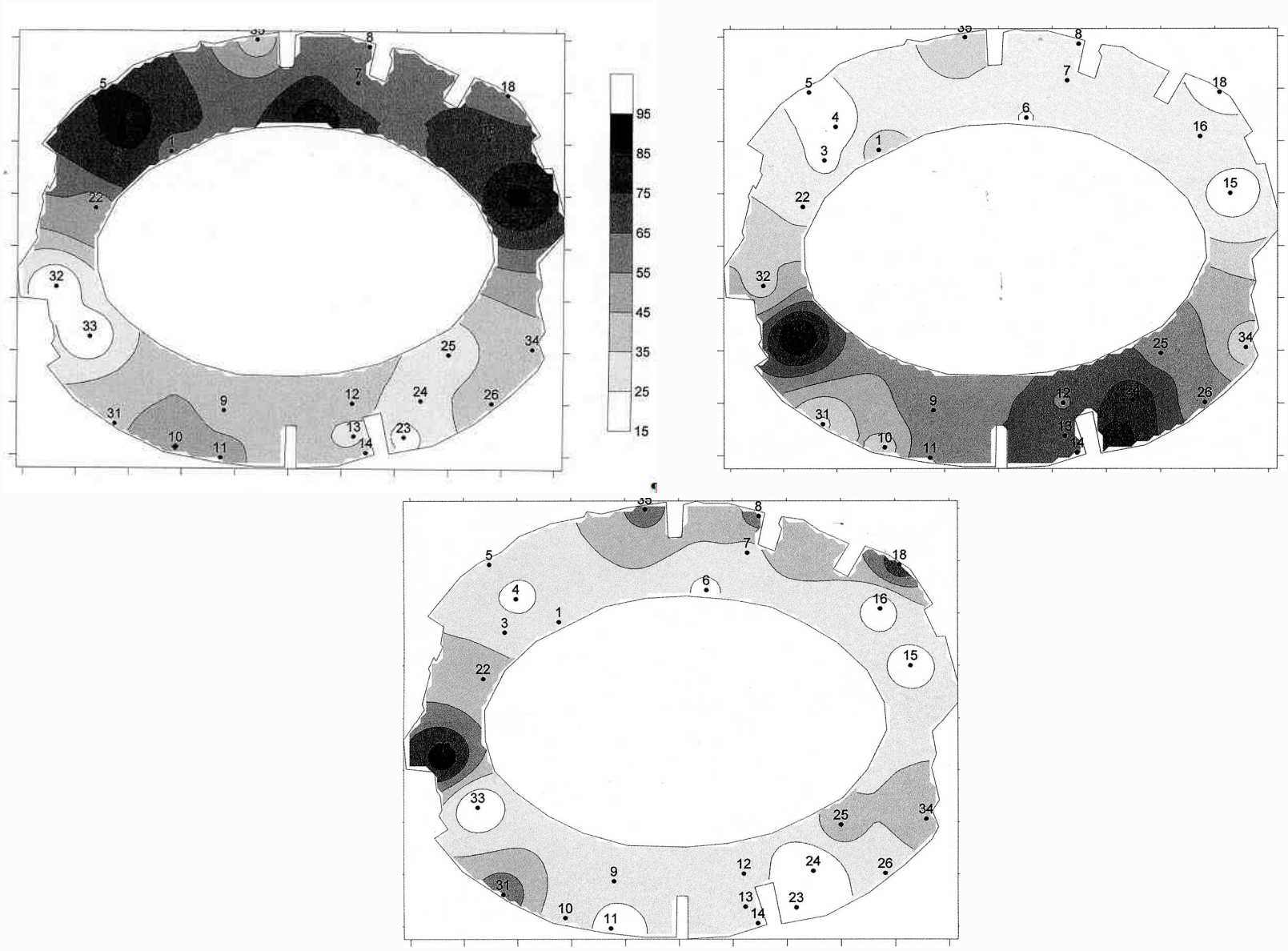
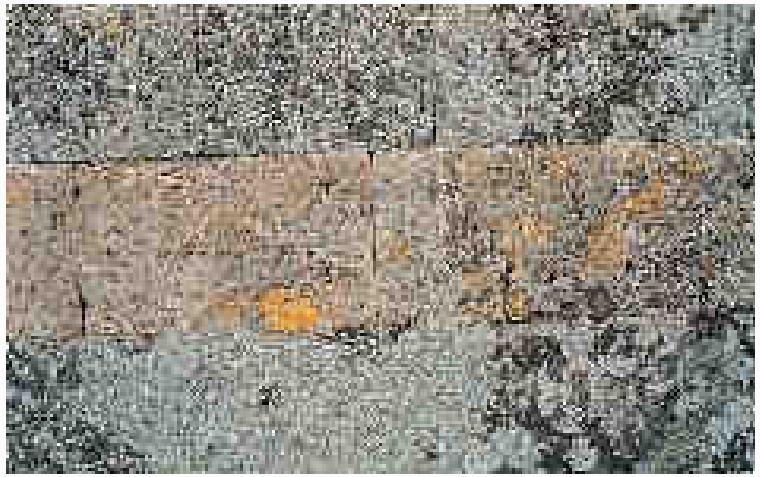


FIGURE 3 - Location of the five main clusters of relevés (see Figure 2) within the amphitheater. Symbols, refer to clusters (see Figure 2, Table 1), as follows: ○ = 1, ■ = 2, ▲ = 3, ❑ = 4, ● = 5.


95
85
75
65
55
45
35
25
15

Lichen communities are complex and diverse: before restoration one should know the main factors influencing their growth




courrier
de
l'ouest.fr

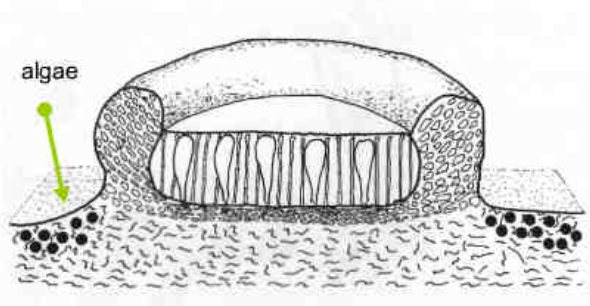
Removal of lichens if often not enough: one should also remove the main causes of their growth

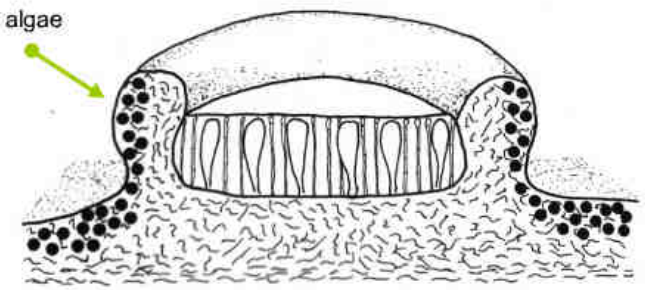
Mechanical removal of lichens may be effective, but…

Sexual reproduction: apothecia

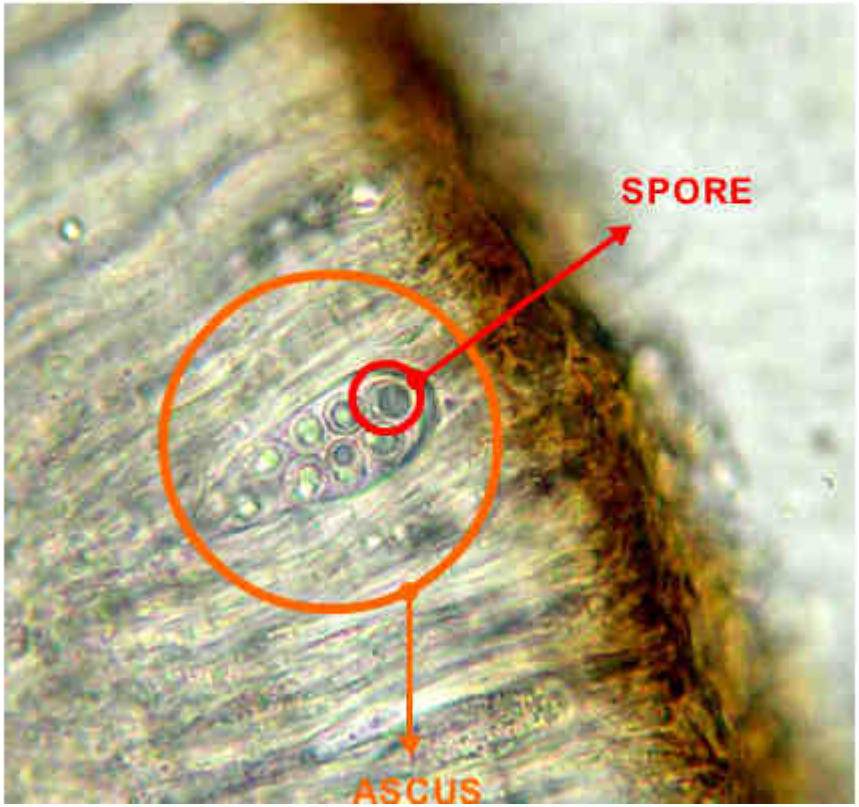
Sexual reproduction occurs as spores produced in specialised fruiting bodies by the fungus: cup-like fruiting bodies (apothecia) or flask-like fruiting bodies (perithecia).

APOTHECIA: spores are produced in **disc-like** fruiting bodies which may appear:
Lecideine - appearing like wine-gums with a margin the same colour as the disc, without algae.
Lecanorine - appearing like jam-tarts with a pastry-like margin the same colour as the thallus, containing algae.



