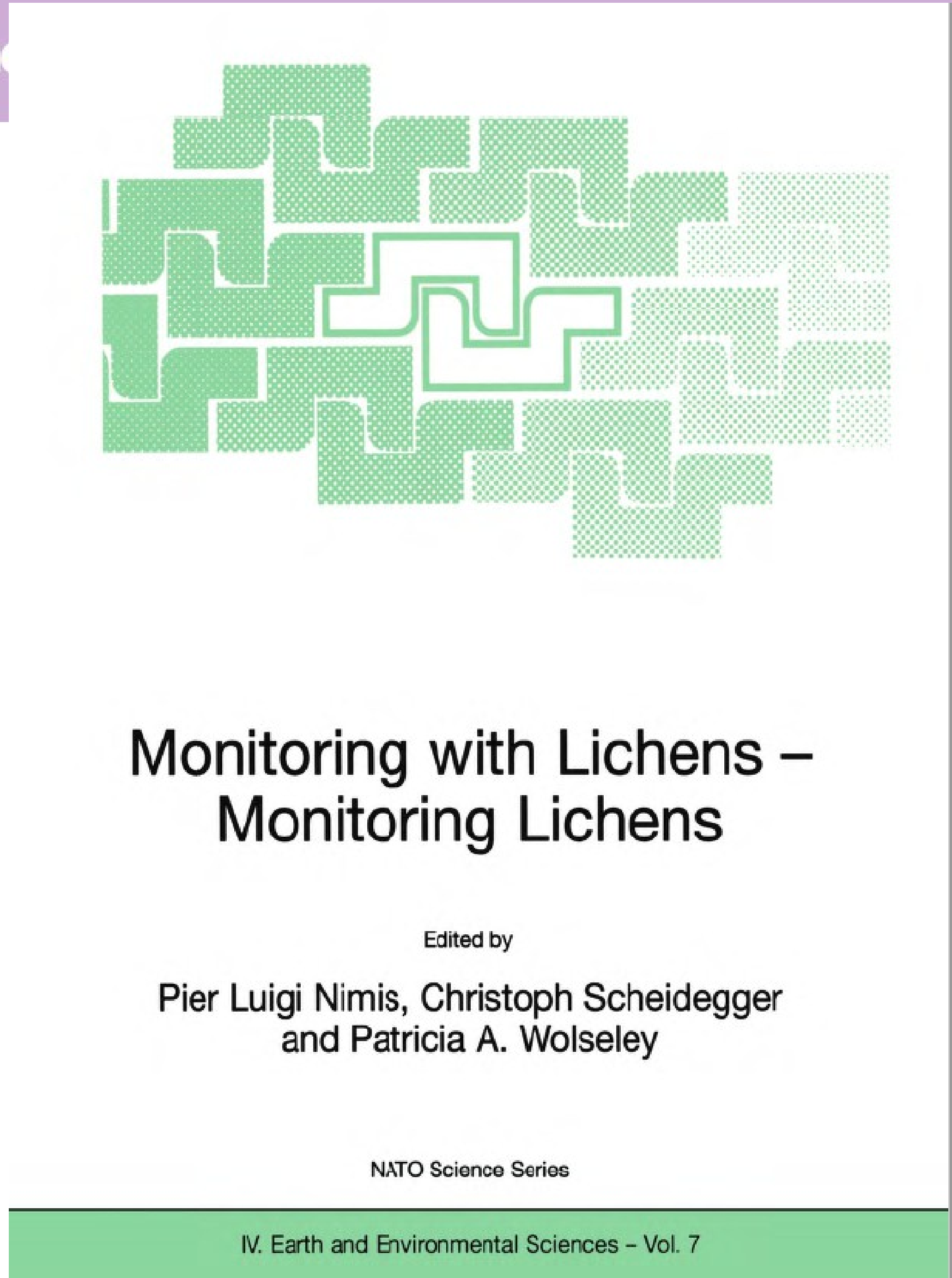
CORSO DI BOTANICA SISTEMATICA

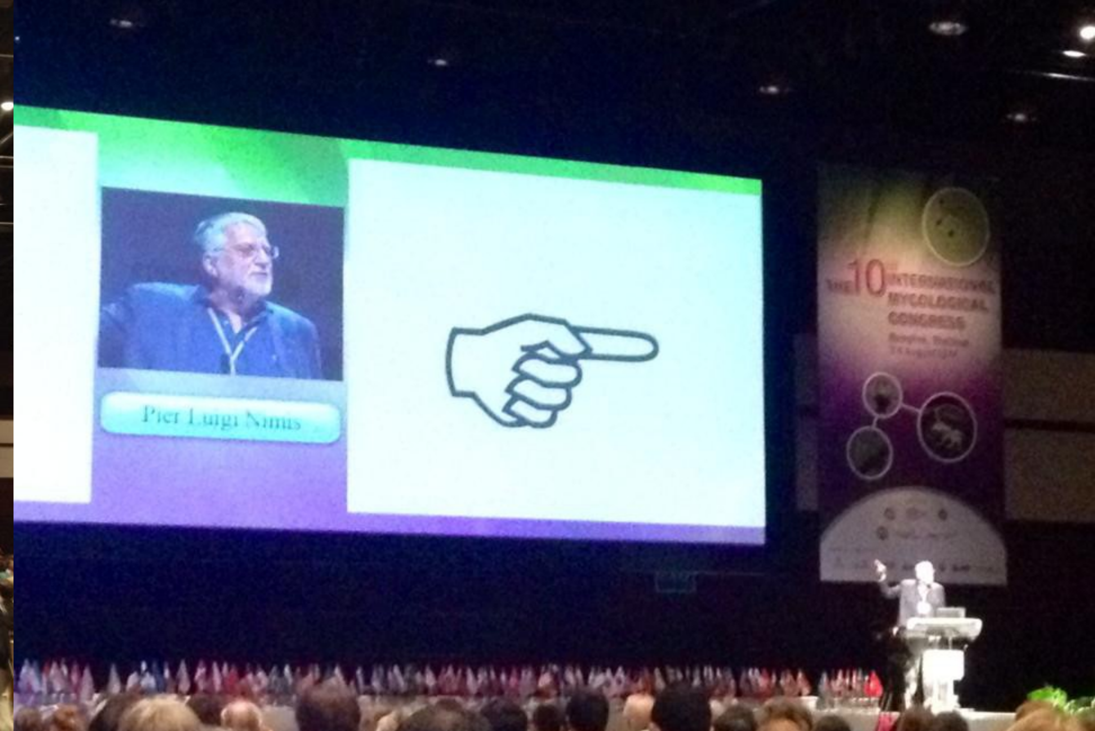
LEZIONE 53

Licheni come biomonitor

(prima parte)

Th… s


Monitoring with Lichens –
Monitoring Lichens
Edited by
Pier Luigi Nimis, Christoph Scheidegger
and Patricia A. Wolseley
NATO Science Series
IV. Earth and Environmental Sciences – Vol. 7


Pier Luigi Nimis
MYCOLOGICAL
CONGRESS


FIE LD.
EARTH. WE'RE ON IT.
FIE LD.
EARTH. WE'RE ON IT.

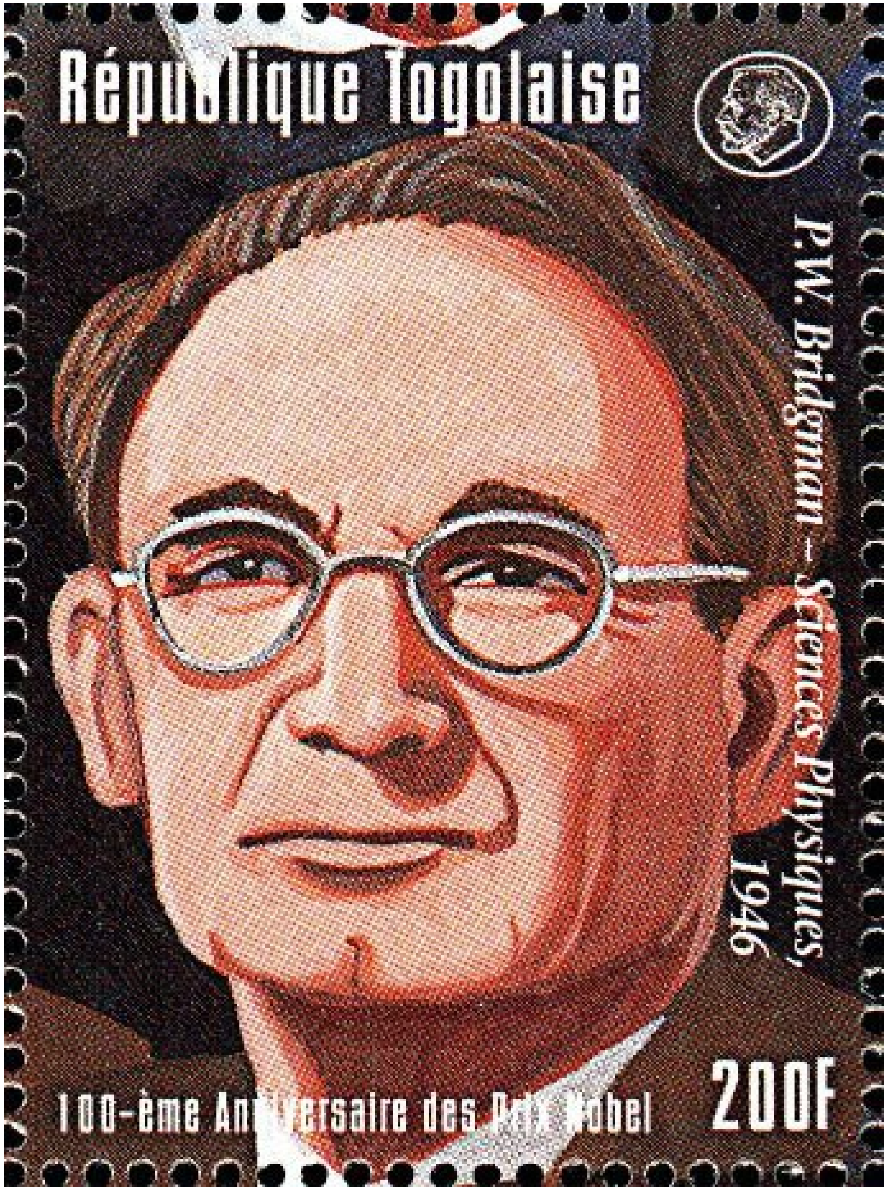
The 10th International Mycological Congress

