The sensitivity of lichens to air pollution has been known for a long time.

…we are sensitive beings,
said the lichen…

This sensitiveness to specific pollutants (e.g. SO_2), and tolerance towards others (e.g. O_3) is linked to specific biological peculiarities of lichens:

- their metabolism depends on dry and wet depositions from the atmosphere: the continuous change in hydration status implies a continuous bi-directional matter flux of water and dissolved substances;
- This flux occurs over the entire surface of the thallus, as they have no cuticle or stomatal openings;
- nutrient and pollutants can be absorbed in gaseous form, in solution and associated with particulate matter;
- there are no external selection mechanisms;
- there are no specific mechanisms for getting rid of contaminated parts;
- lichens are "long-living" organisms, with temporal integration of phenomena.

In epiphytic lichens the alterations induced by damaging pollutants can manifest themselves at three levels:

Fisiological → Alteration of some fundamental aspects of lichen symbiosis, e.g. impairment of photosynthetic activity, specific enzymatic activities, etc.

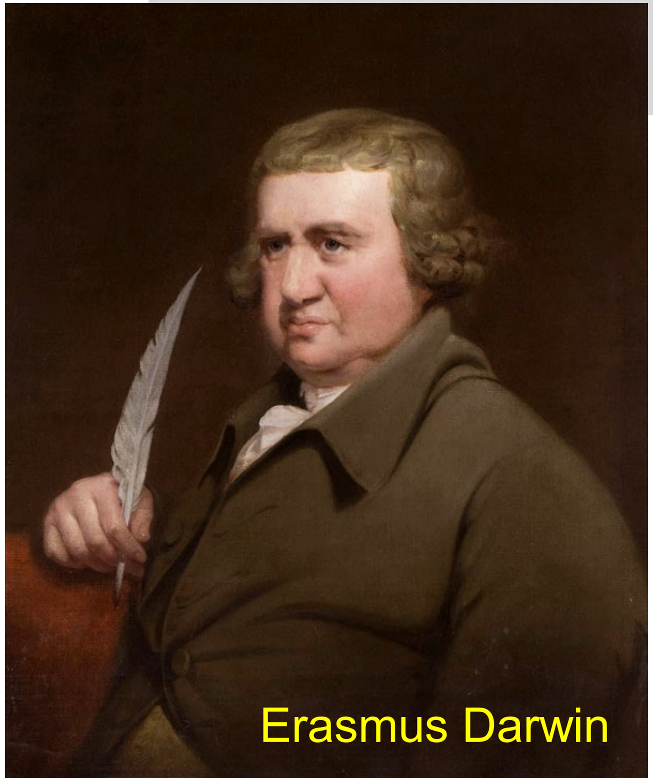
Morphological → Discolouration, changes in the morphology of the thallus, reduction in growth

Ecological → Modification in the coverage/frequency of single species, with alteration of competition among species, and change in the composition of the communities (eventually, with compromise of “lichen biodiversity“)

Extrait du *Bulletin de la Société botanique de France.*
Séance du 13 juillet 1866, t. XIII, pp. 364 à 371.

LES LICHENS DU JARDIN DU LUXEMBOURG, par **M. W. NYLANDER.**

Les Lichens sont de tous les végétaux ceux qui sont le plus répandus dans la nature ; ils vivent sur les écorces, le bois, les rochers, la pierre, la terre,


Erasmus Darwin

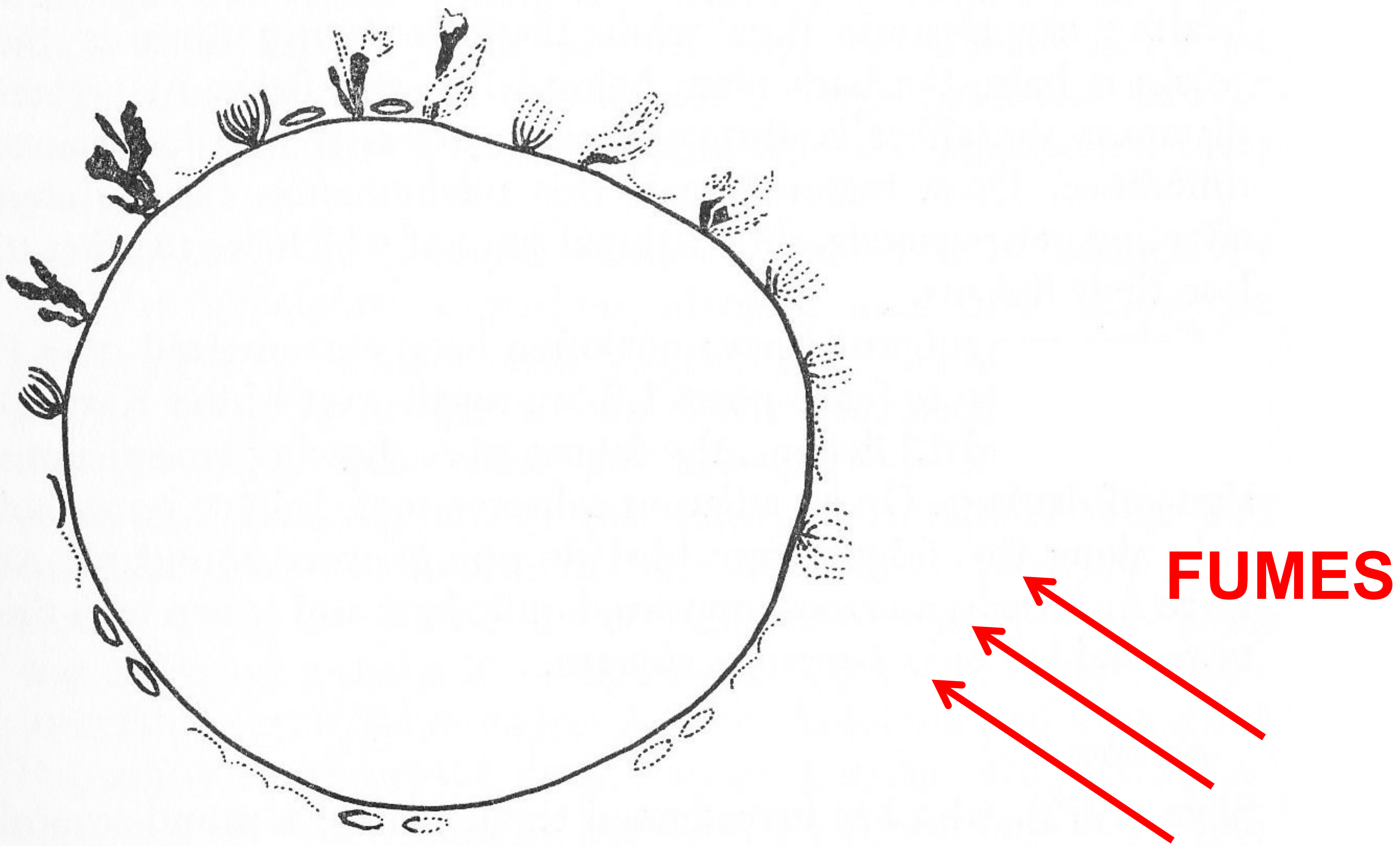


Fig. 2 Pattern of damage to epiphytes on trunk of beech tree (*Fagus sylvatica*) 400 m west of the newly opened smelter at Invergordon, Scotland. Black: living thallus; dotted lines: visibly damaged thallus. *Ramalina farinacea* (tufts), *R. fraxinea* (ribbons), *Hypogymnia physodes* (flattened ellipse), *Parmelia subaurifera* (arcs). Crustaceous lichens not shown