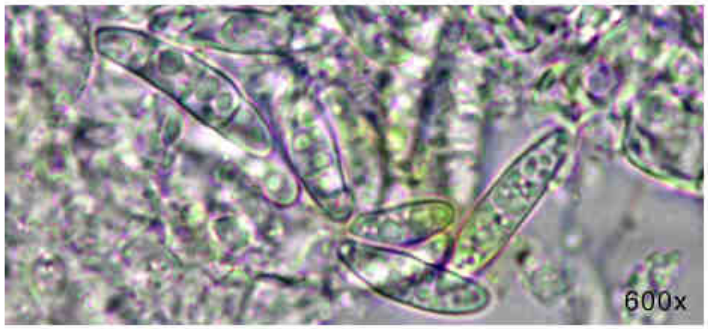


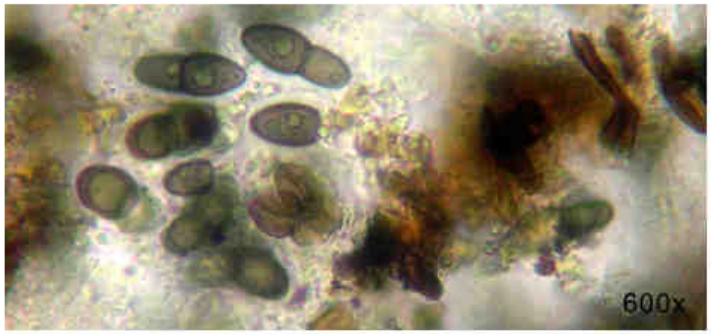
In a thin section of the disc of the fruiting body the **spores** appear in sac-like structures called **asci**, which are surrounded by packing tissue that protects them.



Sexual reproduction: more about spores...

The asci are like pumps under pressure, so that when the spores are ripe they may be shot out to be dispersed from the surface of the disc of an apothecium or through the ostiole of a perithecium.

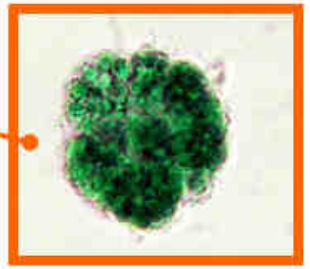




Spores can be colourless or brown, simple - consisting of a single cell, or of 2 or more cells divided by cell walls (septa). Number, form, colour and septation of spores are only seen under the microscope and are important features for identification of many species.

Vegetative reproduction: soredia

SOREDIA are very small granular propagules formed from a mixture of hyphae and algal cells, usually occurring in rather distinct powdery patches called **soralia**.
Soralia may appear in different forms that are important to observe for identification.

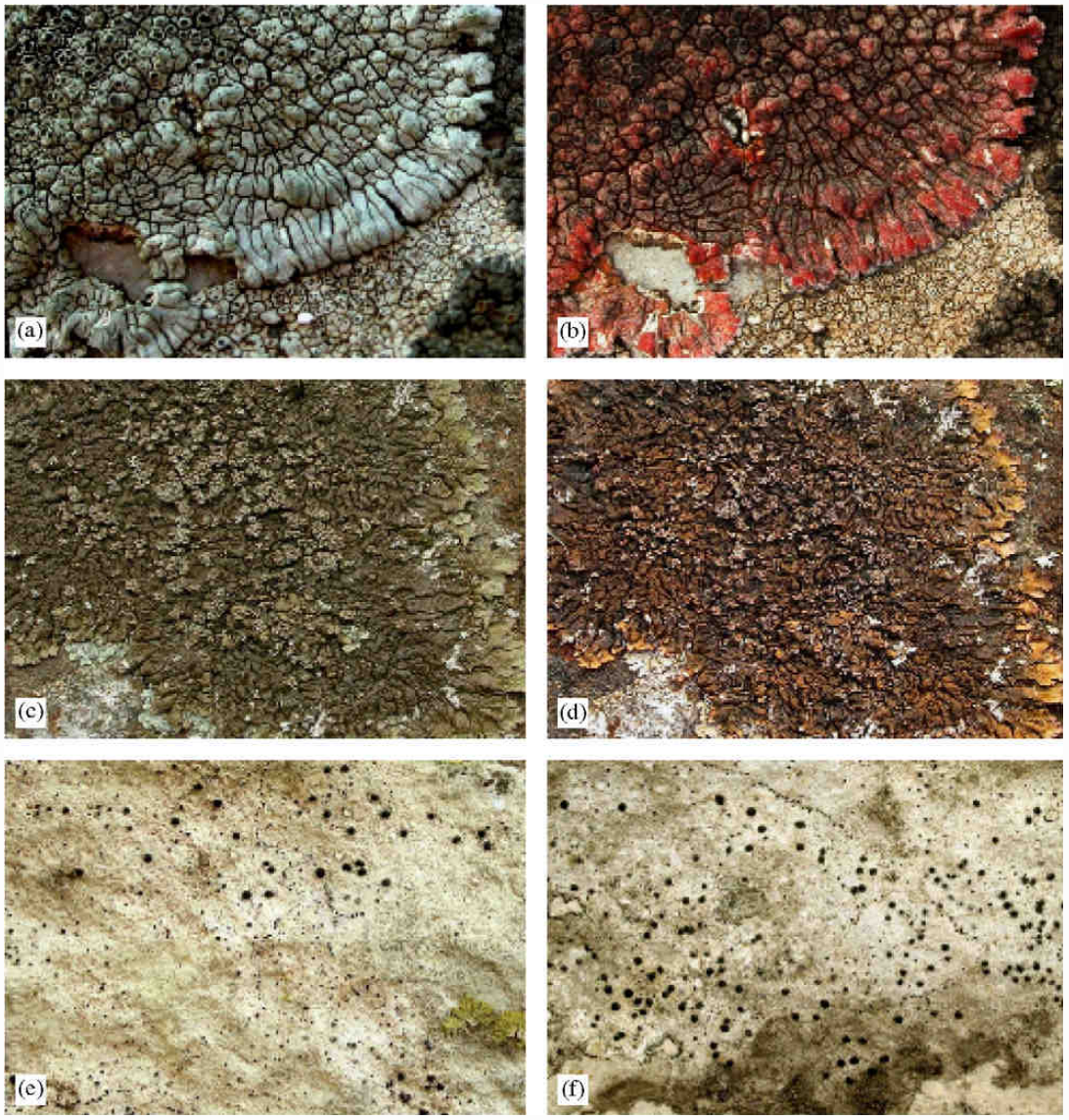


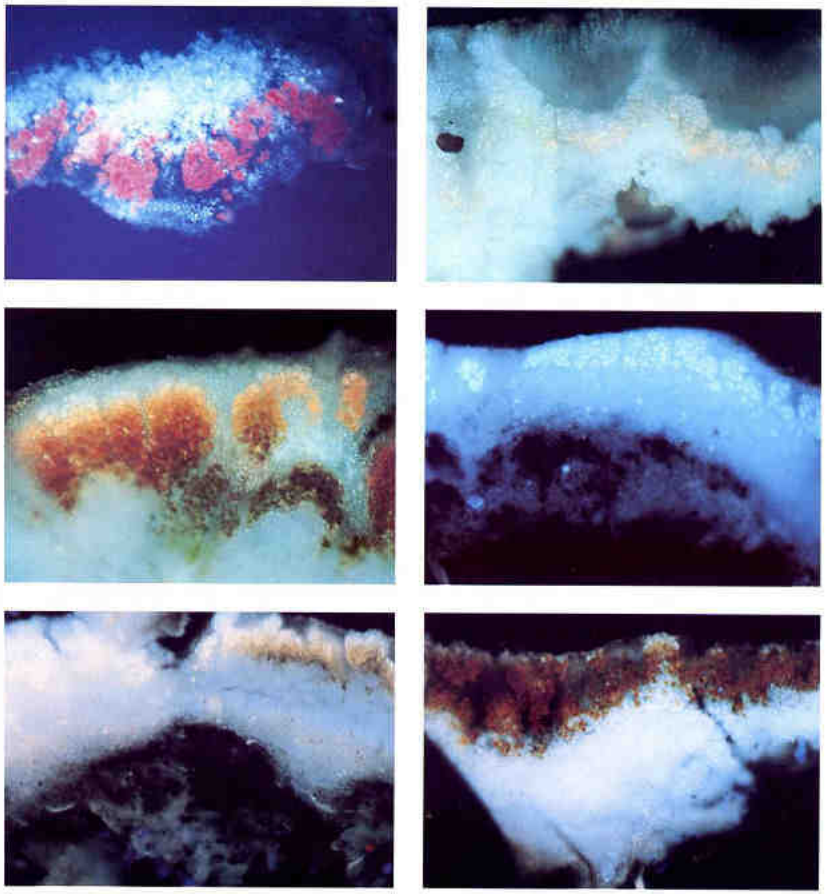
SOREDIUM

In the presence of extensive areas covered by sorediate lichens the use of biocides may be necessary