Bangkok - Thailand
3 - 8 August 2014

Lichens, air pollution and human health

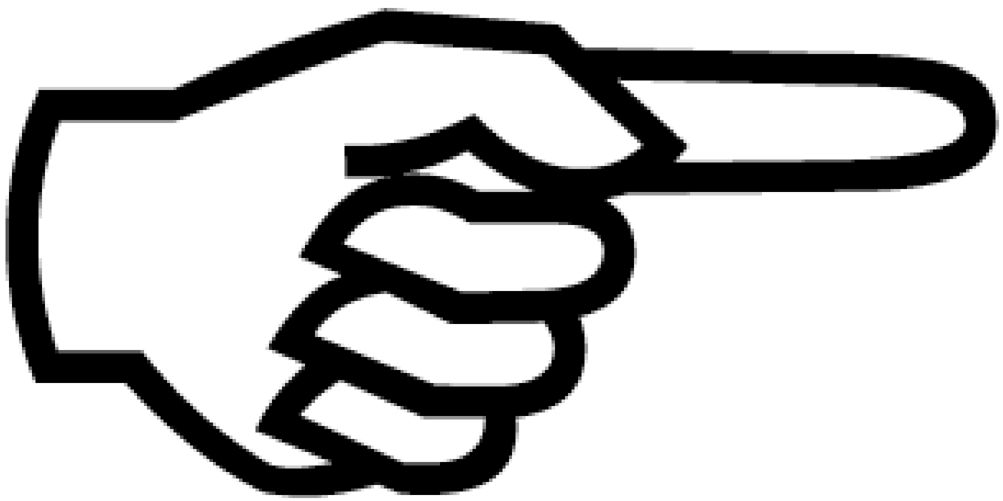
Pier Luigi Nimis

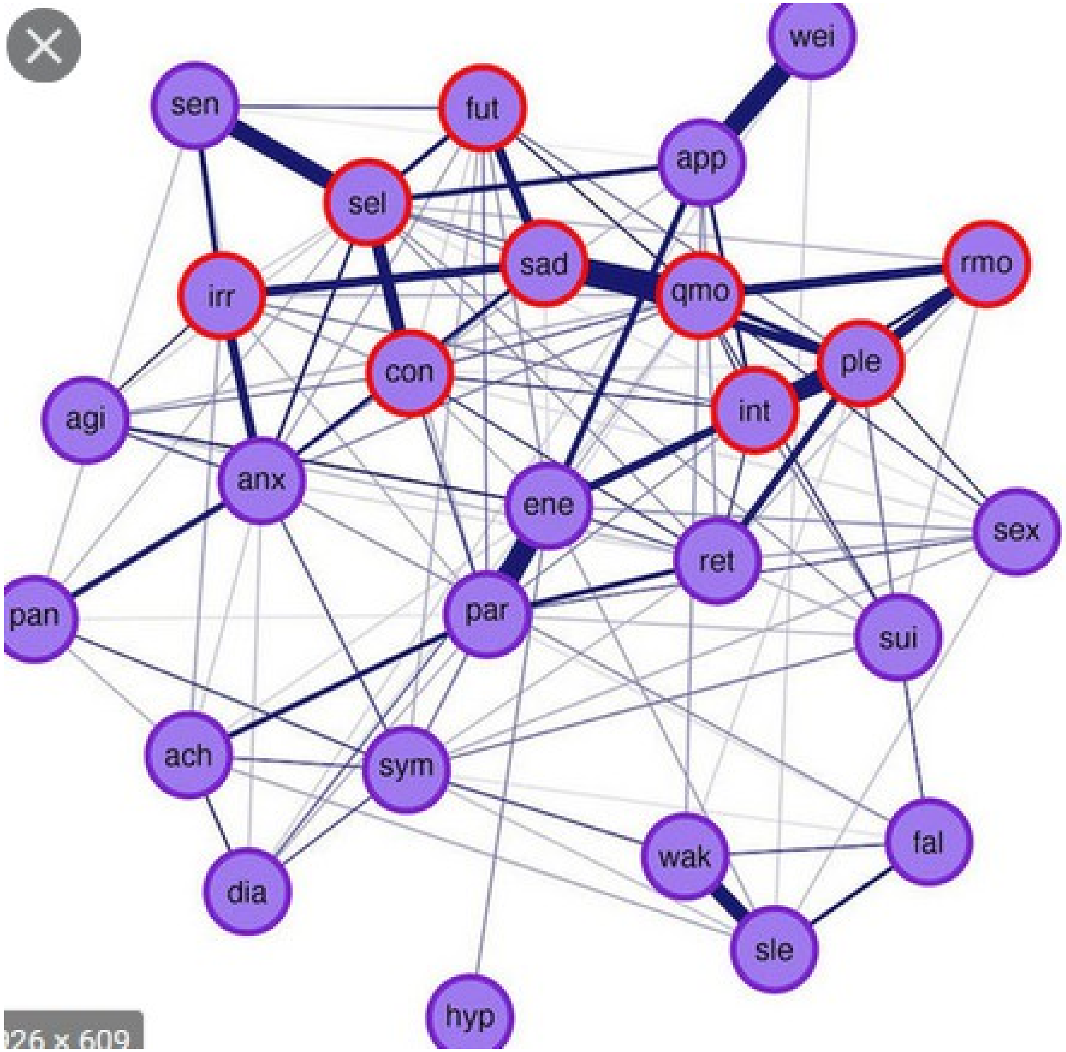
Dept. of Life Sciences – University of Trieste (Italy)


République Togolaise
P.W. Bridgman – Sciences Physiques, 1946
200F

Some concepts:

1 – Indicator

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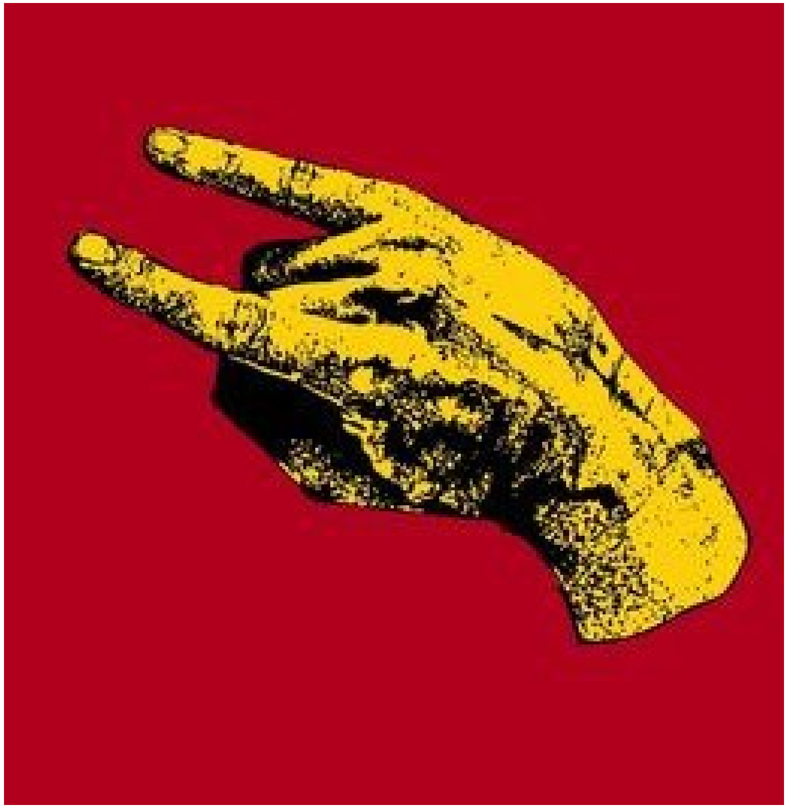


Some concepts:

2 – Air quality

Air quality is something which is estimated by indicators of air quality

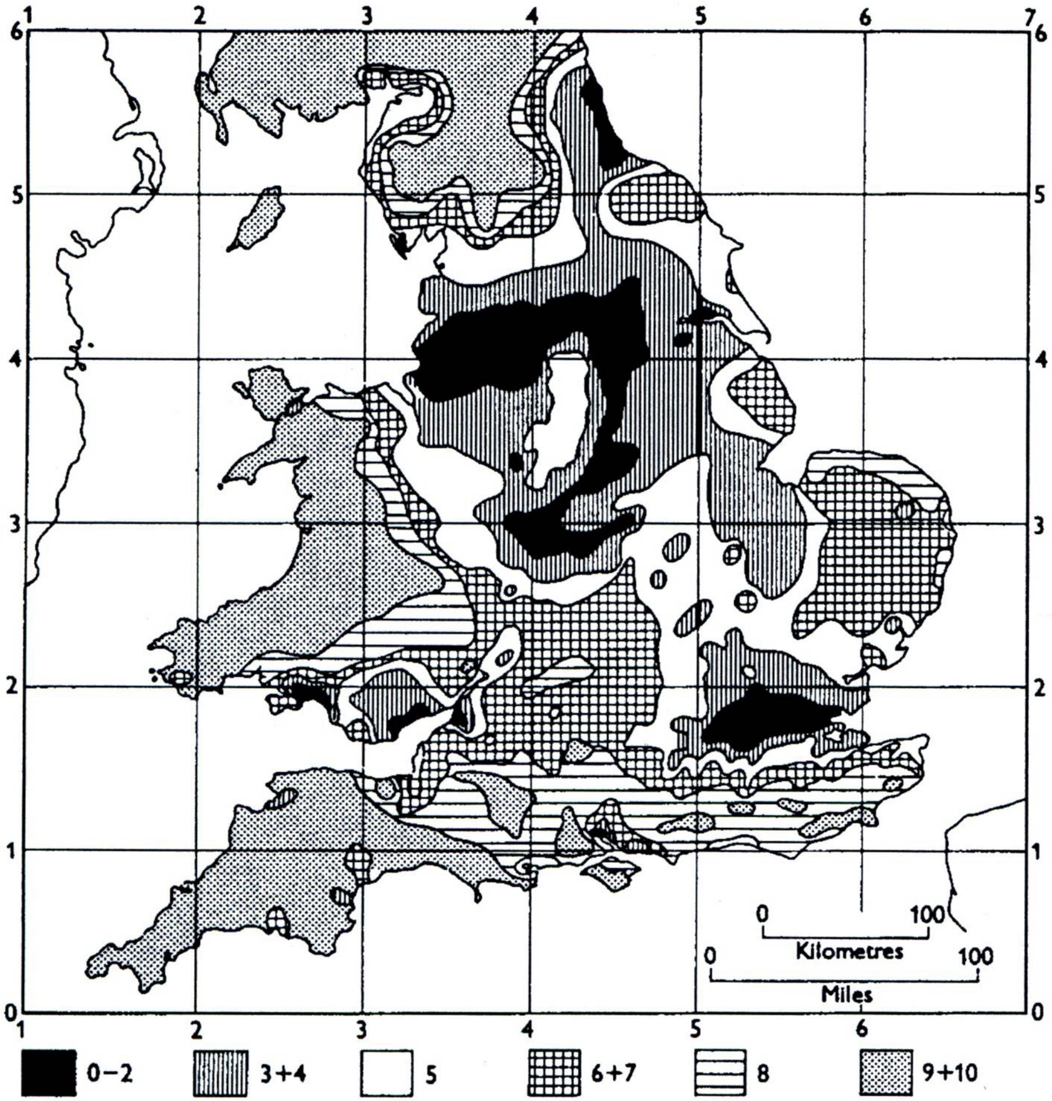
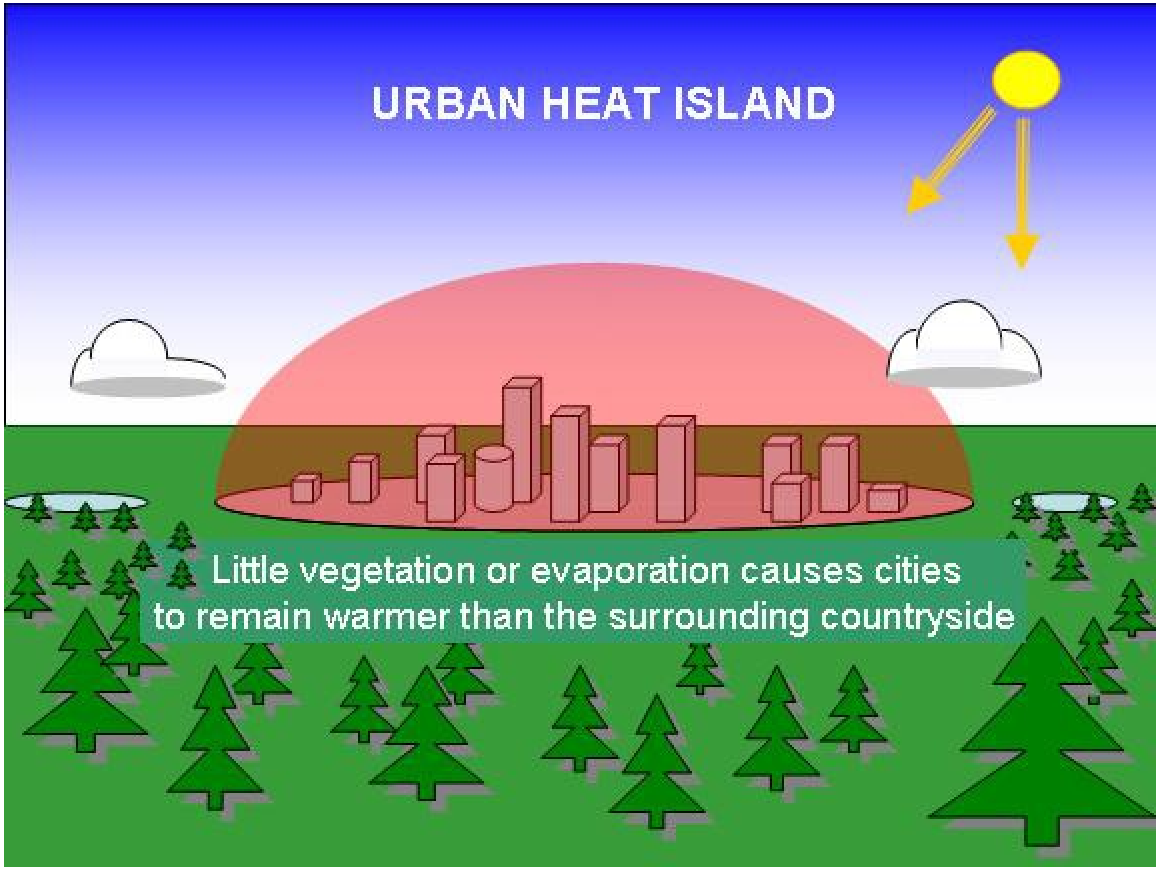
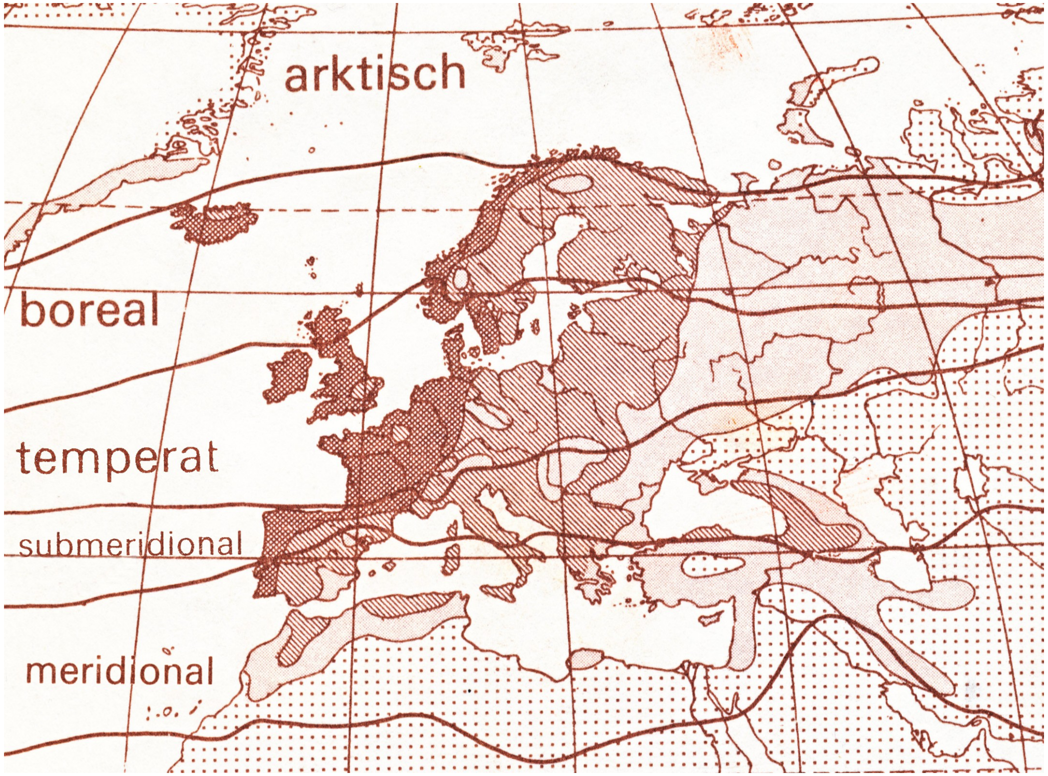


Figure 1. The Hawksworth and Rose Zones in England and Wales in 1970, with minor corrections (after [24]).


URBAN HEAT ISLAND
Little vegetation or evaporation causes cities
to remain warmer than the surrounding countryside


NORWAY
SWEDEN
IRELAND
UNITED KINGDOM
North Sea
DENMARK
UNION OF SOVIET SOCIALIST REPUBLICS
NETH.
W. GERMANY
E. GERMANY
POLAND
BELGIUM
LUX.
Atlantic Ocean
CZECHOSLOVAKIA
LIECH.
FRANCE
SWITZ.
AUSTRIA
HUNGARY
ROMANIA
SAN MARINO
ANDORRA
Black Sea
PORTUGAL
SPAIN
Corsica (Fr.)
YUGOSLAVIA
BULGARIA
ITALY
ALBANIA
Gibraltar (U.K.)
Balearic Is. (Sp.)
GREECE
TURKEY
Sardinia (It.)
Sicily
Crete (Gr.)
Mediterranean Sea


arktisch
boreal
temperat
submeridional
meridional

54 lichen species

$$IAP_1 = \sum_{1}^{n} Q \times C$$

$$IAP_2 = \sum_{1}^{n} Q \times C \times F$$

$$IAP_3 = \sum_{1}^{n} \frac{Q \times C \times F}{V \times S}$$

$$IAP_4 = \sum_{1}^{n} C$$

$$IAP_5 = \sum_{1}^{n} Q \times C$$

$$IAP_6 = \sum_{1}^{n} \frac{C \times F}{V \times S}$$

$$IAP_7 = \sum_{1}^{n} \frac{Q \times C}{V \times S}$$

$$IAP_8 = \sum_{1}^{n} F$$

$$IAP_9 = \sum_{1}^{n} Q \times F$$

$$IAP_{10} = \sum_{1}^{n} Q$$

40 selected lichen species

$$IAP_{11} = \sum_{1}^{n} Q \times C$$

$$IAP_{12} = \sum_{1}^{n} Q \times C \times F$$

$$IAP_{13} = \sum_{1}^{n} \frac{Q \times C \times F}{V \times S}$$

$$IAP_{14} = \sum_{1}^{n} C$$

$$IAP_{15} = \sum_{1}^{n} Q \times C$$

$$IAP_{16} = \sum_{1}^{n} \frac{C \times F}{V \times S}$$

$$IAP_{17} = \sum \frac{Q \times C}{V \times S}$$

$$IAP_{18} = \sum_{1}^{n} F$$

$$IAP_{19} = \sum_{1}^{n} Q \times F$$

$$IAP_{20} = \sum_{1}^{n} Q$$

Figure 2. IAP-Formulas tested in the first phase of the Swiss project. (Q = factor of accompanying species; C=% cover, scaled as follows: 0,+,1,2,3,4,5; F = frequency-value (1-10); V = vitality (3 levels: very good, moderate, poorly developed); S = damage (3 levels: no, moderate, strong damage) (from [42]).