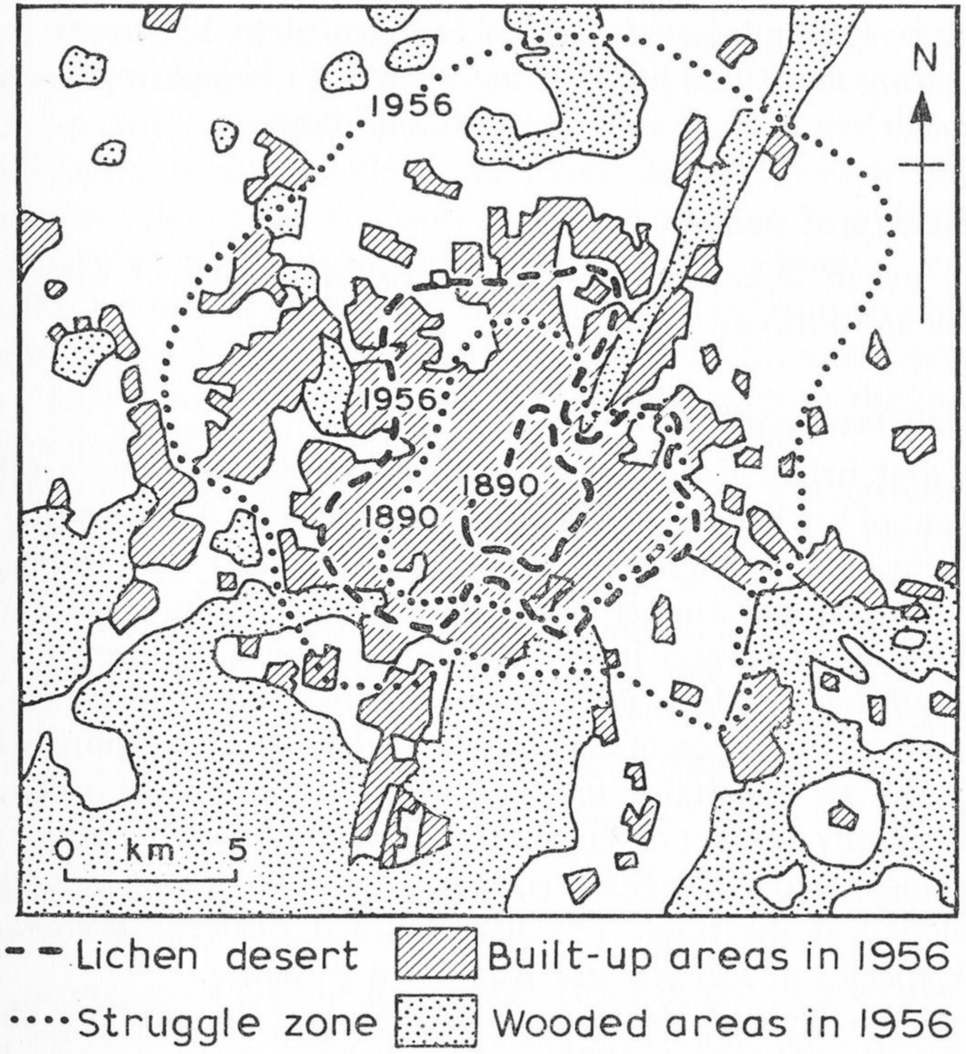


Fig. 1 Extension of pollution damage in München, Germany, between 1890 and 1956 (after Mägdefrau, 1960, p. 211)

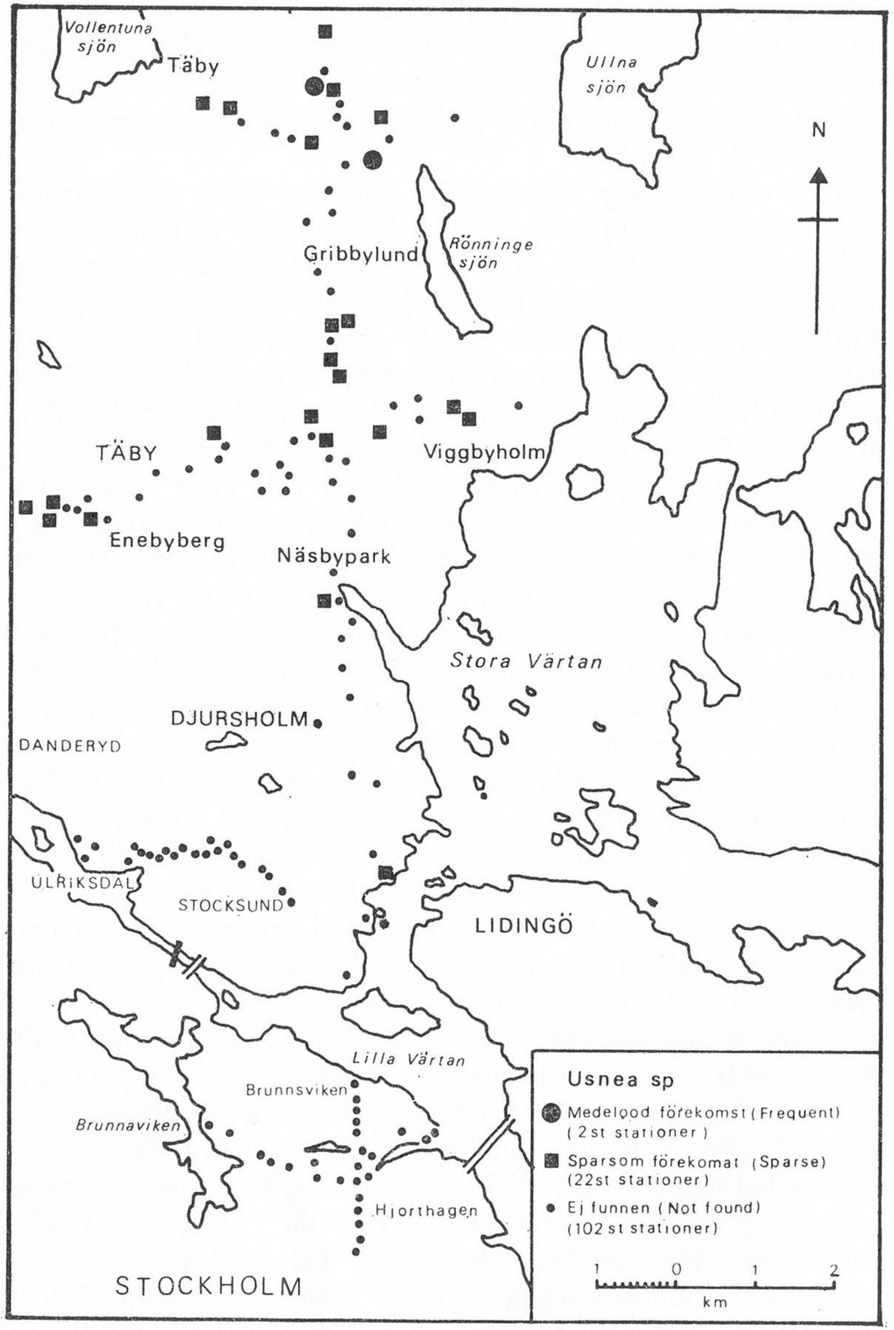


Fig. 1 Distribution of *Usnea* species on coniferous trees in the area north of Stockholm (after Lundström, 1968, p. 34)