Microemulsion Concentrate
PLATINUM MICRO
MASONRY BIOCIDE

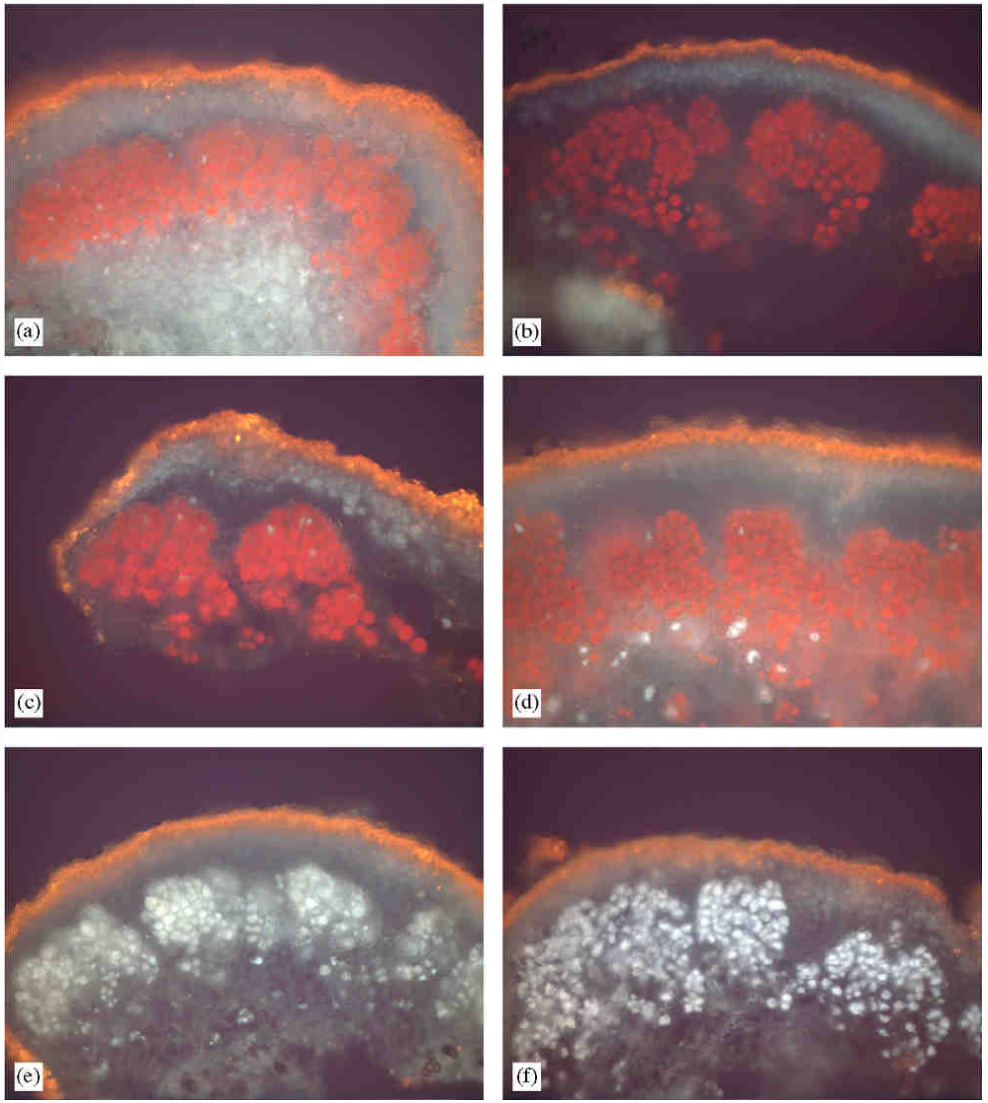

Wykamol
microtech
BIOCIDE
LOW HAZARD
RAPID ACTION
1 LITRE

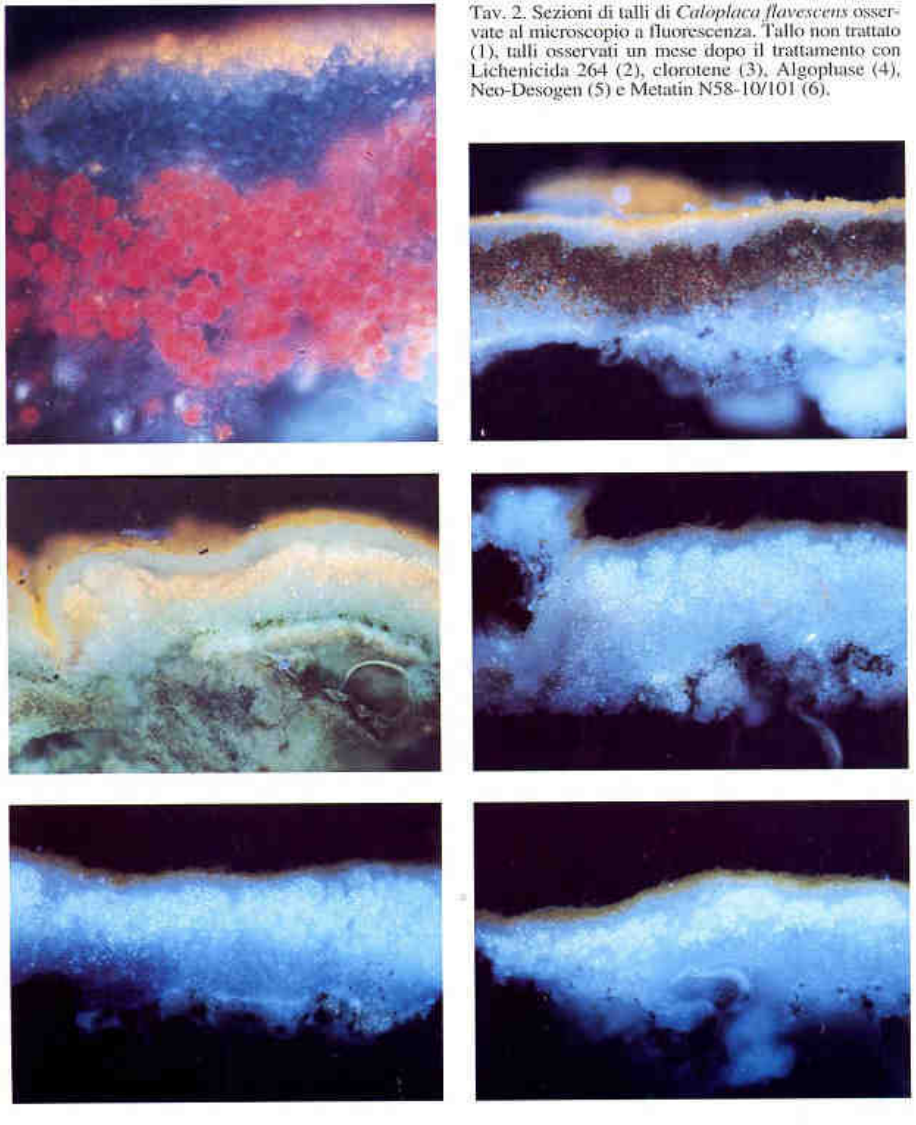

(a)
(b)
(c)
(d)
(e)
(f)



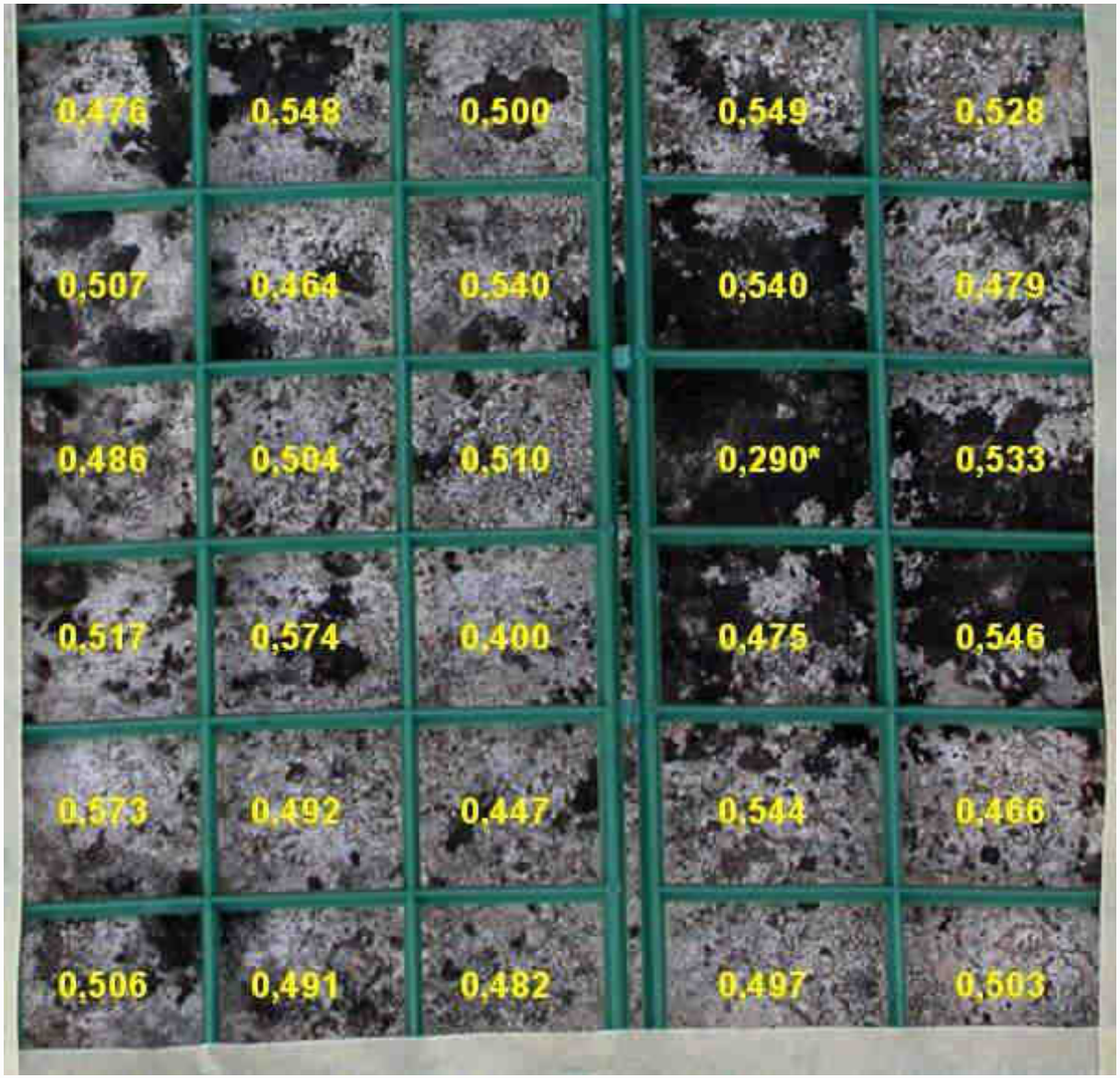
Tav. 3. Sezioni di talli di *Aspicilia radiosa* osservate al microscopio a fluorescenza. Tallo non trattato (1), talli osservati dieci giorni dopo il trattamento con Metatin N58-10/101 (3) e un mese dopo il trattamento con Neo-Desogen (2), Metatin N58-10/101 (4), Algophase (5), Lichenicida 264 (6).

mente a modificazioni della molecola clorofilliana. Tale metodo, pur non fornendo risultati numerici, si rivela particolarmente utile nella valutazione comparata dell'attività algale e nel caso dei licheni, in cui le sezioni trasversali mantengono la distribuzione spaziale dei componenti simbiontici, le comparazioni possono essere


(a)
(b)
(c)
(d)
(e)
(f)



Tav. 2. Sezioni di talli di *Caloplaca flavescens* osservate al microscopio a fluorescenza. Tallo non trattato (1), talli osservati un mese dopo il trattamento con Lichenicida 264 (2), clorotene (3), Algophase (4), Neo-Desogen (5) e Metatin N58-10/101 (6).