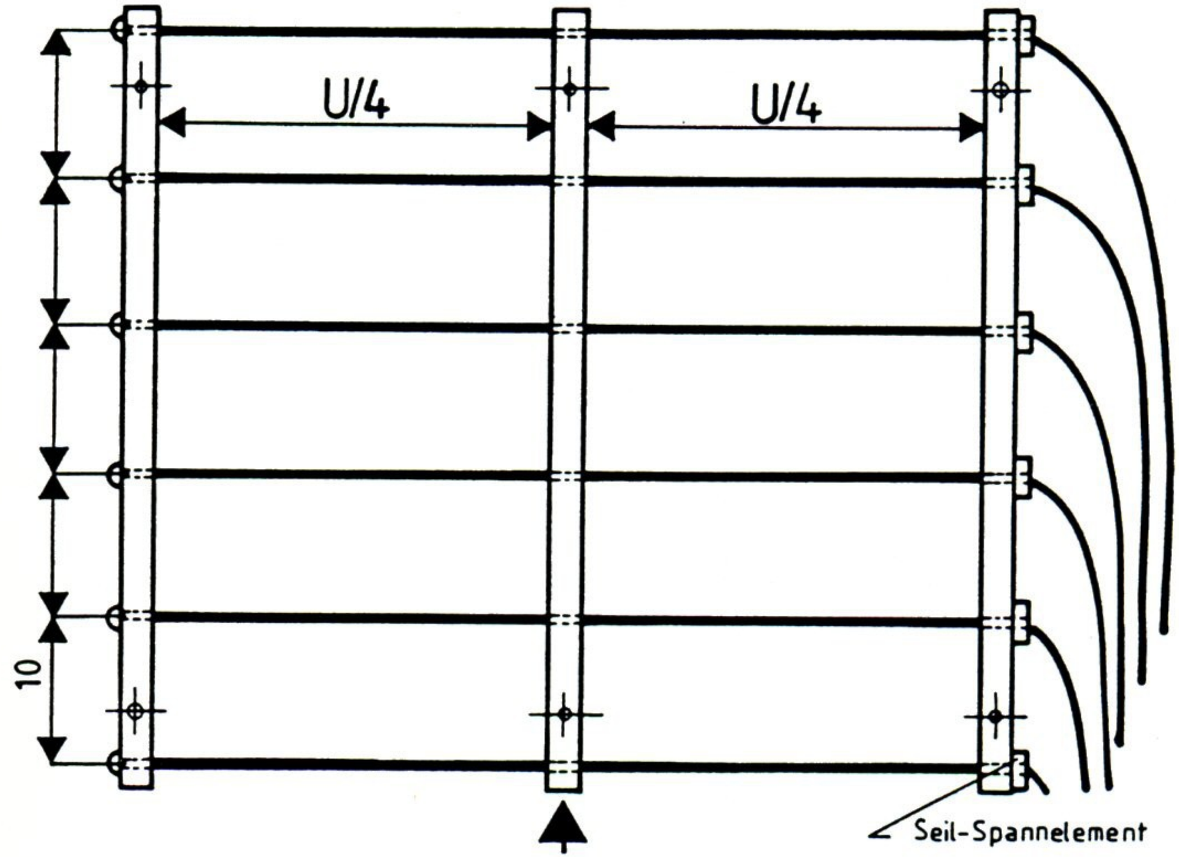
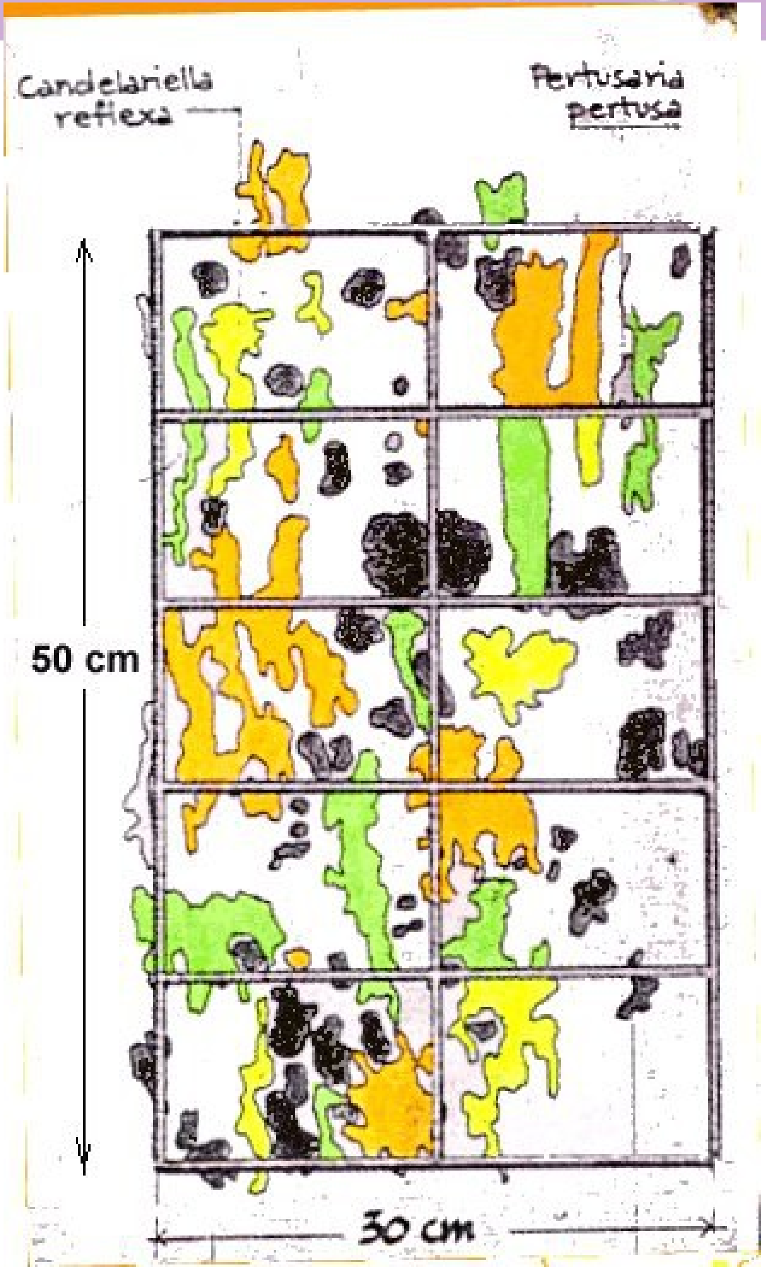
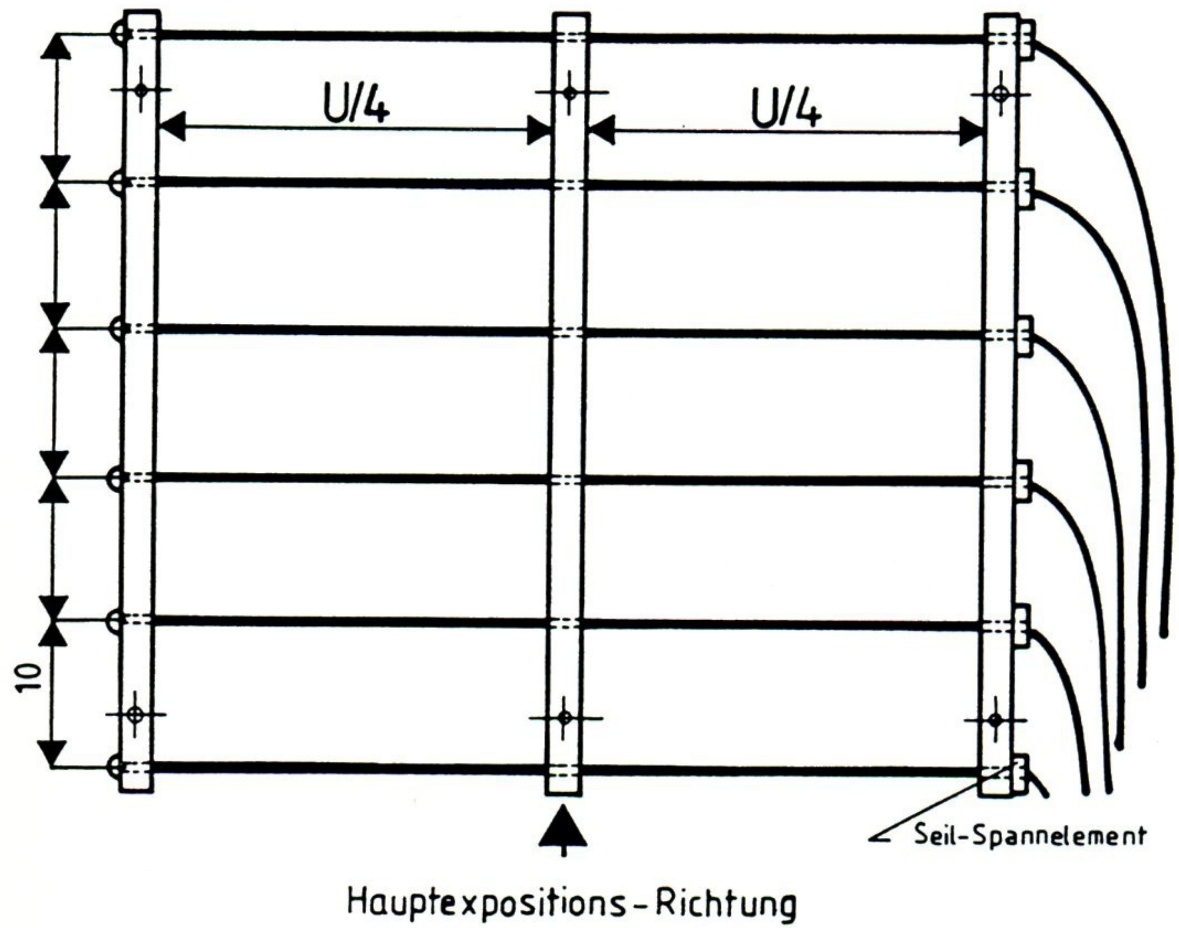