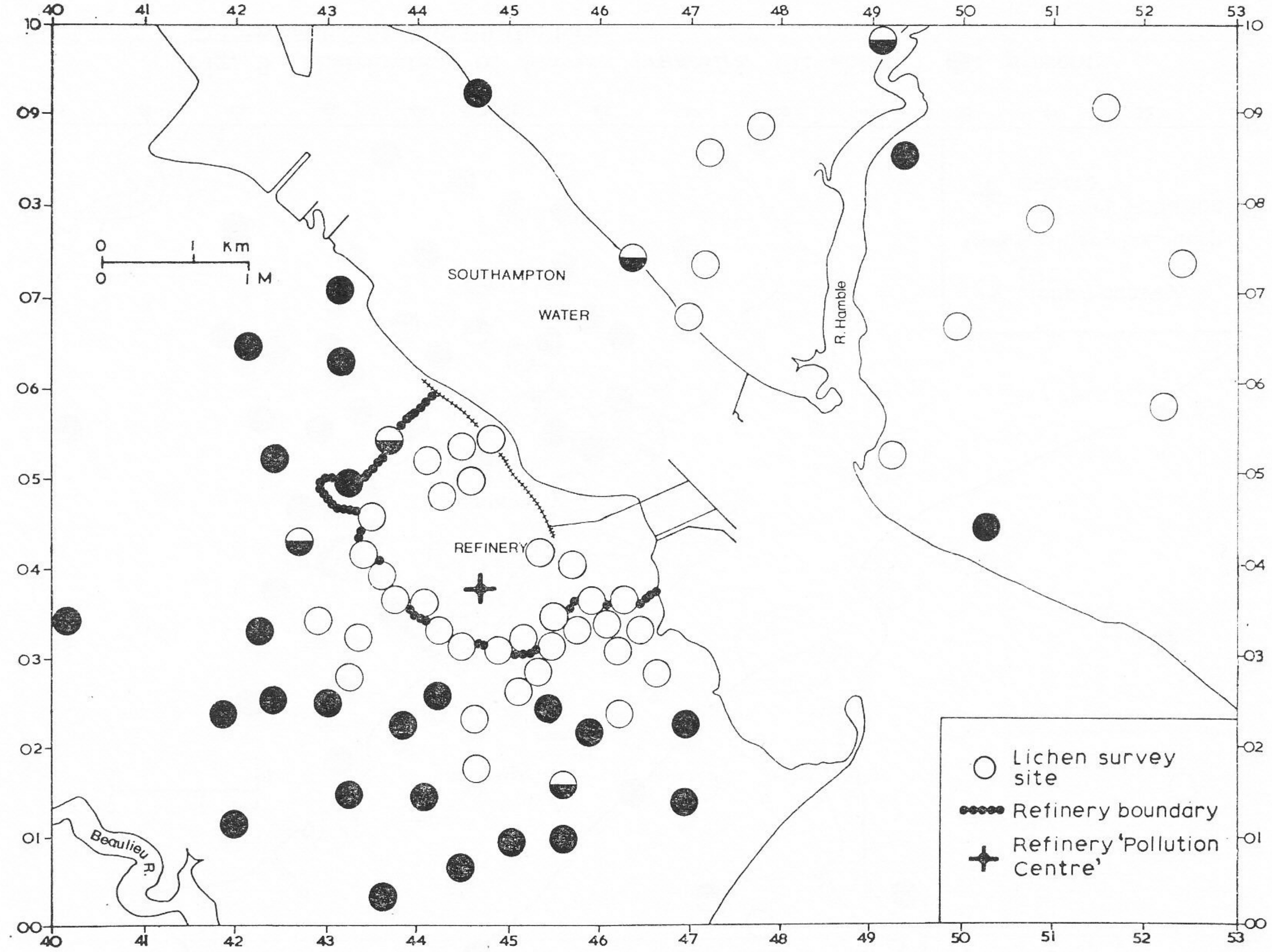


Fig. 6 Distribution of *Parmelia caperata*. ○: absent; ●: present; ◒: present, but only on the base

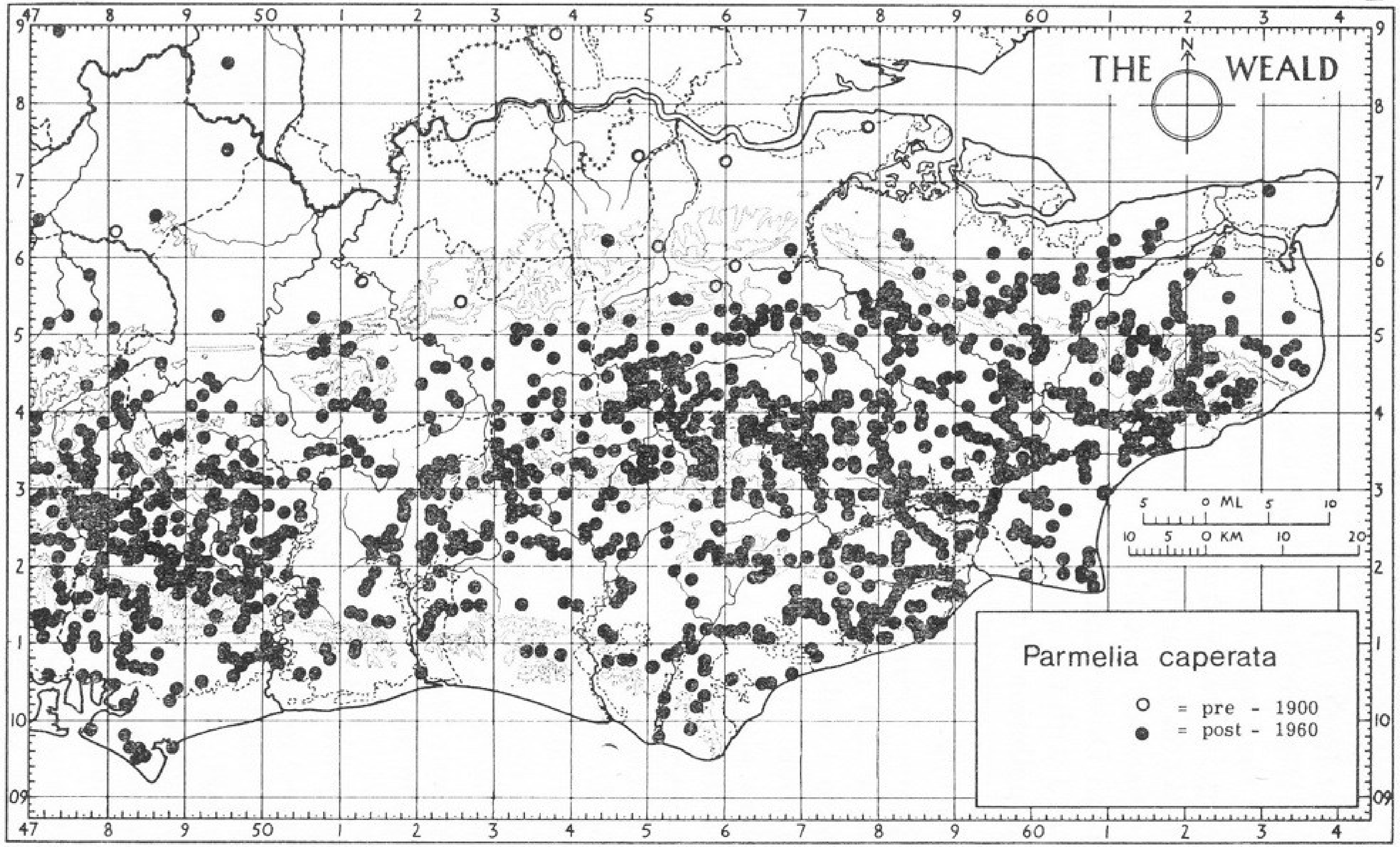


Fig. 1 Distribution of *Parmelia caperata* in south-east England

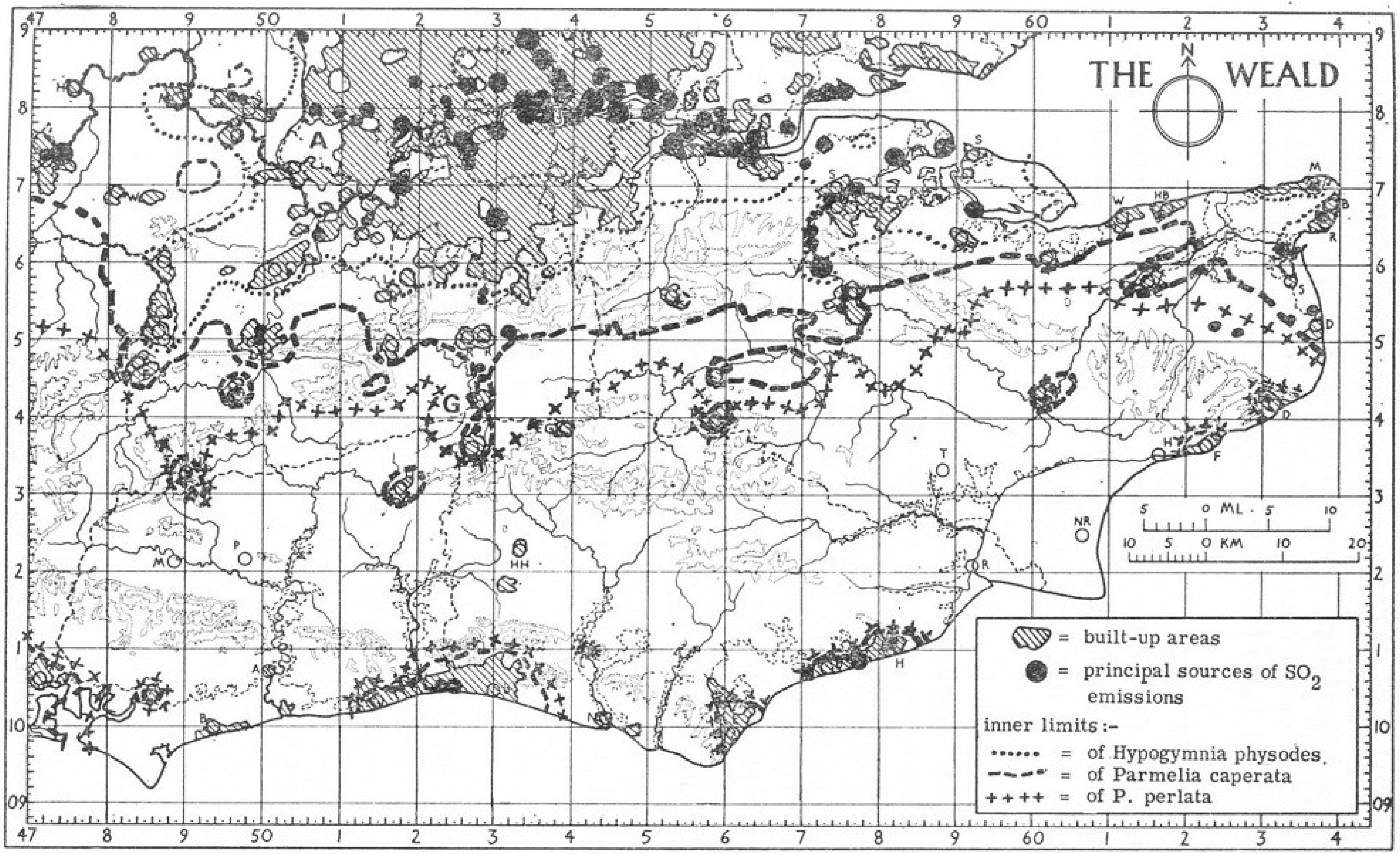


Fig. 6 Built-up areas, principal sources of sulphur dioxide emissions, and the inner limits of *Hypogymnia physodes*, *Parmelia caperata* and *P. perlata* in south-east England; the sizes of the dots indicating sulphur dioxide emission sources are proportional to the size of the source (after Rose, 1970)