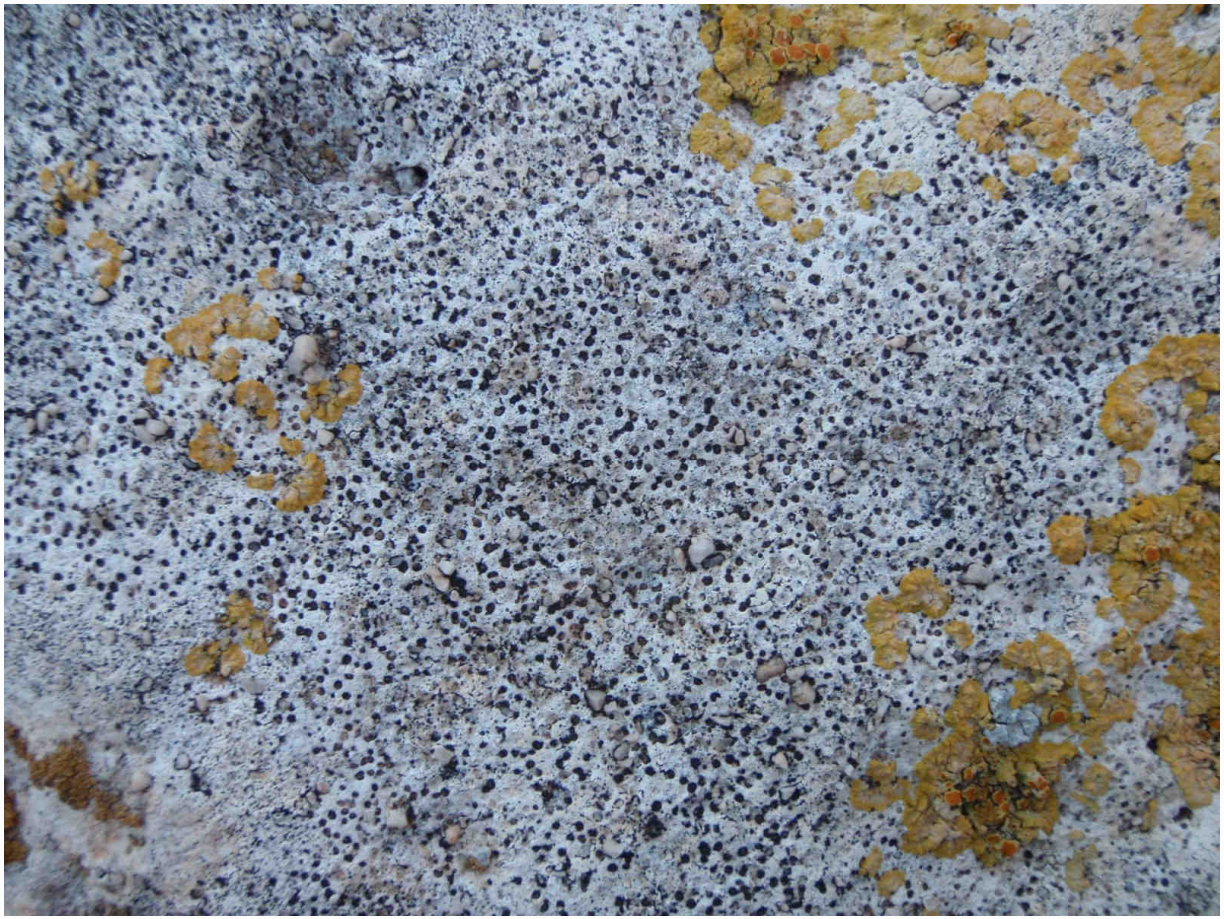

0,476
0,548
0,500
0,549
0,528
0,507
0,464
0,540
0,540
0,479
0,486
0,504
0,510
0,290*
0,533
0,517
0,574
0,400
0,475
0,546
0,573
0,492
0,447
0,544
0,466
0,506
0,491
0,482
0,497
0,503

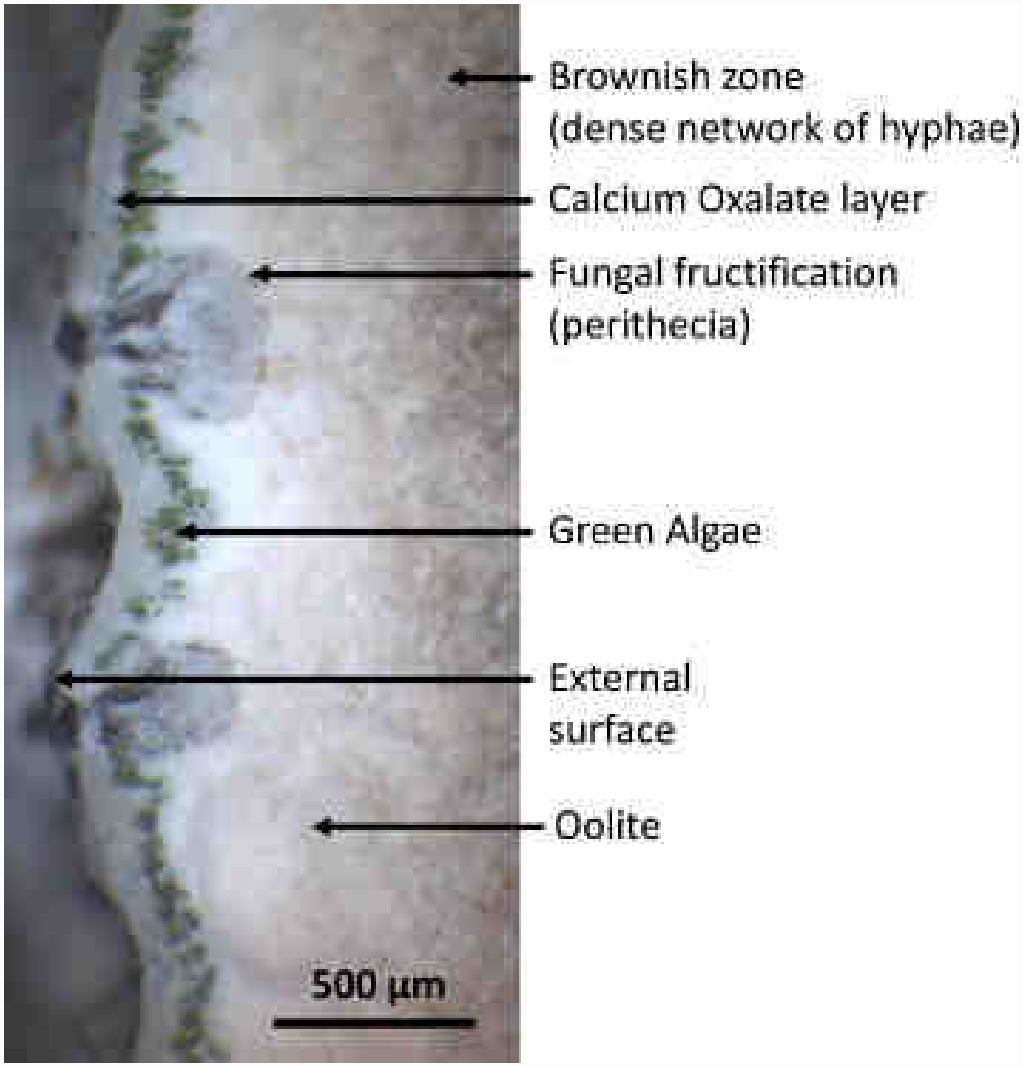
The performance of biocides is species-dependent, their effects on stone surfaces are variable according to rock type and climate. Before applying a biocide, tests should be carried out on small surfaces.

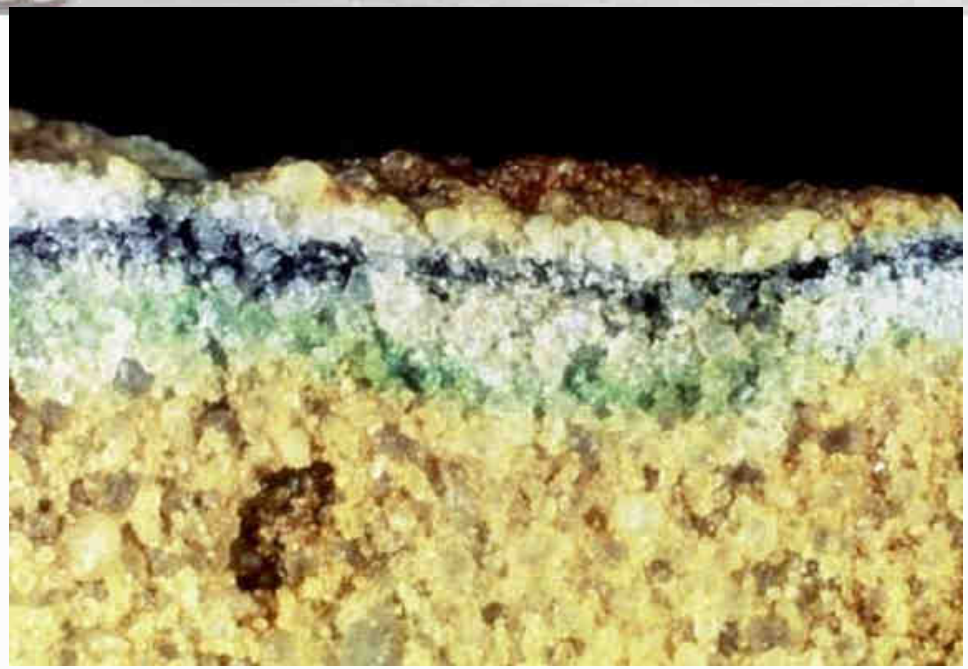

Microemulsion Concentrate
PLATINUM MICRO
MASONRY BIOCIDE


Wykamol
microtech
BIOCIDE
LOW HAZARD
RAPID ACTION
1 LITRE

Biocides are generally harmful to human health: their extensive use in archaeological areas should not be endorsed

