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THALLUS VARIATIONS OF *PARMELIA CAPERATA* EXPOSED IN SUBURBS AND INDUSTRIAL AREA (VENICE, NORTH-EAST ITALY)

Die Veränderungen der Thalli von *Parmelia caperata*, exponiert in vorstädtischen und industriellen Gebieten (Venedig, Nord-Ost-Italien)

by

Giovanni CANIGLIA, Tommaso TASSONI & Cristian CARBONI

Key words: *Parmelia caperata*, explant, anthropic environment, variations, vitality.

Schlagwörter: *Parmelia caperata*, Expontate, anthropogene Umwelt, Thallus-Veränderungen, Vitalität.

Summary: Near Venice some explanted thalli of *Parmelia caperata* were exposed to verify the variation of their growth along a transect in urban, rural and industrial zones. Periodically each thallus has been measured to verify its change. Some appreciable variations were recorded after three month only.

Zusammenfassung: Im Umfeld von Venedig wurden Thalli von *Parmelia caperata* ausgesetzt, um die Veränderung entlang eines Transekts in städtischen, ländlichen und industriellen Zonen aufzuzeigen. In bestimmten Abständen wurde jeder Thallus untersucht, um die Veränderungen zu registrieren. Nennenswerte Veränderungen wurden erst nach drei Monaten registriert.

Introduction

Parmelia caperata (L.) ACH. is a widely distributed lichen species in

temperate zones; in Italy it finds its optimum in the Orno-Ostryon belt, on barks with slightly acid pH, where it is easy to find and recognize it (NIMIS, 1983). For its sensivity it can be used as a bioindicator of air quality (HAWKSWORTH, ROSE, 1978; CRESPO et. al., 1981; ZOBEL, 1988). The aim of this work is to verify if an exposure of the thallus out of ist natural environment results in a serious damage and to point out the time in which it occurs.

Methods

About twenty heathy thalli of *Parmelia caperata,* with their underlying bark (explants), have been taken from the prealpine zone of Lamen Valley (Belluno North-east Italy), at about 600 meters above sea level.These explants were fixed by means of hot plastic glue on a brick board, inert material on which the hot plastic glue assures a good adhesion for six months at least (CANIGLIA, 1995).

The study area is a plain zone next to Venice where this species is totally absent owing to the lackness of suitable trees to be colonized. *Parmelia caperata* (L.) ACH. exists, however, near this zone at Bosco Nordio (Chioggia) (DE BENETTI, CANIGLIA, 1989).

Ten sites along a belt of 10 km have been chosen in the study area. The distance among each site was about 1 km (Fig. 1). The belt was directed from SE to NW, from Venice-Fusina to the suburbs of Spinea (country town to the west of Venice). A couple of explants were exposed in every site; they were fixed to poles about 3 m high, and oriented to North-east. In the study area there are many industrial activities of considerable environmental impact such as:

- a thermoelectric power station,
- petrolchemistry industries,
- roads of heavy traffic.

Toward North-West the territory gradually gives place to agricultural areas and residential zones. Inside the industrial zone there are also some atmospheric monitoring stations from which have been collected data about SO_2 and NO_x during the experimentation period. The maximum value of the SO_2 (monthly average) was registered in December 1994 (56 $\mu g/m^3$); the maximum value of NO_x (monthly average) was registered in January 1995 (227 ppb). To measure the variations of the thalli surface and to define the health of samples in relation to the exposition site it has been used a non-destructive technique based on image analysis. This technique is very similar to the non-destructive and reflectoscopie-based technique used for the investigation of works of art (SPEZZANI, 1992).

It has been tried to quantify the lichen state of health by means of the analysis of images taken on three different ways:

1. image given by reflected visible light (no filter used);
2. image given by reflected light filtered through I.R. filter that cuts off radiations with wavelength lower than 720 nm (Hoya I.R. filter: Light RM 72);
3. image given by reflected light filtered through I.R. filter that cuts off radiations with wavelength lower than 900 nm (Hoya I.R. filter: Light RM 90).