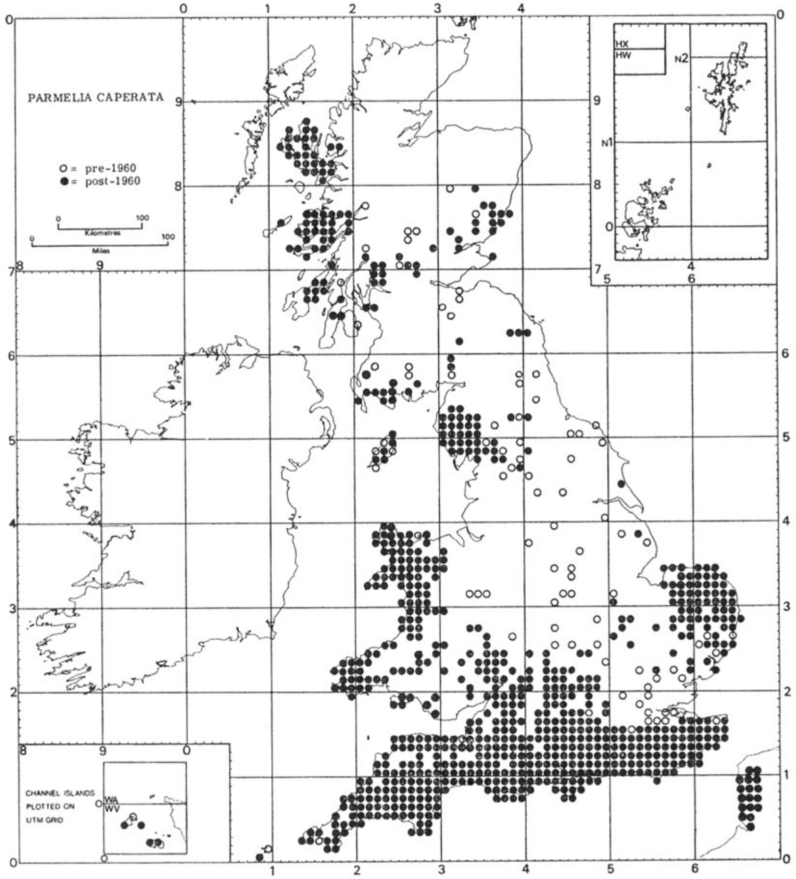


Fig. 6 Pre- and post-1960 distribution of *Parmelia caperata* in the British Isles (excluding Ireland)

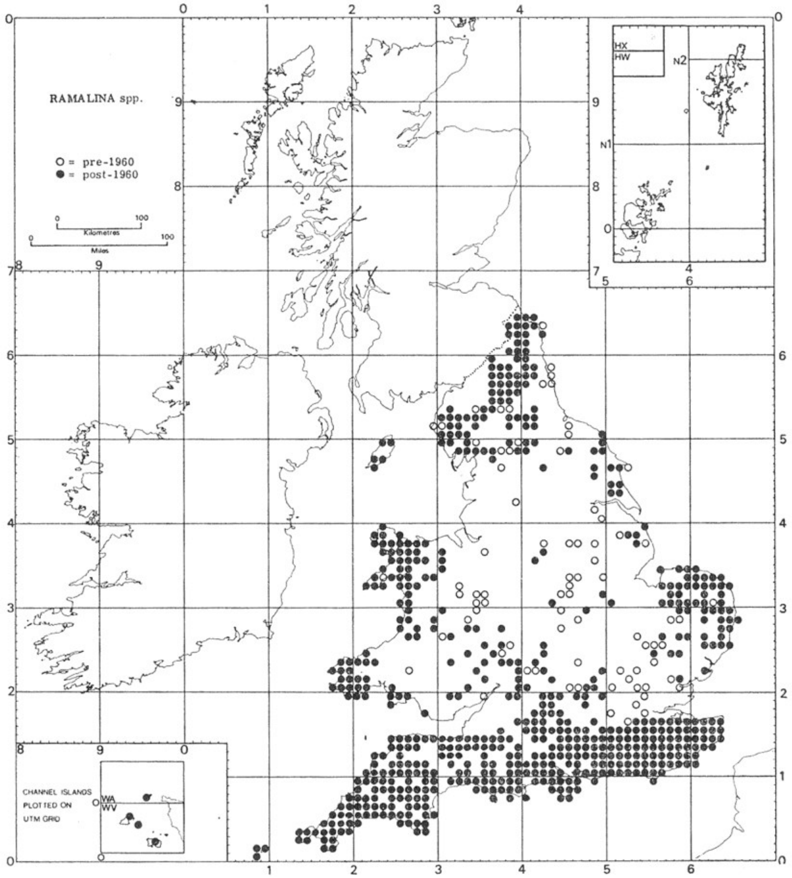


Fig. 7 Pre- and post-1960 distribution of *Ramalina* spp. in the British Isles (excluding Ireland and Scotland)

Table 2 Comparison between mean winter sulphur dioxide readings of volumetric gauges and the adjacent lichen vegetation in sites in England and Wales according to the scale of Hawksworth and Rose (1970)

Site	C	Nat. grid ref.	*Sulphur (dioxide μg/m³)*[1] 1967–8	1968–9	1969–70	Mean	Lichen zone
Leicester 3	D1/E	43/586044	N	226	N	226	0
Leicester 14	D1/E	43/590045	N	180	170	175	0–1
Leicester 13	A1	43/599049	182	182	163	169	2
Belper 1	D2	43/349479	178	155	151	161	2
Kew 1	B2	51/172757	150	170	131	150	2–3
Buxton 2	B3	43/068738	186	66	N	126	3
Farnsfield 1	R	43/647566	104	N	N	104	3
Leicester 10	B1	43/583002	91	90	89	90	3
Sheffield 60	O1	43/268856	87	101	76	88	3
Dursley 5	O1	31/761988	N	92	73	87	3–4
Hayfield 2	O2	43/053881	84	N	N	84	3–4
Aspley Heath 1	R	42/923345	88	69	93	83	3
Plymouth 13	A1	20/483550	77	87	82	82	3–4
Kingsnorth 5	O1	51/871646	76	N	69	72	4
Abbots Ripton 1	O1	52/202798	58	63	64	61	5
Prestwood 1	R	42/872012	49	72	N	60	6
Didcot 9	O1	42/562010	50	56	48	51	6
Didcot 4	O2	41/462927	48	58	42	49	6
Didcot 14	O2	41/583848	37	56	40	44	6–7
Plymouth 12	B3	20/478598	36	55	43	44	7
Balcombe 2	O1	51/284310	N	N	43	43	7
Didcot 1	O2	41/493808	41	48	36	41	7
Sparsholt	O2	41/341847	41	N	N	41	7
Didcot 6	O1	41/423995	40	44	35	39	7
Rogate 1	O2	41/794241	N	N	34	34	8
Torquay 3	B1	20/922657	32	33	N	32	8
Camborne 1	O1	10/628407	26	40	14	27	8
Llanberis 1	R	23/577601	24	28	28	27	9
Weymouth 1	O1	30/703820	24	29	14	22	9
Pembroke 13	O1	11/955990	N	8	N	8	9–10

C: site classification of Warren Spring Laboratory; A–E: urban and industrial; O: open country; R: rural community; 1–3: sub-classifications

N: no data available

[1] mean winter sulphur dioxide values abstracted from Warren Spring Laboratory (1969–71)

Hawksworth, D.L., Rose, F. (**1970**) *Qualitative scale for estimating sulphur dioxide air pollution in England and Wales using epiphytic lichens*. **Nature** 227: 145-148.