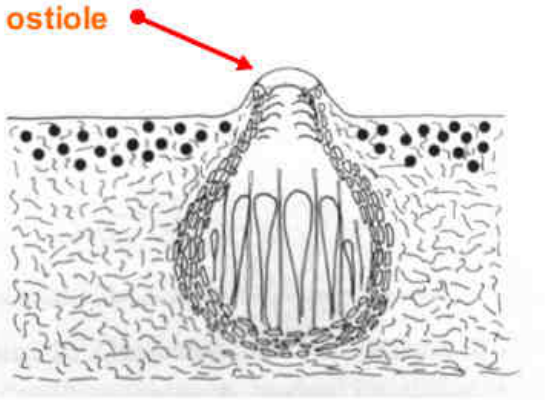



Brownish zone
(dense network of hyphae)
Calcium Oxalate layer
Fungal fructification
(perithecia)
Green Algae
External
surface
Oolite
500 µm

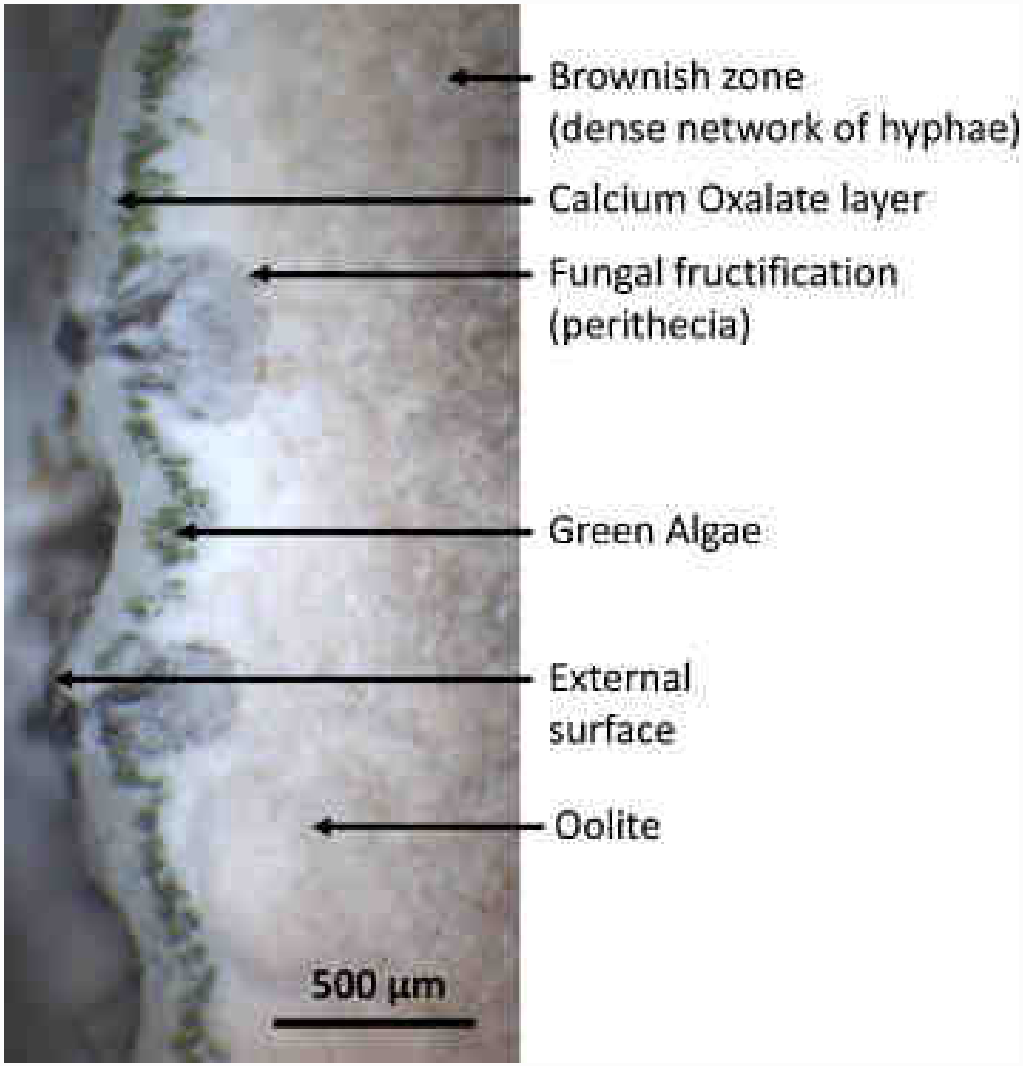


Sexual reproduction: perithecia

PERITHECIA: spores are produced in a flask-shaped fruiting body from which they are released through a pore-like **ostiole**.
Perithecia may be immersed in the thallus or substrate or appear as black carbonised pimples on the thallus.

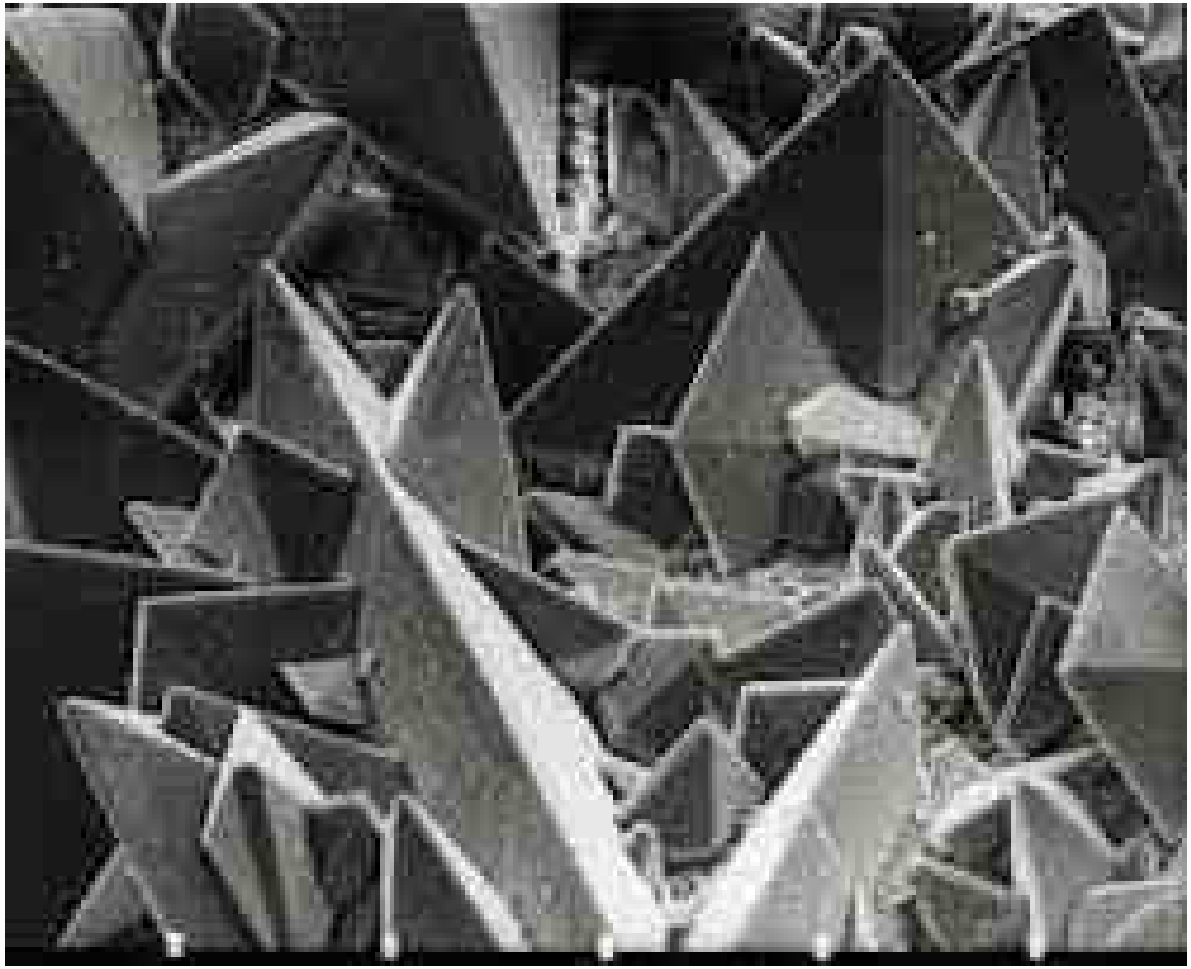


Section of a perithecium


Brownish zone
(dense network of hyphae)
Calcium Oxalate layer
Fungal fructification
(perithecia)
Green Algae
External
surface
Oolite
500 µm


1mm

In the case of endolithic lichens on carbonatic rocks the use of biocides should be avoided



Environmental Science & Technology

Article

pubs.acs.org/est

Heat Shock Treatments: A New Safe Approach against Lichen Growth on Outdoor Stone Surfaces

Mauro Tretiach,* Stefano Bertuzzi, and Fabio Candotto Carniel

Dipartimento di Scienze della Vita, Università degli Studi di Trieste, I-34127 Trieste, Italy