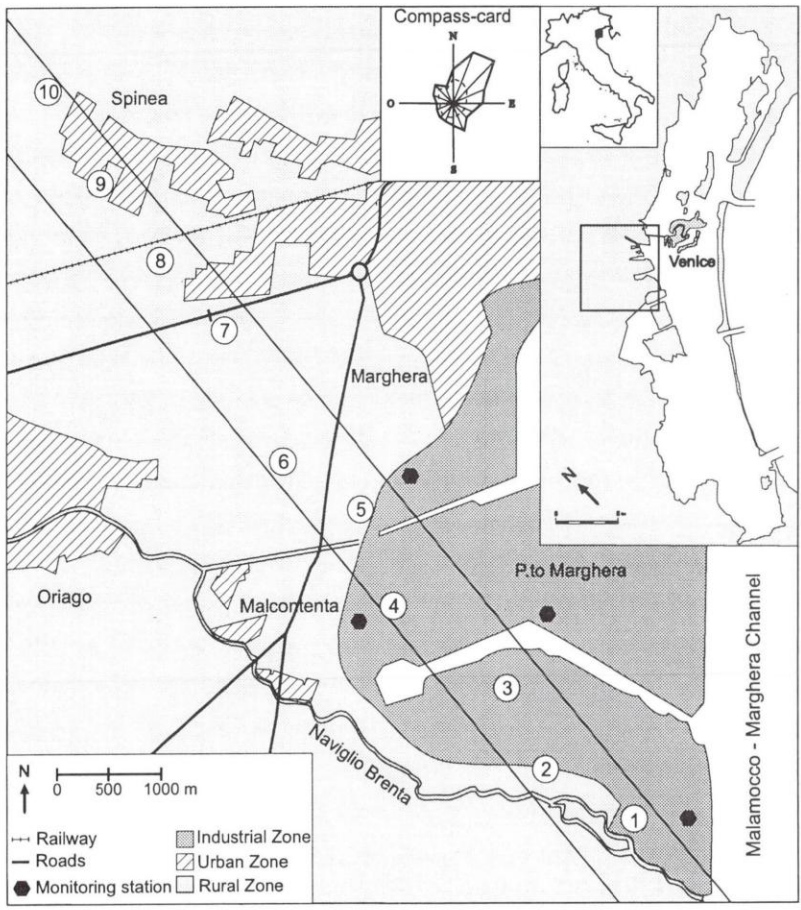

Fig. 1

Each image was taken up in black & white by a vidicon tube camera linked with a computer, converted from the PAL standard and recorded on

hard disk. All the images were analyzed by means an image scanner (Kontron, Vidas 2.1)(CANIGLIA, ZORER, 1990; 1992).

Five minutes before the shot the samples was moistened by deionized water. During the shot the sample was light up by a halogen reflector lamp (Philips 6439. 12 V, 50 W). For all the explants the first image acquisition was made before the start of exposure period, that began in October 1994 and went on for 8 month, till June 1995. A couple of „blank", given by two explanted thalli, was put down again in the place from which they have been taken. Each two month all the thalli, blank include, were brought in lab for the necessary time to the acquisition of their images, then every explant were brought back to its exposition site.

Results

The first thing observed was that for all the thalli, blank included, the trauma of the transplant from their place of origin and the transport in a different landscape caused them some negative effects. It is however interesting to point out other significant results obtained after this research.

Table 1: Total area (cm^2)

survey	t_0	t_1	t_2	t_3	t_4
date	28/09/94	23/11/94	25/01/95	06/04/95	27/06/95
days between collection data	0	55	61	69	80
days of exposure (since 12/10/94)	\	41	104	175	257
Control site	21,22±0,65	21,38±0,47	21,23±1,18	21,39±1,33	23,15±0,91*
Site 1 (industrial zone)	5,16±0,08	4,25±0,08*	3,96±0,46	4,04±0,22	1,40±0,12*
Site 2 (industrial zone)	17,58±0,26	15,04±0,18*	15,15±0,67	15,79±0,90*	14,77±0,21*
Site 3 (industrial zone)	10,32±0,20	10,59±0,38*	10,28±0,25*	10,11±0,41	7,27±0,57*
Site 4 (industrial zone)	14,88±1,00	14,91±0,45	15,51±0,63	15,19±0,49	13,41±0,95*
Site 5 (rural zone)	16,84±0,95	17,04±0,24	18,13±1,74	18,73±0,89	19,76±1,14*
Site 6 (rural zone)	11,85±0,84	12,72±0,45*	12,71±1,02	13,50±0,28*	13,23±0,25
Site 7 (rural zone)	13,00±0,30	13,91±0,51*	14,49±0,39*	14,97±0,44*	15,61±0,45*
Site 8 (rural zone)	9,15±0,32	9,69±0,33*	9,49±0,03	10,60±0,23*	6,93±1,03*
Site 9 (urban zone)	4,92±0,10	5,00±0,22	5,29±0,14*	5,04±0,17*	4,97±0,12
Site 10 (urban zone)	13,65±0,55	14,66±0,86*	14,91±0,32	15,29±0,58	14,92±0,81