Abb. 4: Frequenzgitter zur Erfassung der Flechtenvegetation (nach HERZIG et al. 1985, Seite 58).
U: Umfang, Stammabwicklung
Höhe über Boden: 120 bis 170 cm
Hauptexposition: Richtung mit der bestentwickelten Flechtenvegetation


Candelariella reflexa
Pertusaria pertusa
50 cm
30 cm



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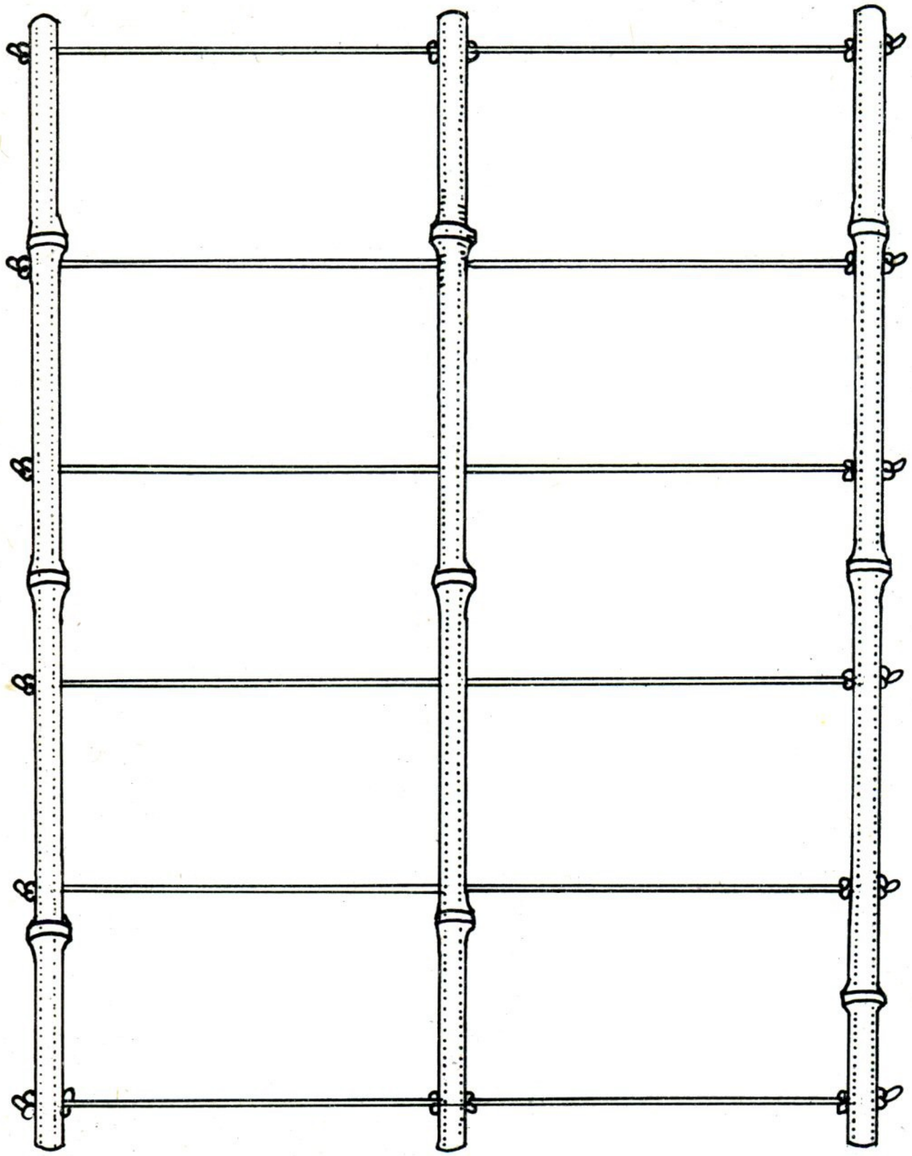
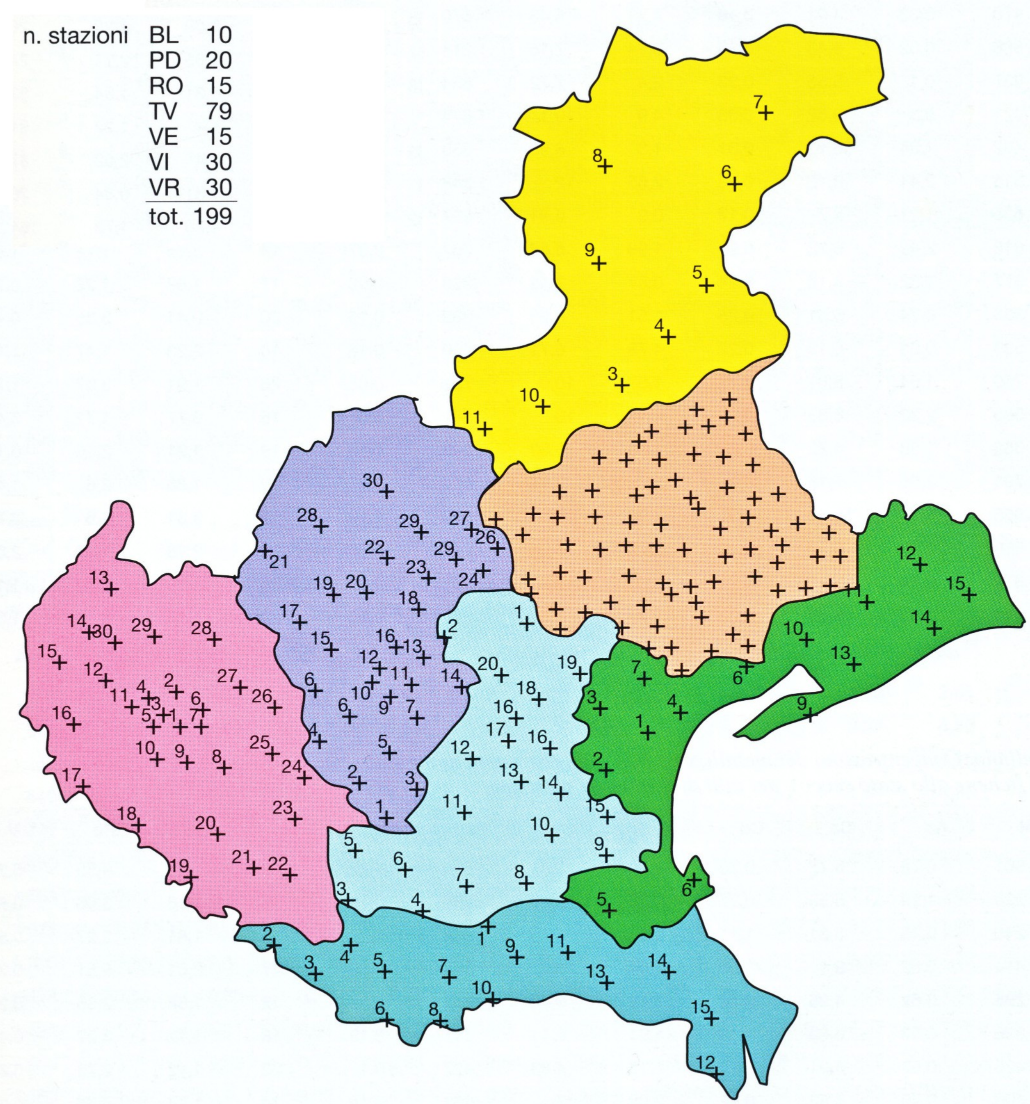