Supporting Information

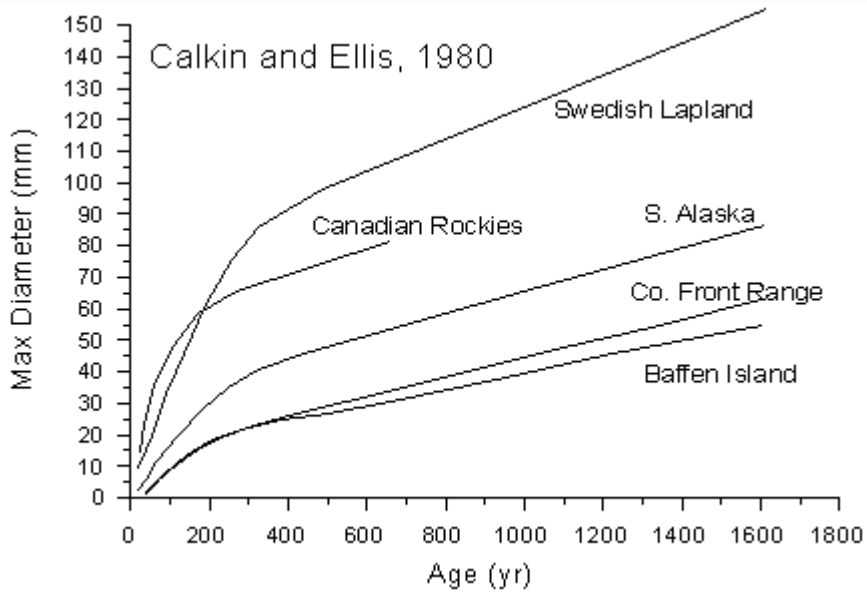
ABSTRACT: The control of lichen growth, particularly important in the field of stone conservation of outdoor monuments, largely depends on the use of biocides, that may be dangerous for the users, the environment and the substratum. A new, alternative approach is proposed, which makes the most of a poorly known peculiarity of poikilohydrous organisms: they are thermo-tolerant (up to 65−70 °C) when dry, but thermo-sensitive when wet. The efficacy of thermal treatments (range: 20−55 °C), in parallel to the application of three biocides, was verified in the laboratory with six epi- and endolithic lichens. Chlorophyll *a* fluorescence emission was checked in treated and nontreated samples of all the species, whereas histochemical observations with a dead cell stain were carried out on one of them. The feasibility of the thermal treatments in the field was verified with a seventh species. The results confirm that a 6 h treatment at 55 °C is sufficient to kill the lichens if they are kept fully hydrated. At 40 °C the organisms are damaged: in this case biocides at concentrations 10× lower than in normal applications can profitably be used. The new protocol is simple, the field equipment cheap, and the negative effects associated with standard biocide treatments are absent.

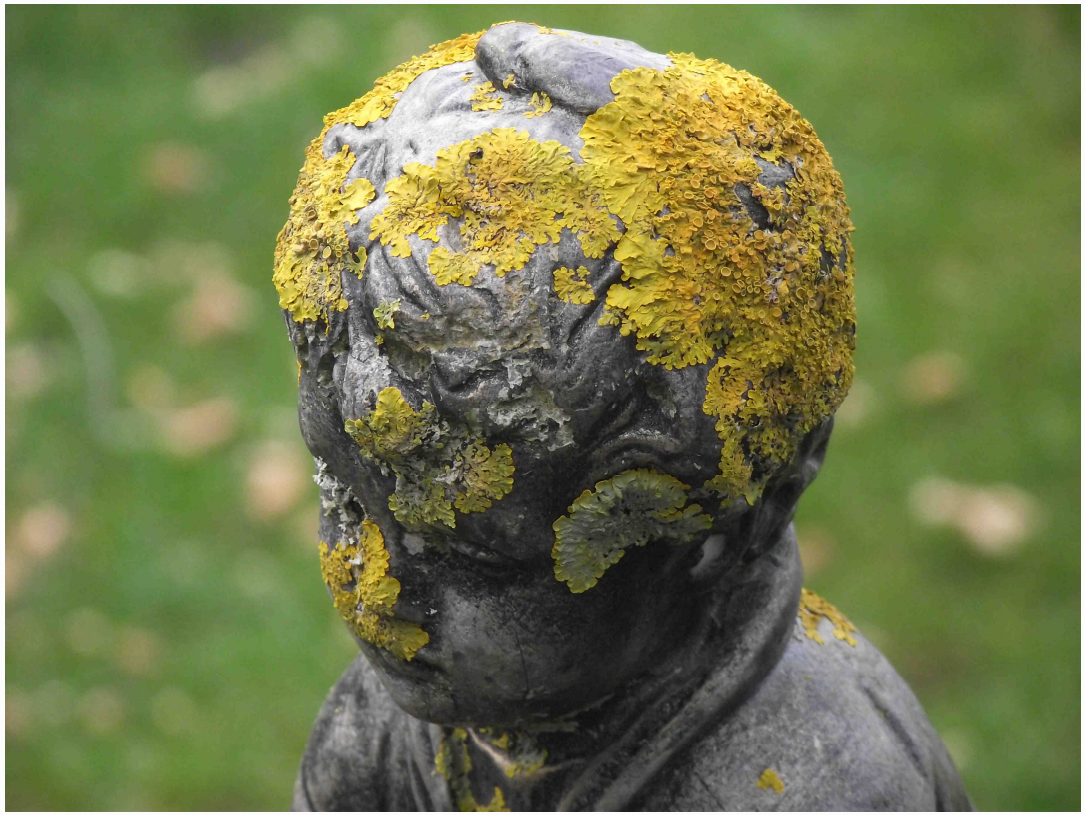
Heat shock treatments may be an effective substitute of biocides


SOLVAY SOLEXIS
FOMBLIN
25/6

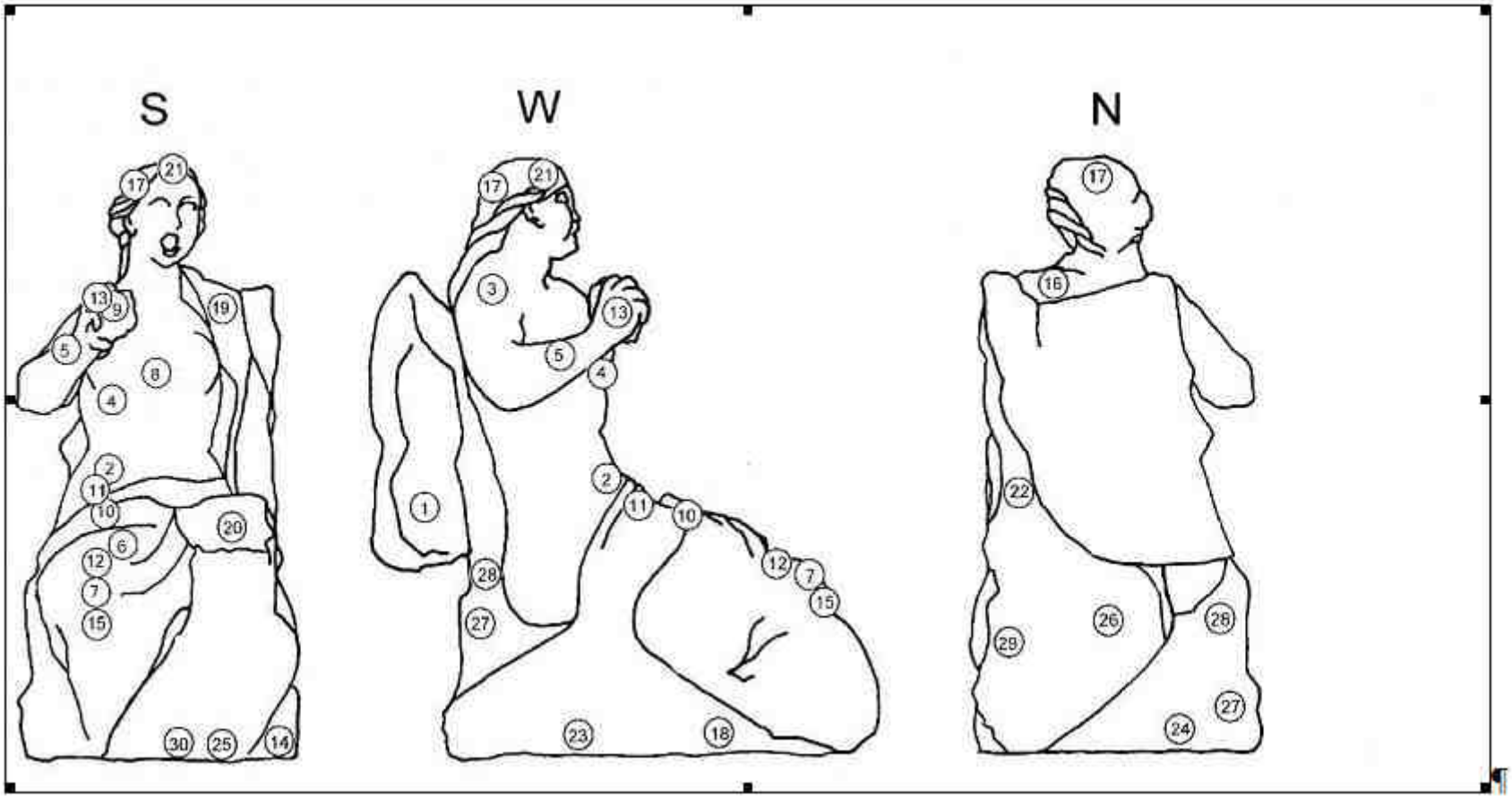

TAXI

Protective films may be dangerous for stone surfaces and their efficiency must be tested case by case