Table 1 Qualitative scale for the estimation of mean winter SO_2 air pollution in England and Wales using epiphytic lichens (after Hawksworth and Rose, 1970)

Zone	Non-eutrophiated bark	Eutrophiated bark	SO_2 ($\mu g/m^3$)
0	Epiphytes absent	Epiphytes absent	?
1	*Pleurococcus viridis* s.l. present but confined to the base	*Pleurococcus viridis* s.l. extends up the trunk	>170
2	*Pleurococcus viridis* s.l. extends up the trunk; *Lecanora conizaeoides* present but confined to the bases	*Lecanora conizaeoides* abundant; *L. expallens* occurs ocasionally on the bases	About 150
3	*Lecanora conizaeoides* extends up the trunk; *Lepraria incana* becomes frequent on the bases	*Lecanora expallens* and *Buellia punctata* abundant; *B. canescens* appears	About 125
4	*Hypogymnia physodes* and/or *Parmelia saxatilis*, or *P. sulcata* appear on the bases but do not extend up the trunks. *Lecidea scalaris*, *Lecanora expallens* and *Chaenotheca ferruginea* often present	*Buellia canescens* common; *Physcia ascendens* and *Xanthoria parietina* appear on the bases; *Physcia tribacia* appears in S	About 70
5	*Hypogymnia physodes* or *P. saxatalis* extends up the trunk to 2.5 m or more; *P. glabratula*, *P. subrudecta*, *Parmeliopsis ambigua* and *Lecanora chlarotera* appear; *Calicium viride*, *Lepraria candelaris*, *Pertusaria amara* may occur; *Ramalina farinacea* and *Evernia prunastri* if present largely confined to the bases; *Platismatia glauca* may be present on horizontal branches	*Physconia grisea*, *P. farrea*, *Buellia alboatra*, *Physcia orbicularis*, *P. tenella*, *Ramalina farinacea*, *Haematomma ochroleucum* var. *porphyrium*, *Schismatomma decolorans*, *Xanthoria candelaria*, *Opegrapha varia* and *O. vulgata* appear; *Buellia canescens* and *X. parietina* common; *Parmelia acetabulum* appears in E	About 60
6	*P. caperata* present at least on the base; rich in species of *Pertusaria* (e.g. *P. albescens*, *P. hymenea*) and *Parmelia* (e.g. *P. revoluta* (except in NE), *P. tiliacea*, *P. exasperatula* (in N)); *Graphis elegans* appearing; *Pseudevernia furfuracea* and *Alectoria fuscescens* present in upland areas	*Pertusaria albescens*, *Physconia pulverulenta*, *Physciopsis adglutinata*, *Arthopyrenia gemmata*, *Caloplaca luteoalba*, *Xanthoria polycarpa*, and *Lecania cyrtella* appear; *Physconia grisea*, *Physcia orbicularis*, *Opegrapha varia* and *O. vulgata* become abundant	About 50
7	*Parmelia caperata*, *P. revoluta* (except in NE), *P. tiliacea*, *P. exasperatula* (in N) extend up the trunk; *Usnea subfloridana*, *Pertusaria hemisphaerica*, *Rinodina roboris* (in S) and *Arthonia impolita* (in E) appear	*Physcia aipolia*, *Anaptychia ciliaris* (in E), *Bacidia rubella*, *Ramalina fastigiata*, *Candelaria concolor* and *Arthopyrenia biformis* appear	About 40
8	*Usnea ceratina*, *Parmelia perlata* or *P. reticulata* (S and W) appear; *Rinodina roboris* extends up the trunk (in S); *Normandina pulchella* and *U. rubiginea* (in S) usually present	*Physcia aipolia* abundant; *Anaptychia ciliaris* occurs in fruit; *Parmelia perlata*, *P. reticulata* (in S and W), *Gyalecta flotowii*, *Ramalina obtusata*, *R. pollinaria*, and *Desmazieria evernioides* appear	About 35
9	*Lobaria pulmonaria*, *L. amplissima*, *Pachyphiale cornea*, *Dimerella lutea*, or *Usnea florida* present; if these absent crustose flora well developed with often more than 25 species on larger well-lit trees	*Ramalina calicaris*, *R. fraxinea*, *R. subfarinacea*, *Physcia leptalea*, *Caloplaca aurantiaca*, and *C. cerina* appear	Under 30
10	*L. amplissima*, *L. scrobiculata*, *Sticta limbata*, *Pannaria* spp., *Usnea articulata*, *U. filipendula* or *Teloschistes flavicans* present to locally abundant	As 9	'Pure'

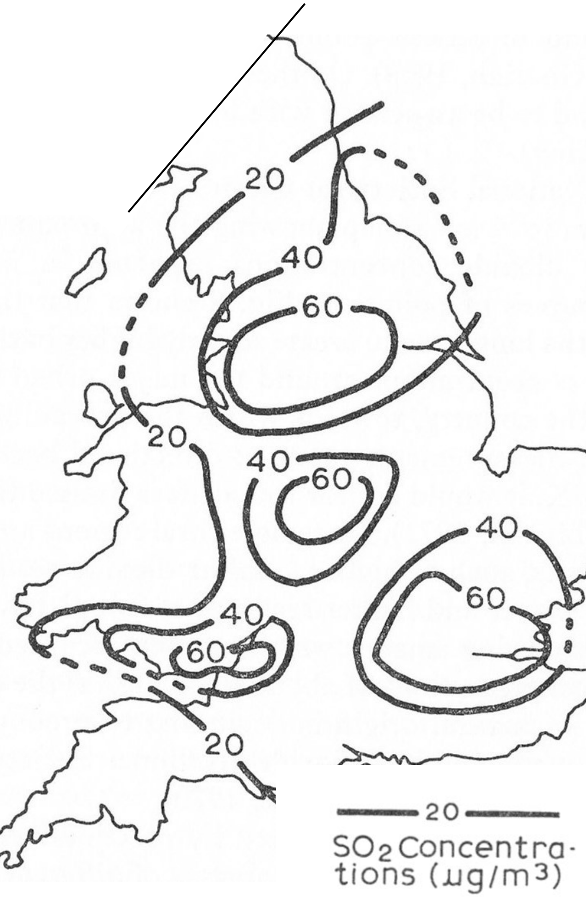


Fig. 2 Approximate annual mean sulphur dioxide concentration at sites remote from local pollution

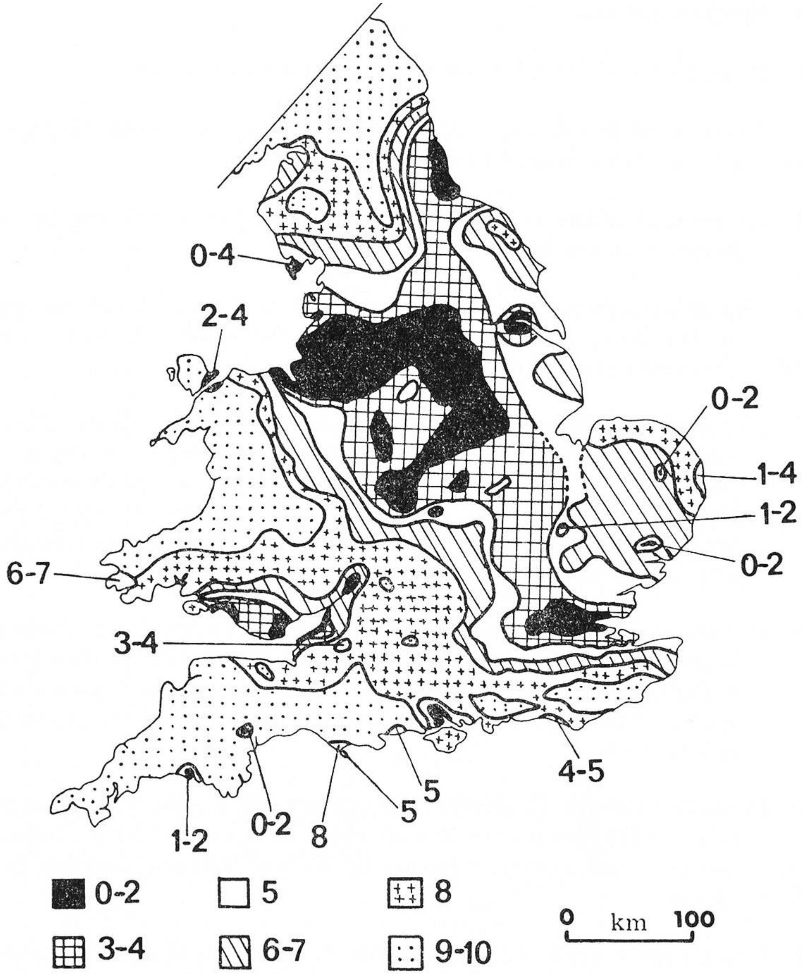


Fig. 2 Preliminary zone-map showing the extent of SO_2 air pollution in England and Wales based on the scales in Table 1 (after Hawksworth and Rose, 1970, p. 146)

IAP maps

The 'Index of Atmospheric Purity' (IAP) proposed by DeSloover

From the mid-1960s two researchers, De Sloover and Le Blanc, attempted to quantify the information provided by bioindicators by introducing a numerical index that should evaluate the level of air pollution, based on the number, frequency and tolerance of the different lichen species present in a given area (I.A.P., Index of Air Purity).

$$I.A.P. = (n/100)\ \Sigma Qi * fi$$

where: n= number of species within the relevé; Q = toxitolerance value of a certain species «i»; f = frequency of the same specie «i»

In a few years, there was a «florilegium» of new IAPs, because many authors proposed their own IAP formula, changing *e.g.* the poleotolerance values, the weight to the cover values of poleo-sensitive species, or of poleo-tolerant ones, introducing correction factors etc.