The 10th International Mycological Congress



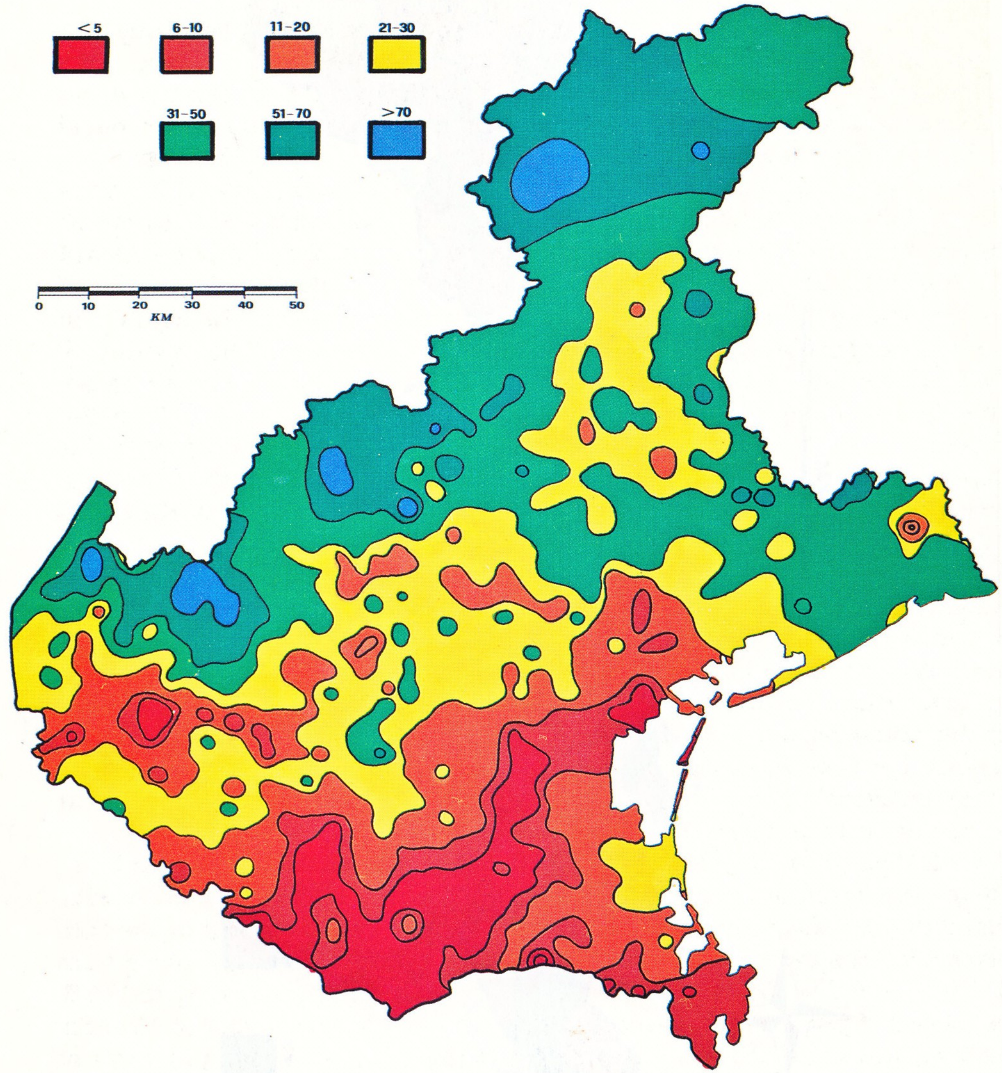
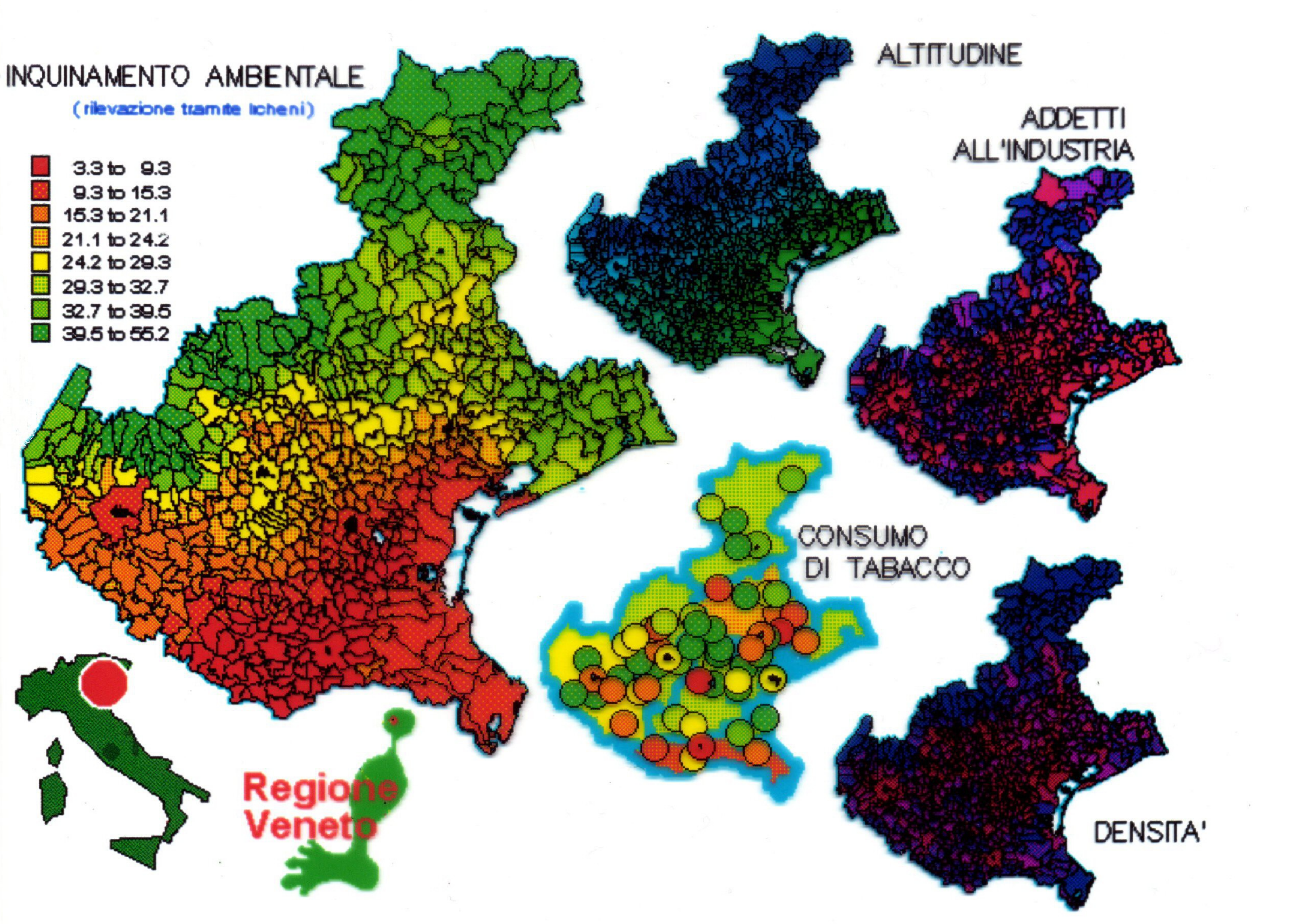
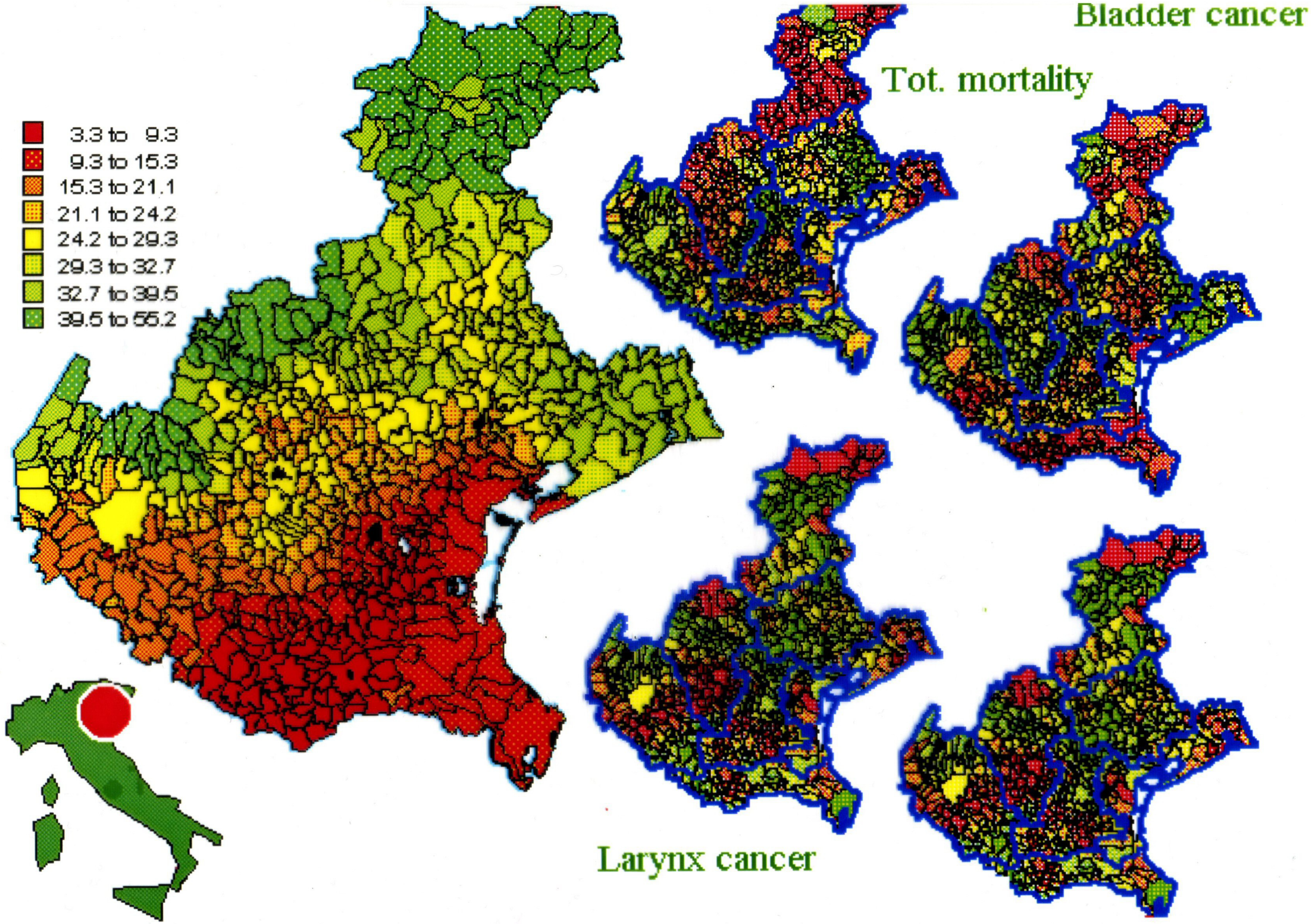
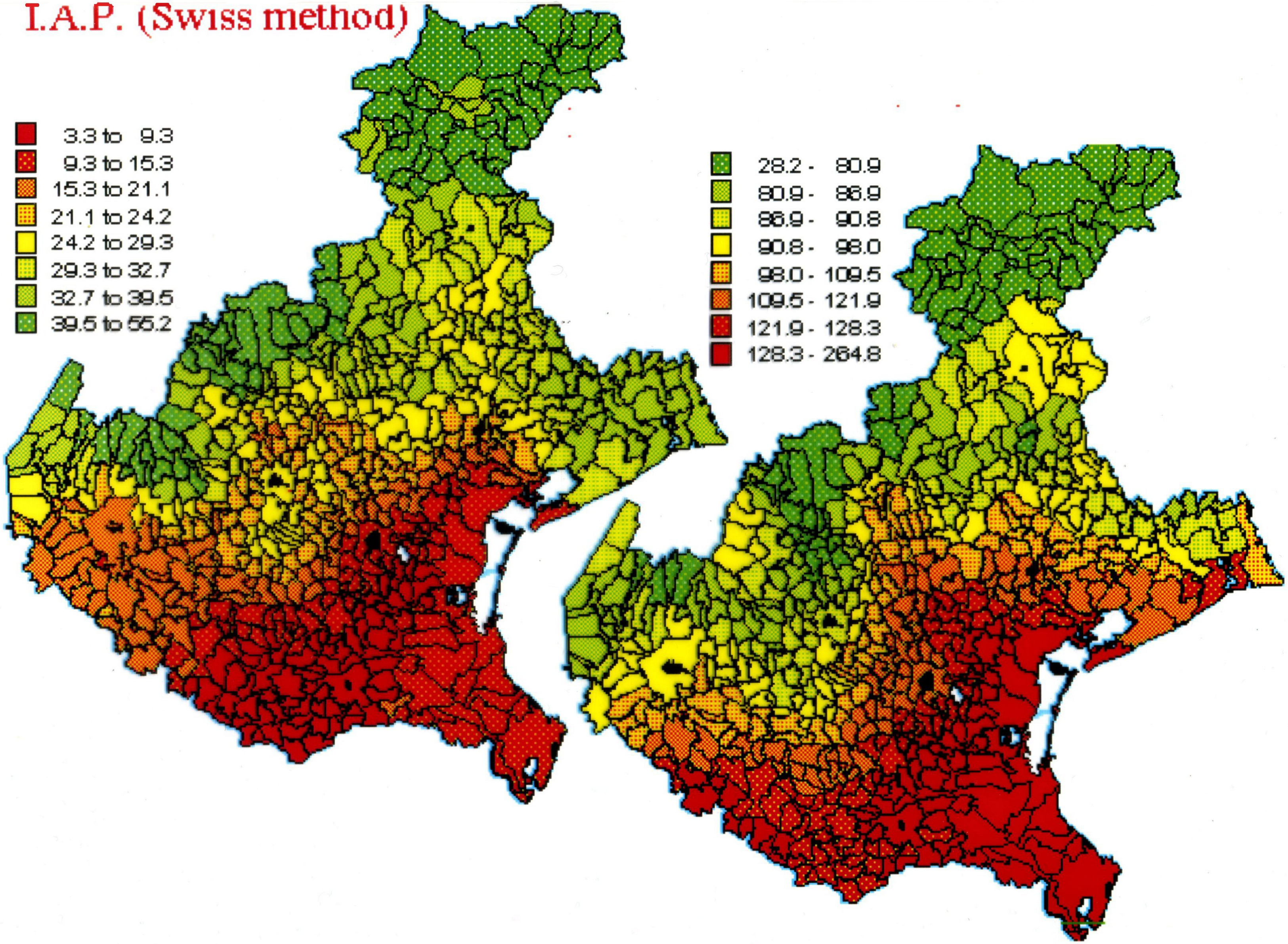