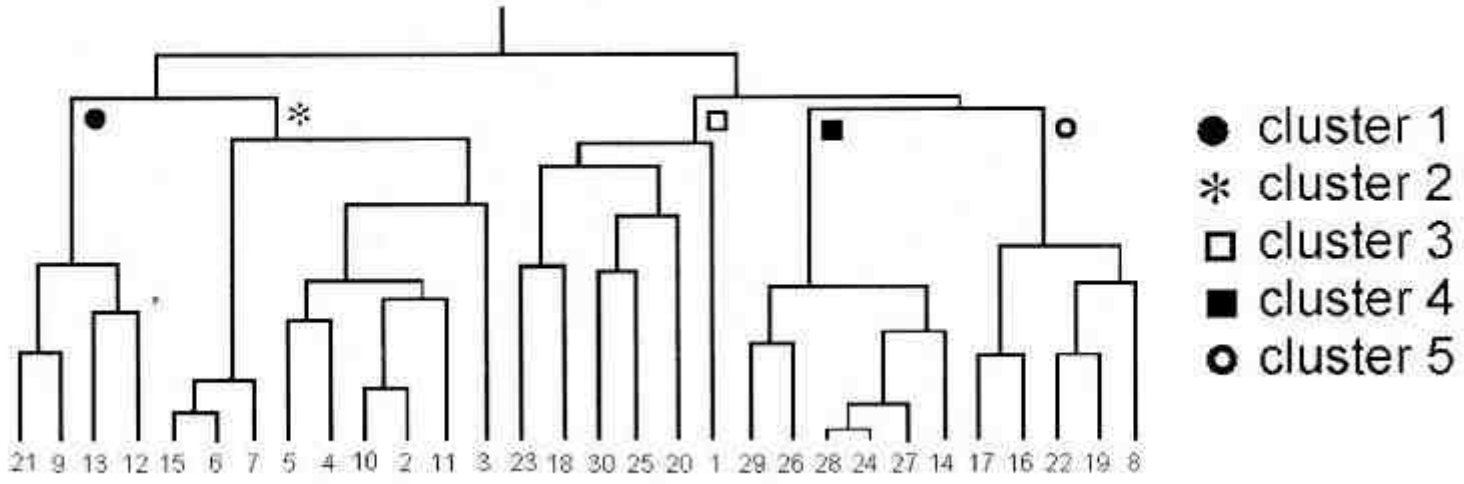

Calkin and Ellis, 1980
Max Diameter (mm)
Age (yr)
Swedish Lapland
Canadian Rockies
S. Alaska
Co. Front Range
Baffen Island
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
0
200
400
600
800
1000
1200
1400
1600
1800

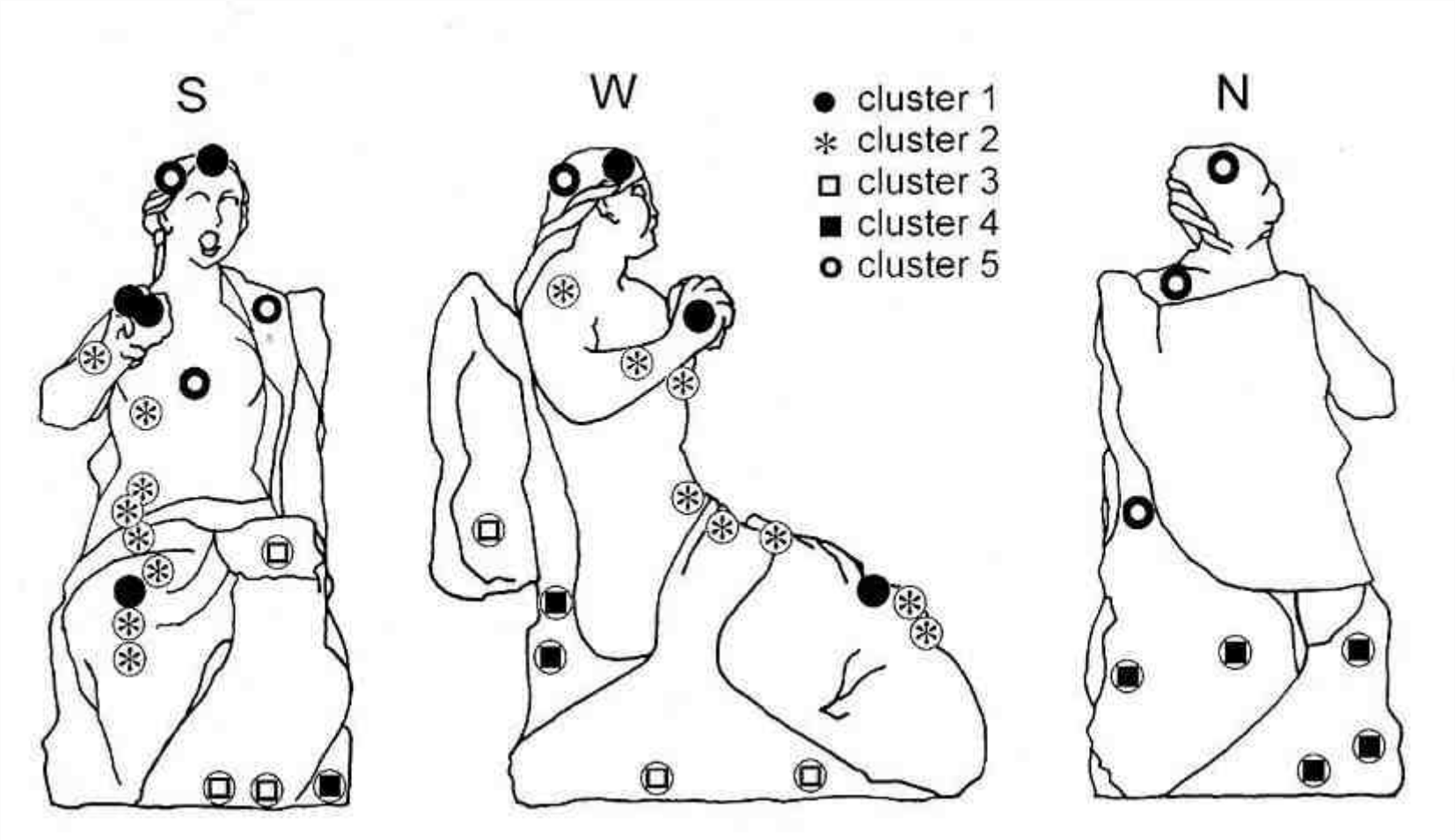


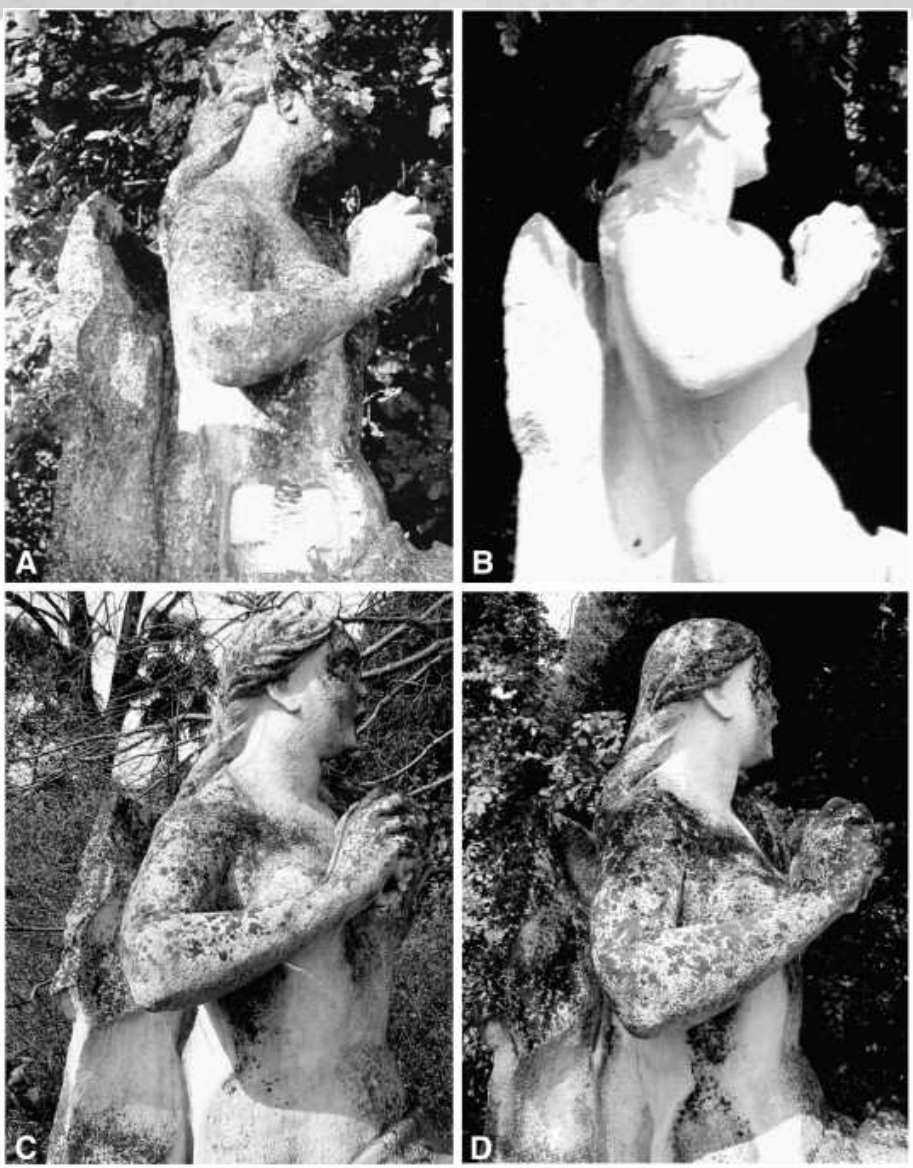




S
W
N

¶


21 9 13 12 15 6 7 5 4 10 2 11 3 23 18 30 25 20 1 29 26 28 24 27 14 17 16 22 19 8
cluster 1
cluster 2
cluster 3
cluster 4
cluster 5


S
W
N
cluster 1
cluster 2
cluster 3
cluster 4
cluster 5



A: pre-restoration, B: 1996 (restoration), C: 2004, D. 2008

Sometimes elimination of lichens has little sense and should be avoided if the causes favouring lichen growth cannot be eliminated

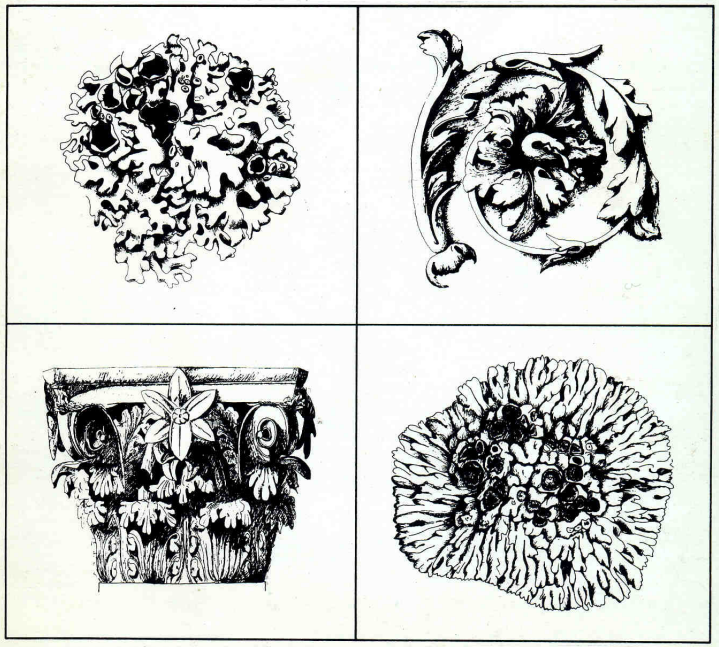
Molti siti archeologici possono trasformarsi in veri e propri "giardini botanici" per il lichenologo. Al valore artistico e storico si aggiunge una importante valenza naturalistica: i diversi materiali usati per le costruzioni determinano la presenza di molti licheni che sarebbero altrimenti assenti.