The born of the «Ammann» or «Swiss» method

Staub – Reinhaltung der Luft 48 (1988) 233–238

Staub Reinhaltung der Luft

Evaluation und Kalibrierung der Schweizer Flechten-Indikationsmethode mit wichtigen Luftschadstoffen

Luzius Liebendörfer, Rolf Herzig, Martin Urech und Klaus Ammann,

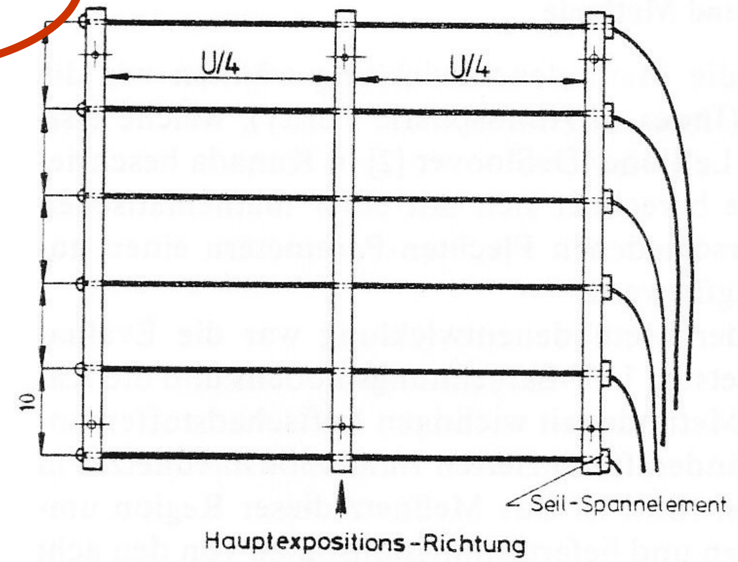


Bild 2. Neu entwickeltes Frequenzgitter zur quantitativen Analyse der Flechtenvegetation

Where: Bern, CH

• What they have at their disposal: ten automated recording gauges, with data on the main generalist pollutants: SO_2, NO_x, PM elemental content, Benzene.

• What they do: they select trees in the immediate vicinity of the automated recording gauges, on which they detect the lichen flora and vegetation: list of species present, coverage of individual species, n. of individuals and so on and so forth. Each relevé is taken within an extendable grid, covering half the circumference of the tree trunk, selected where the lichen cover is the highest.

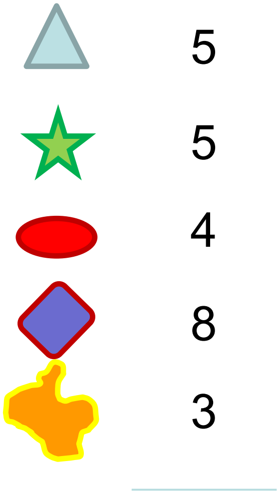
• Next steps: different I.A.P.s are "invented", constructed in a different way each time. Just for fun, try to propose yours. Eventually, there will be 20 IAP, numbered IAP1 to IAP20.

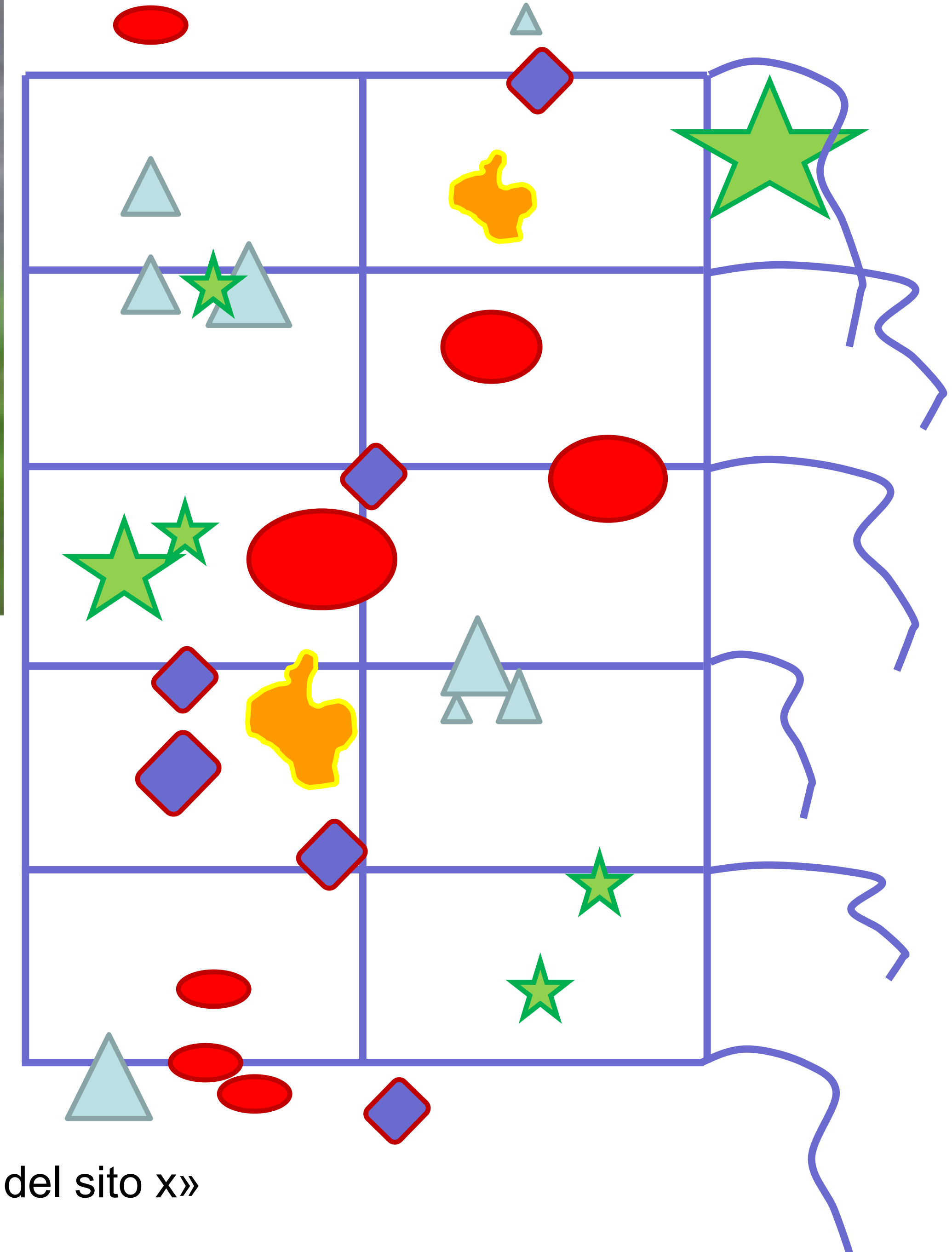
Then, they study the polynomial correlations between the chemical-physical descriptors of "air quality" and the IAPs calculated for all the sites hosting a automated recording gauge.

Some of these correlations are very bad, but one is highly significant, which is the one calculated based on the **IAP18**.

Another interesting observation: if the number of pollutants is reduced, the polynomial correlations are progressively less significant, but the most important contribution to the significance is given by SO2, subordinately by NOx, and then progressively by the trace elements, which bring a contribution very reduced.