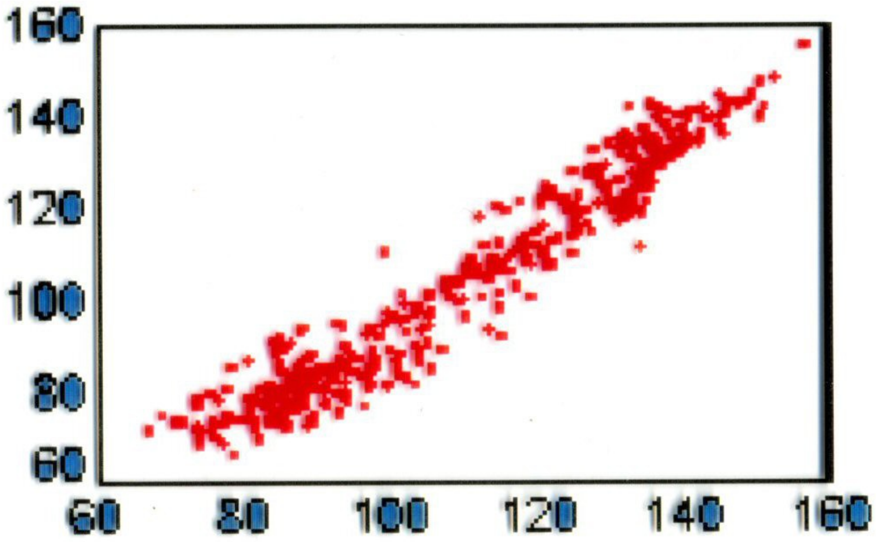
Fig. 21: I.A.P. map of the entire Region of Veneto. The regional territory has been subdivided into 7 zones, characterized by different I.A.P. values.


INQUINAMENTO AMBENTALE
(rilevazione tramite licheni)
3.3 to 9.3
9.3 to 15.3
15.3 to 21.1
21.1 to 24.2
24.2 to 29.3
29.3 to 32.7
32.7 to 39.5
39.5 to 55.2
ALTITUDINE
ADDETTI ALL'INDUSTRIA
CONSUMO DI TABACCO
DENSITA'
Regione Veneto


3.3 to 9.3
9.3 to 15.3
15.3 to 21.1
21.1 to 24.2
24.2 to 29.3
29.3 to 32.7
32.7 to 39.5
39.5 to 55.2
Bladder cancer
Tot. mortality
Larynx cancer

I.A.P. (Swiss method)




160
140
120
100
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60
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120
140
160

scientific correspondence

Lichens, air pollution and lung cancer

The relationship between lung cancer and atmospheric pollution remains controversial[1–3] despite 50 years of discussion, partly because studies are frequently restricted to small, well-monitored areas. In contrast to instrumental monitoring, bioindication techniques allow the mapping of pollution effects over wide areas with a high sampling density. We have compared a biodiversity map of pollution-sensitive organisms, the lichens[4], with mortality maps of a large part of northeastern Italy, the Veneto region (18,364 km^2, population ~4 million). Our results strongly support a relationship between air pollution and lung cancer.

The lichen study (data from 1991)[5] was based on 2,425 measurements of epiphytic lichen biodiversity at 662 locations, calculated as the sum of frequencies of all species in a sampling grid of 10 units[6]. The mortality data at municipal level (1981–88) derive from the Italian National Institute of Statistics. Kernel indicators for the estimate of density functions[7,8] were used for the analysis.

Biodiversity shows low, if any, correlation with several types of cancer (including larynx cancer, $r=0.016$), and with mortality by chronic bronchitis ($r=0.15$) because of the high mortality in mountain areas. There is no correlation with lung cancer in male migrants ($r=0.07$), or in resident women ($r=0.12$). Municipal data concerning women have a poor statistical quality because lung cancer deaths in women are relatively few (13% of total lung cancer deaths), and there are pronounced differences in the smoking habits of women from rural and urban areas[8].

However, biodiversity (Fig. 1a) and lung cancer in young (aged under 55 years) native male residents (Fig. 1b) are highly correlated ($r=0.82$, Fig. 2), even when corrected for spatial autocorrelation with bayesian analysis[7]. When all age-groups are included, the correlation becomes lower ($r=0.6$), owing to higher mortality of older men in mountain areas, many of whom emigrated between 1950 and 1970 to coal mines in Belgium.

We tested the hypothesis that lung cancer is correlated with lichen biodiversity as a result of air pollution, using pollution data recorded in nine municipalities since 1986. In these regions the correlation between biodiversity and lung cancer in young male residents was high ($r=0.95$, $P<0.001$). Furthermore, there was a high correlation with common anthropogenous pollutants, such as SO_2, NO_3, dust and SO_4^{2-} ($r=0.93$, 0.87, 0.86 and 0.85, respectively; $P<0.01$ in all cases); and no correlation with non-anthropogenous substances such as Cl^-, Ca^{2+}, Mg^{2+}, HCO_3^-, K^+, Na^+, or with all other types of cancer.

Lichens are notoriously sensitive to sulphur dioxide[4], but the low SO_2 concentrations recorded in the survey area are unlikely to produce carcinogenic effects.

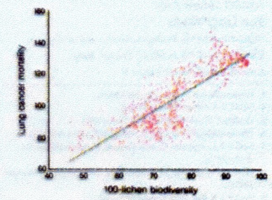


Figure 2 Scatter diagram relating lichen biodiversity (100 − sum of frequencies) and lung cancer mortality (observed/expected cases × 100; males aged under 55 years) in all municipalities of the Veneto region ($r=0.82$, $F=845.9$, $P<0.0001$).

However, the patterns of SO_2 concentration revealed by lichens do reflect the long-distance transport of different pollutants that may be emitted with SO_2, some of which may have carcinogenic effects.

The densely populated eastern and western parts of the Veneto plain are upwind and downwind of the main pollution sources, which may explain the low correlation between lung cancer in young males and population density ($r=0.23$). Pollution was higher between 1960 and 1980, but the main patterns of atmospheric transport have remained constant, indicating that time-lag factors are irrelevant.