CONSIGLIO NAZIONALE
DELLE RICERCHE
CENTRO DI STUDIO "CAUSE DI
DEPERIMENTO E METODI
DI CONSERVAZIONE DELLE OPERE
D'ARTE" - ROMA

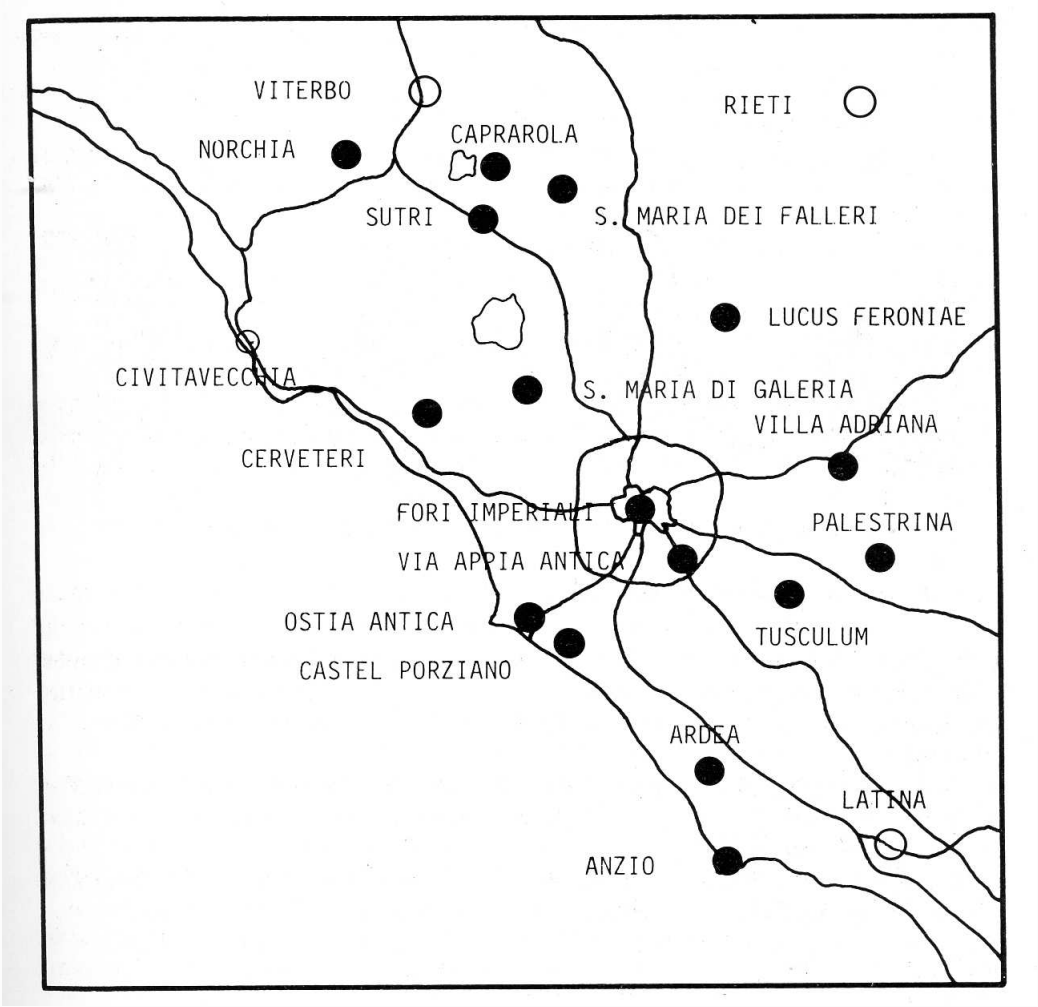
DIPARTIMENTO DI BIOLOGIA
SEZIONE DI GEOBOTANICA
ED ECOLOGIA VEGETALE
UNIVERSITÀ DEGLI STUDI
TRIESTE

P.L. NIMIS, M. MONTE, M. TRETIACH

FLORA E VEGETAZIONE LICHENICA DI AREE ARCHEOLOGICHE DEL LAZIO

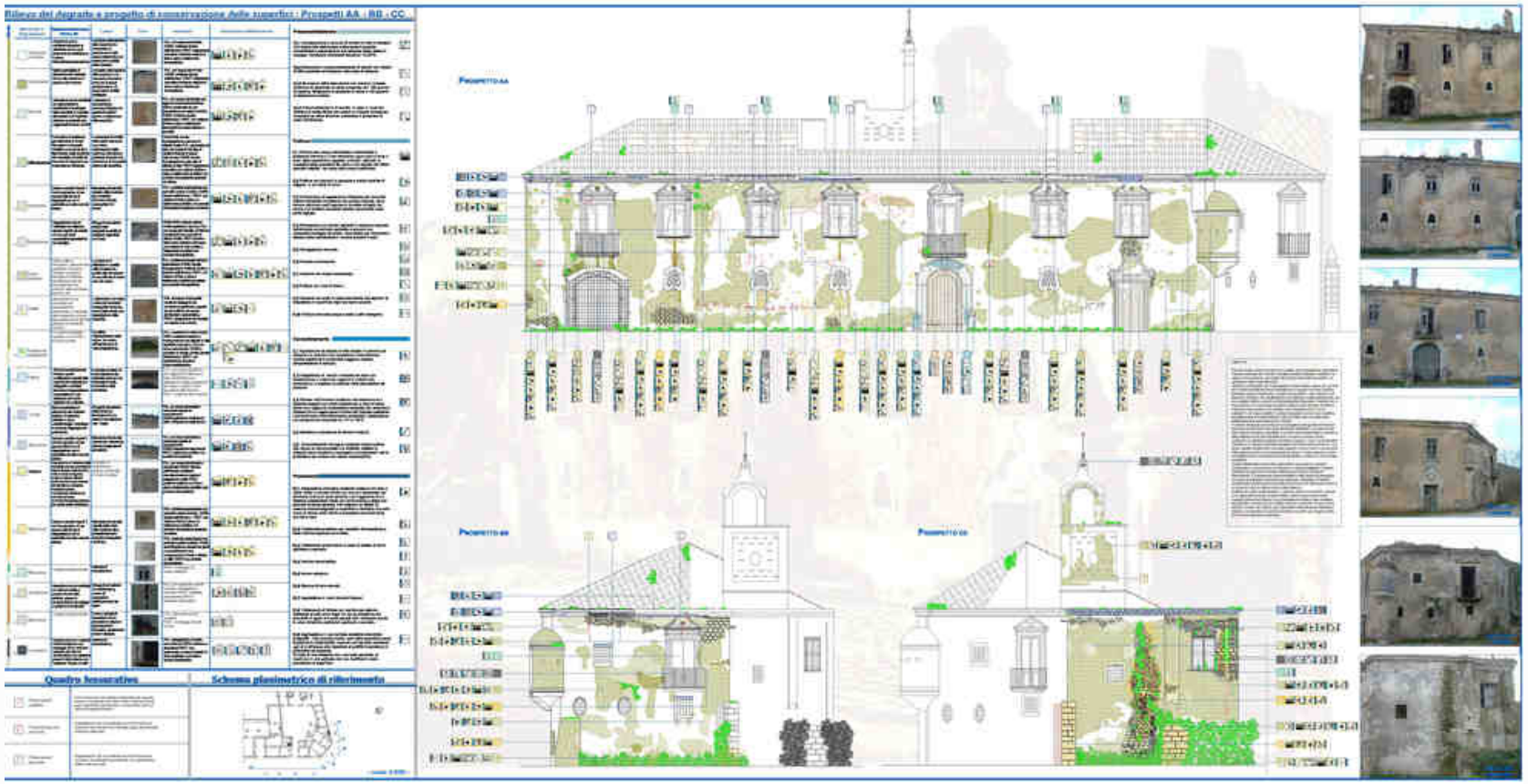


Trieste 1987


VITERBO
RIETI
NORCHIA
CAPRAROLA
SUTRI
S. MARIA DEI FALLERI
LUCUS FERONIAE
CIVITAVECCHIA
S. MARIA DI GALERIA
VILLA ADRIANA
CERVETERI
FORI IMPERIALI
PALESTRINA
VIA APPIA ANTICA
OSTIA ANTICA
TUSCULUM
CASTEL PORZIANO
ARDEA
LATINA
ANZIO

Biodiversity may be an important element of archaeological areas: its conservation should be considered in restoration plans


NORMAL - 1/88
ALTERAZIONI MACROSCOPICHE DEI MATERIALI LAPIDEI: LESSICO
Gruppi:
NORMAL - B Metodologie Biologiche
NORMAL - C Metodologie Chimiche
NORMAL - P Metodologie Petrografiche


Rilievo del degrado e progetto di conservazione delle superfici - Prospetti AA - BB - CC
Quadro fessurativo
Schema planimetrico di riferimento
Prospetto AA
Prospetto BB
Prospetto CC

Much more research is needed:
exciting work ahead!

THANK YOU FOR THE ATTENTION!