* = the difference between this measure and the former has statistic significance (t test; α =0,05)

In table 1 are reported all the analytical data as regards the surface variations in function of the exposition time and in relation for the site air quality. To compare the area variations of the explants, each measure (repeated three times) of the thallus surface was normalized. The "blank" reveals a slow, but constant growth even after 7 month of exposure. This growth was quantified as 10%. The explanted samples placed in the more critical sites (sites: 1 - 2 - 3 - 4, in the center of the industrial zone), stopped their development and seemed to lose large part of thallus (up to the 70% in site 1). From site 5 to site 8 (rural zone) only a light increase of surface were observed until 7 month of exposure. After this time there, was a loss of thallus. In sites 9 and 10 (sub-urban zone) the thalli surfaces kept the same surface during all the period of observation. In order to simplify the graph (fig. 2) only some more significant temporal trends of surface variation are shown.

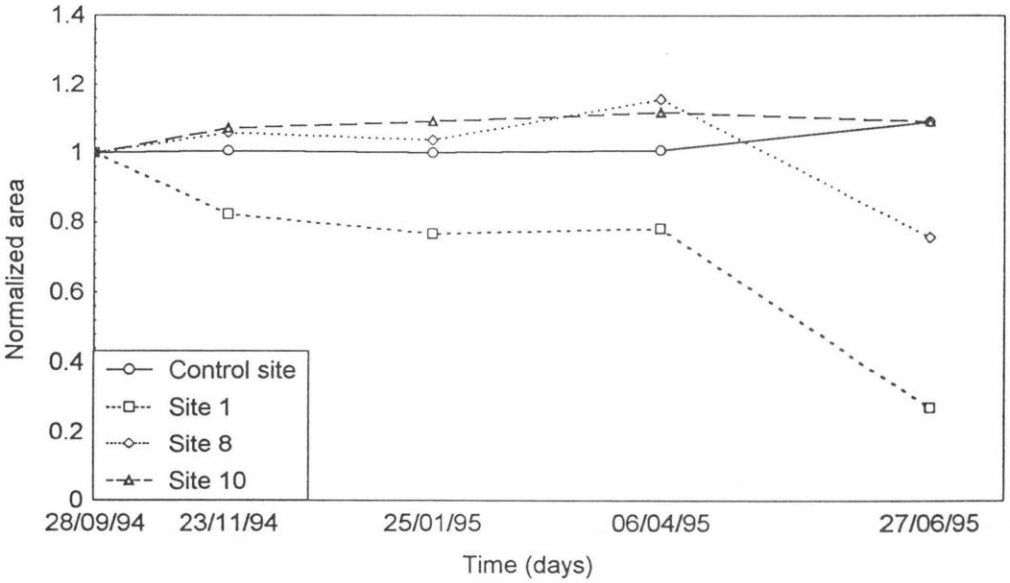

Fig. 2: Normalized areas: time trend

The evaluation of the health state was made by means of visible light to evaluate the marked chromatic changes and by the use of infrared filters to quantify the surface of reflecting areas. The colour variations give subjective informations about lichen health, due to the colour perception. The chlorophyll of a healthy photobiont cell reflects the infrared radiations, thus an image given by the reflected infrared light is helpful to give an objective valuation because it is not dependent from thallus colour (KAUPPI, KAUPPI, 1978). If the photobiont is damaged, the chlorophyll loses its reflecting ability: the lichen thallus image

taken through a filter that cuts off the visible light (wavelength < 720 nm) appears darker than an image taken without filter. The fig. 3 shows the grey level percentage distribution of a sample of site one (industrial zone) from september 1994 (t_0), to june 1995 (t_4). The images shot through the filter that cuts off the wavelength lower than 900 nm show the progressive „shading darking" of the thallus. This progressive worsening of the conditions of the thallus is pointed out from the shifting toward lower levels (dark shade) of the representative grey level percent distribution.

Conclusion

In this work it has been tested a new, non-destructive monitoring technique to use in lichen desert zones. This method is based on the changes of allogenic lichen thalli in new environmental conditions. During this experience we met some problem concerning:

- as time goes by, the lichen underlying bark gets deformed, causing an image distorsion;
- the growth can be erroneously estimated because the thallus lobes are overlapped;
- the individual response of each explant to the environmental changes is unknown;
- focus errors during the image acquisition can be done, because an infra-red image differs from a visible image for the focal point (HOOKER, BROWN, 1977);
- errors in the lichen contour tracing can be done during image analysis.