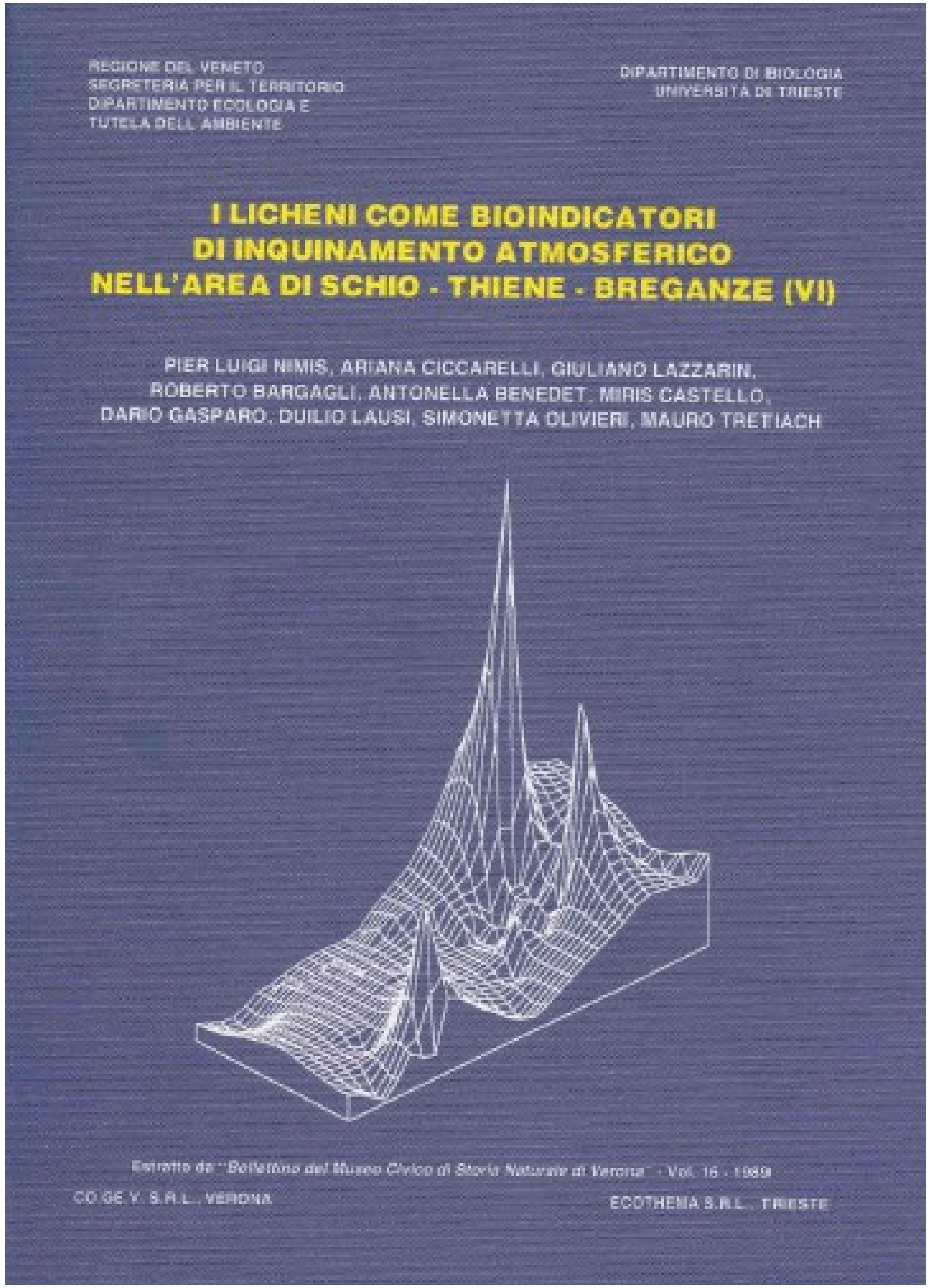
How is IAP_{18} calculated?

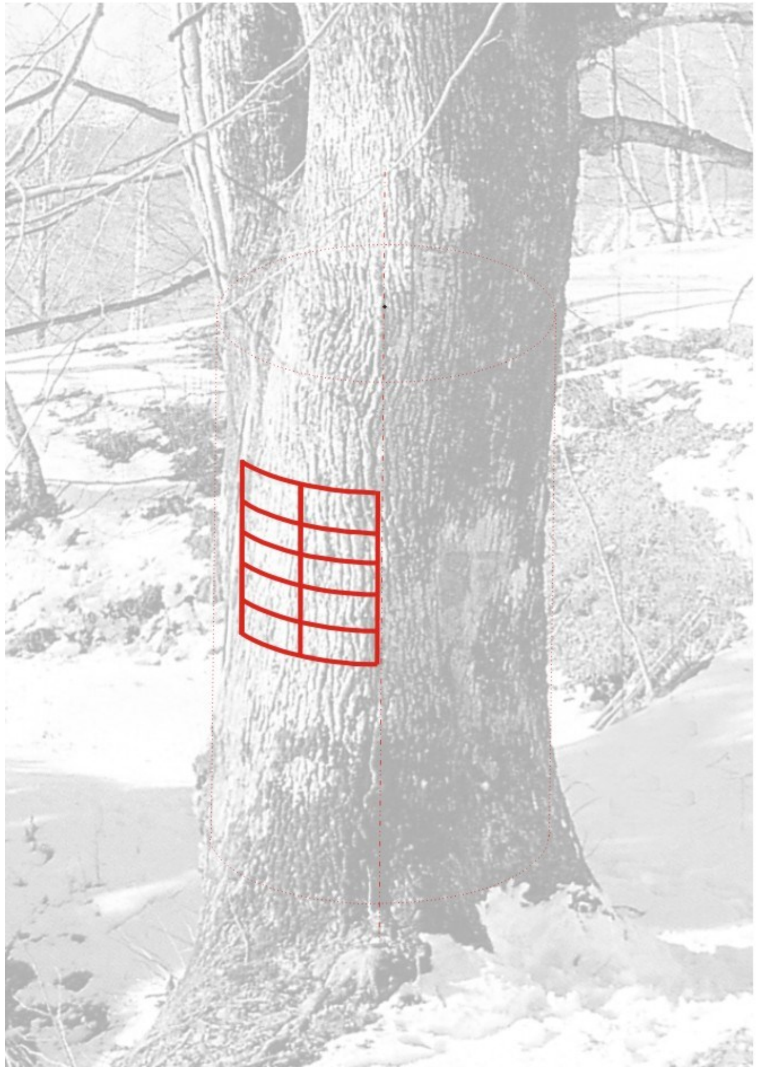




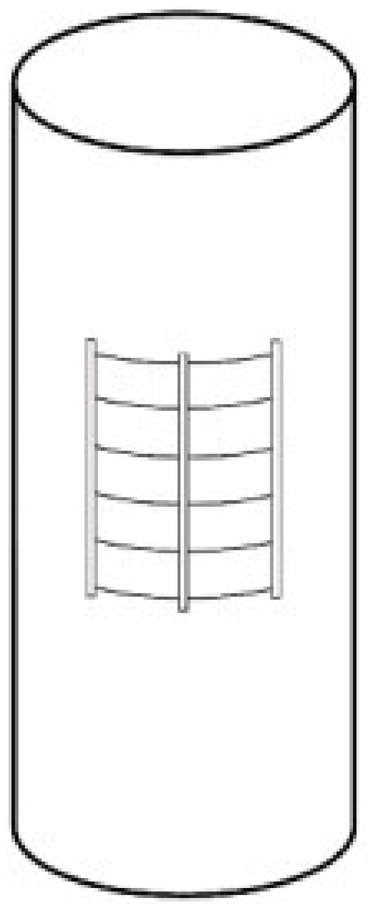
25 «I.A.P.$_{18}$ dell'albero n del sito x»

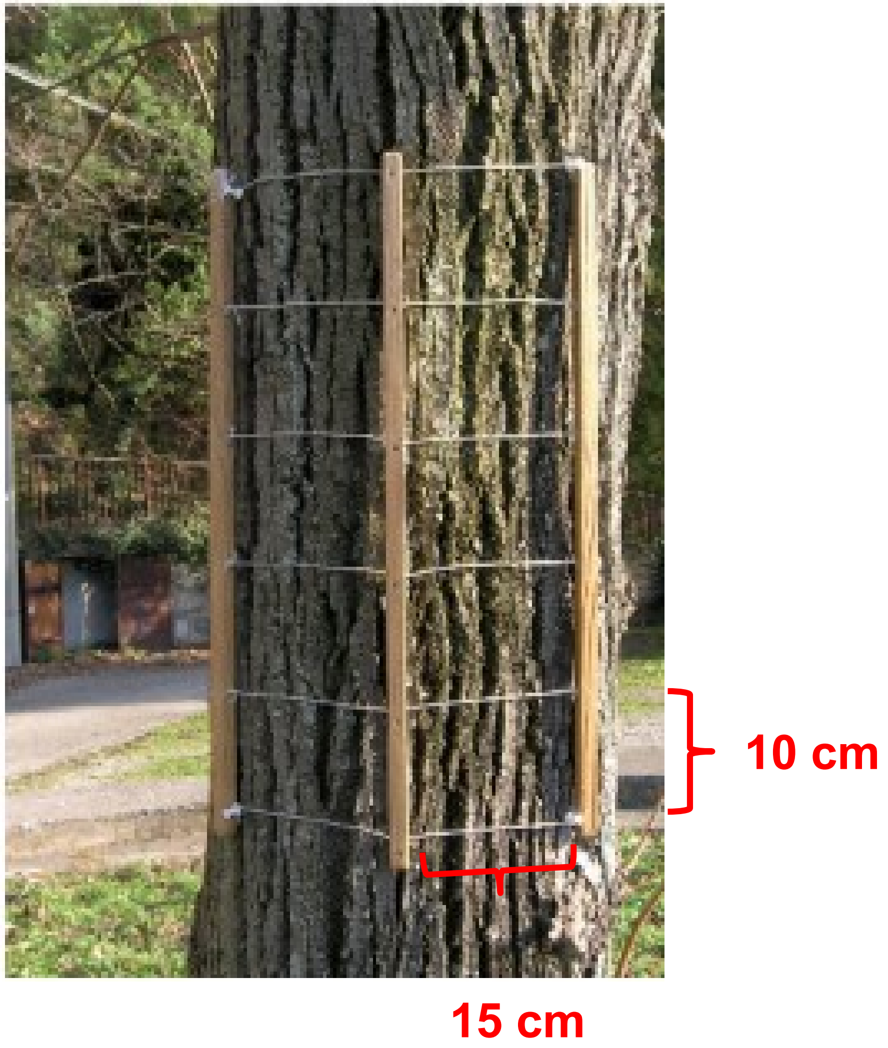
The first pilot project in Italy: a case-study in North-eastern Veneto





The empirical decision of using a standard sampling area of 30x50 cm (10 sampling units, 15x10 cm each) actually determined the passage from a I.A.P.$_{18}$ value to a true biodiversity value.