The relative risk associated with pollu-

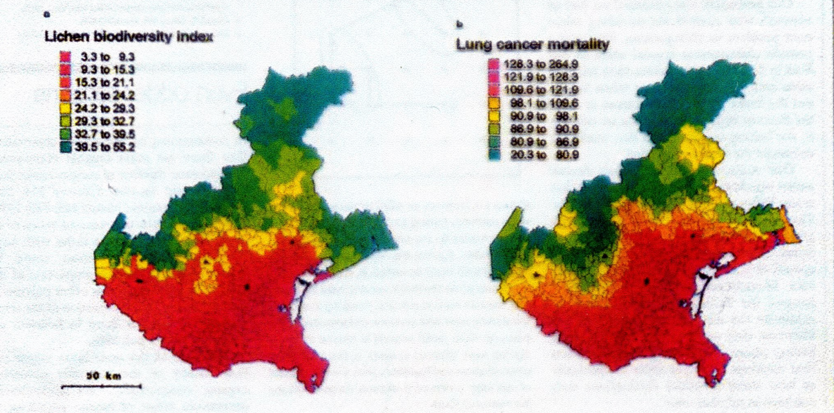
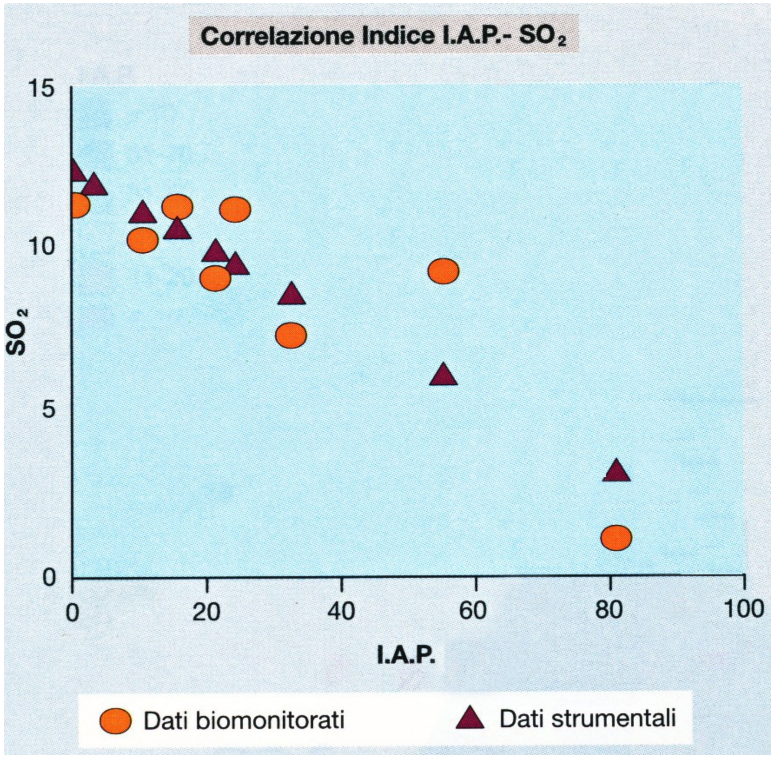


Figure 1 a, Lichen biodiversity, calculated as the sum of frequencies of all epiphytic species in a sampling grid of 10 units; and **b,** lung cancer mortality in young male residents (expressed as observed/expected cases × 100), in the region of Veneto. Scale intervals are based on percentiles of values distribution.

However - Correlation does not imply causality



Correlazione Indice I.A.P.- SO2
15
10
5
0
SO2
0
20
40
60
80
100
I.A.P.
Dati biomonitorati
Dati strumentali

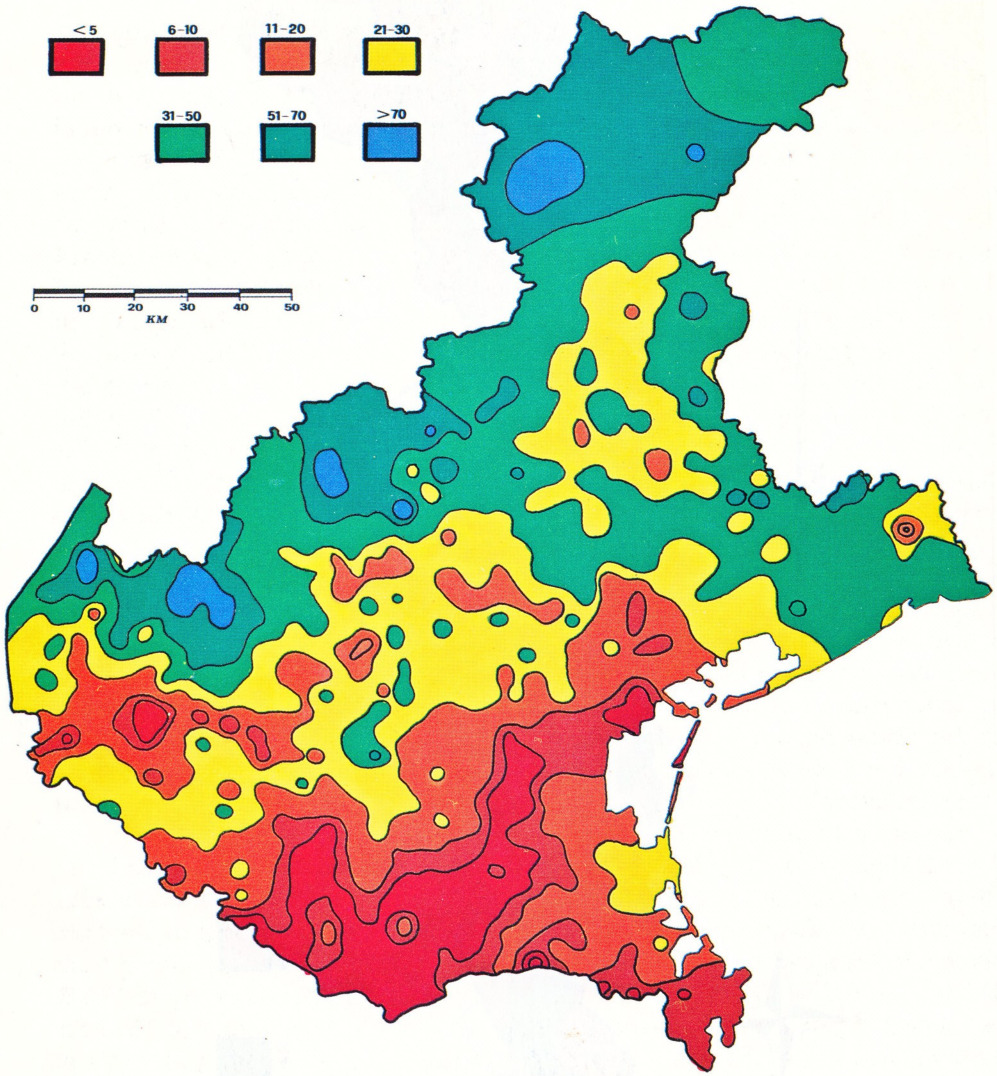
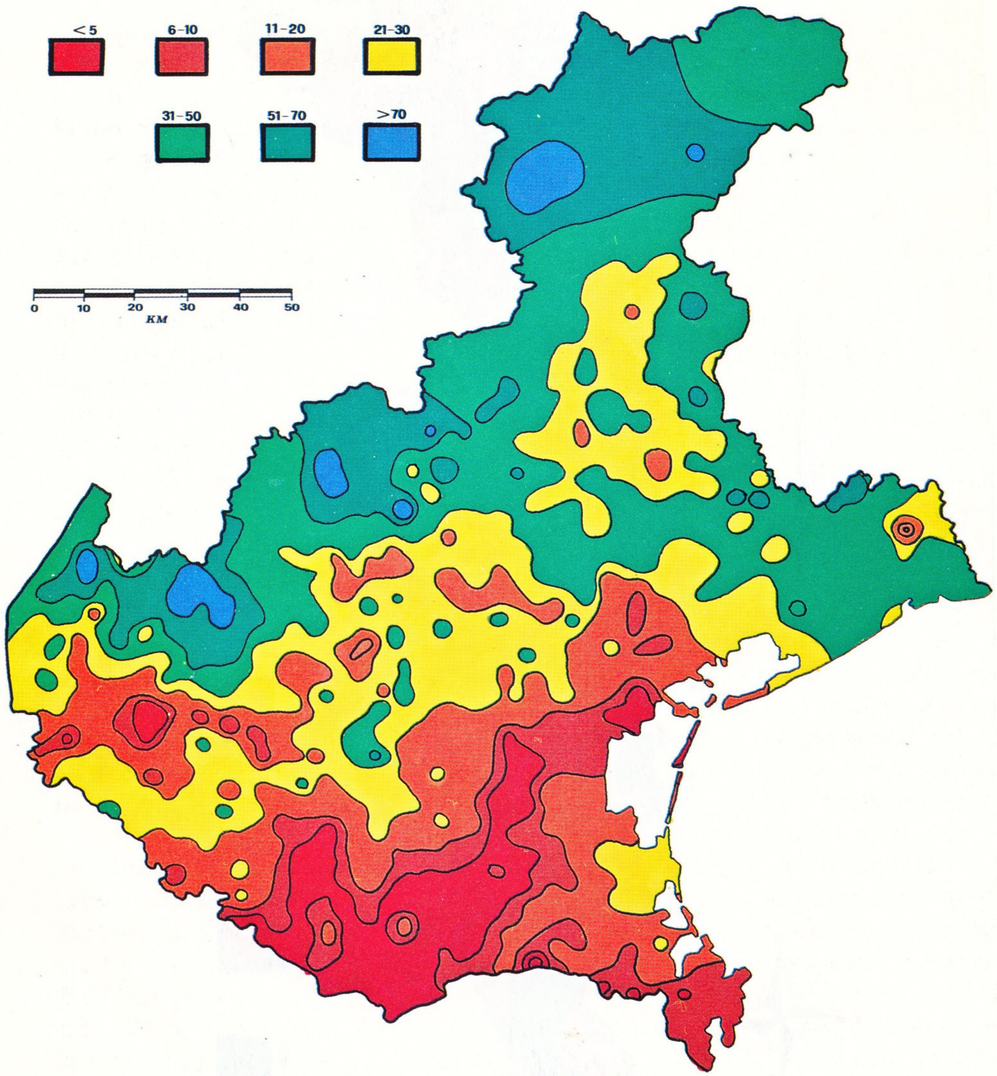


Fig. 21: I.A.P. map of the entire Region of Veneto. The regional territory has been subdivided into 7 zones, characterized by different I.A.P. values.


(c) 1999 MikeLevin.com



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