In particular this experience seems to demonstrate that it is possible to obtain significant responses after exposure of 3-4 month only. Concerning the infra-red measures, the most readable results ar obtained from images given by reflected light filtered through I.R. filter that cuts off radiations with wavelength lower than 900 nm.

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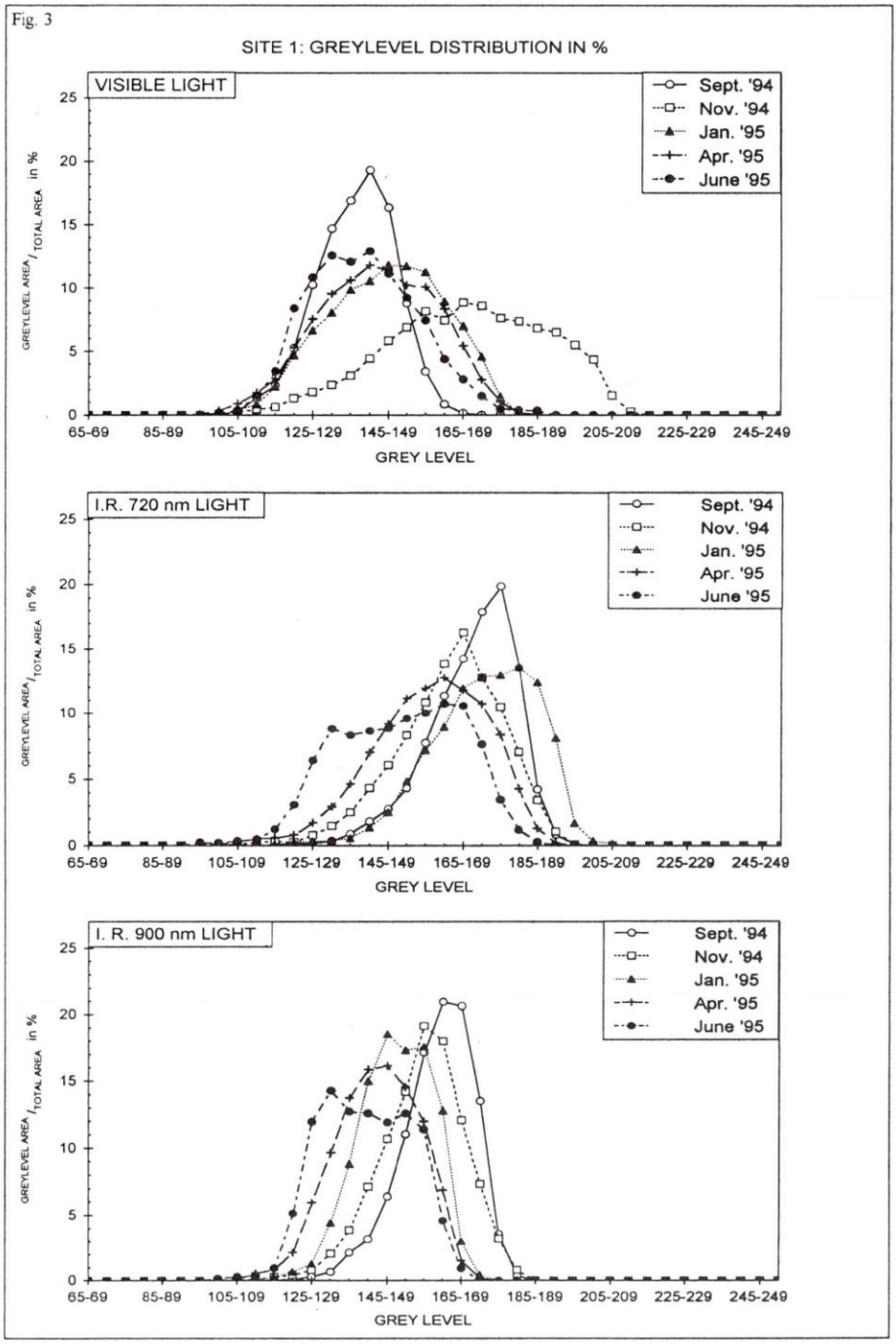

Fig.3: Site 1, Greylevel Distribution in %

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Address:

Giovanni CANIGLIA, Tommaso TASSONI & Cristian CARBONI
Dipartimento di Biologia
Via Trieste, 75
I-35121 Padova
Italy
Fax: +39-49-827 62 30
E-Mail: Caniglia@civ.bio.unipd.it