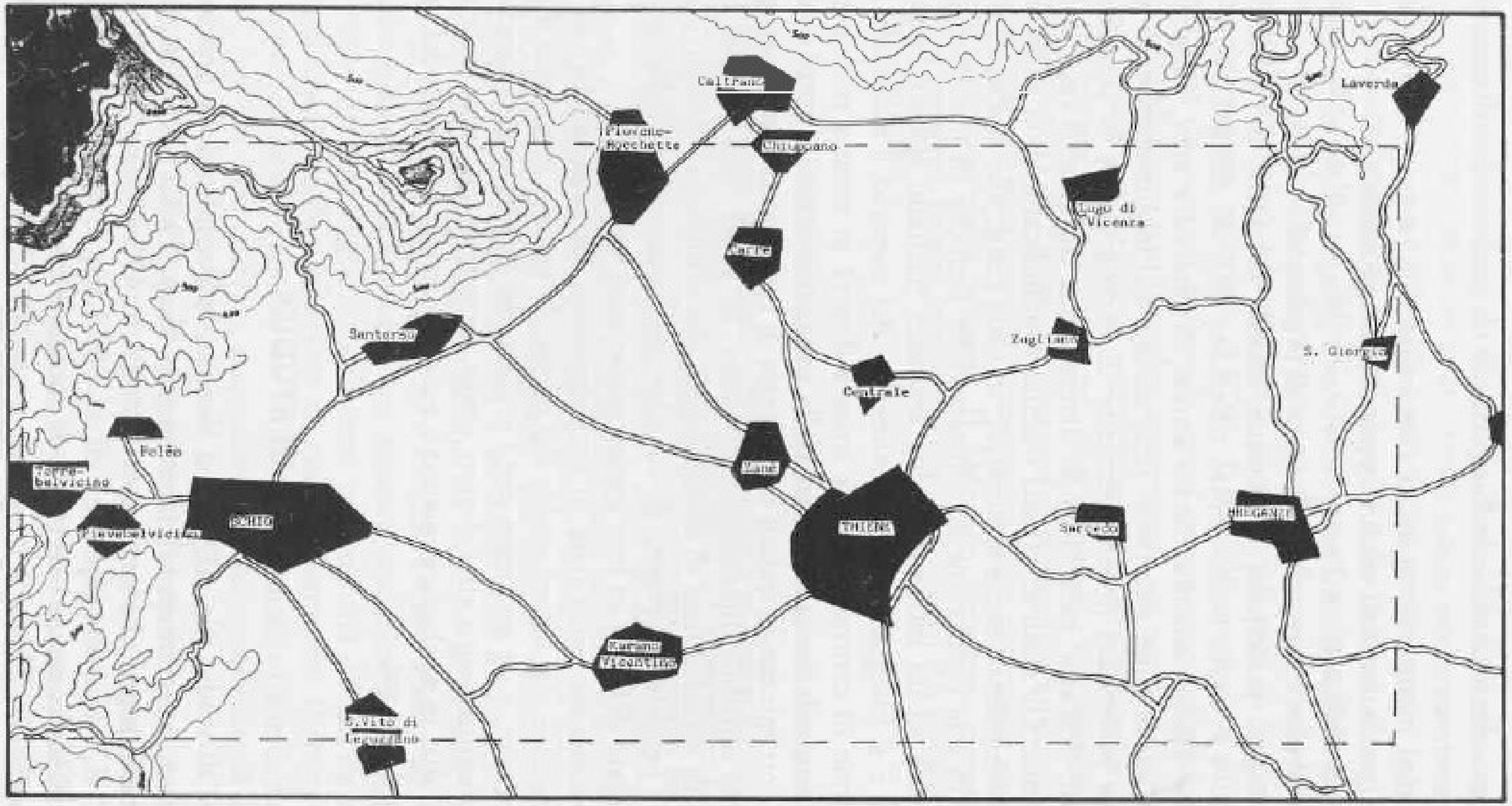
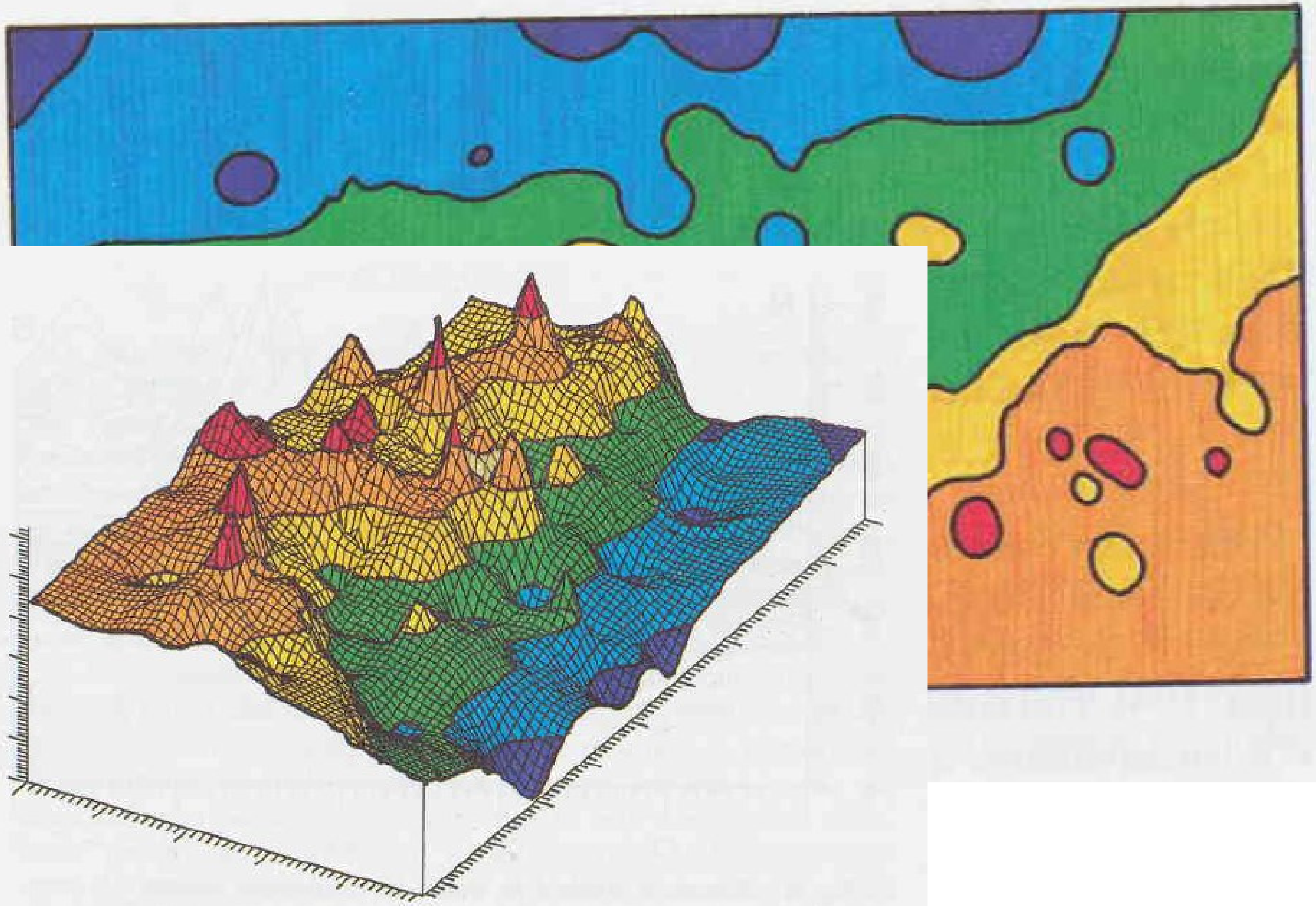
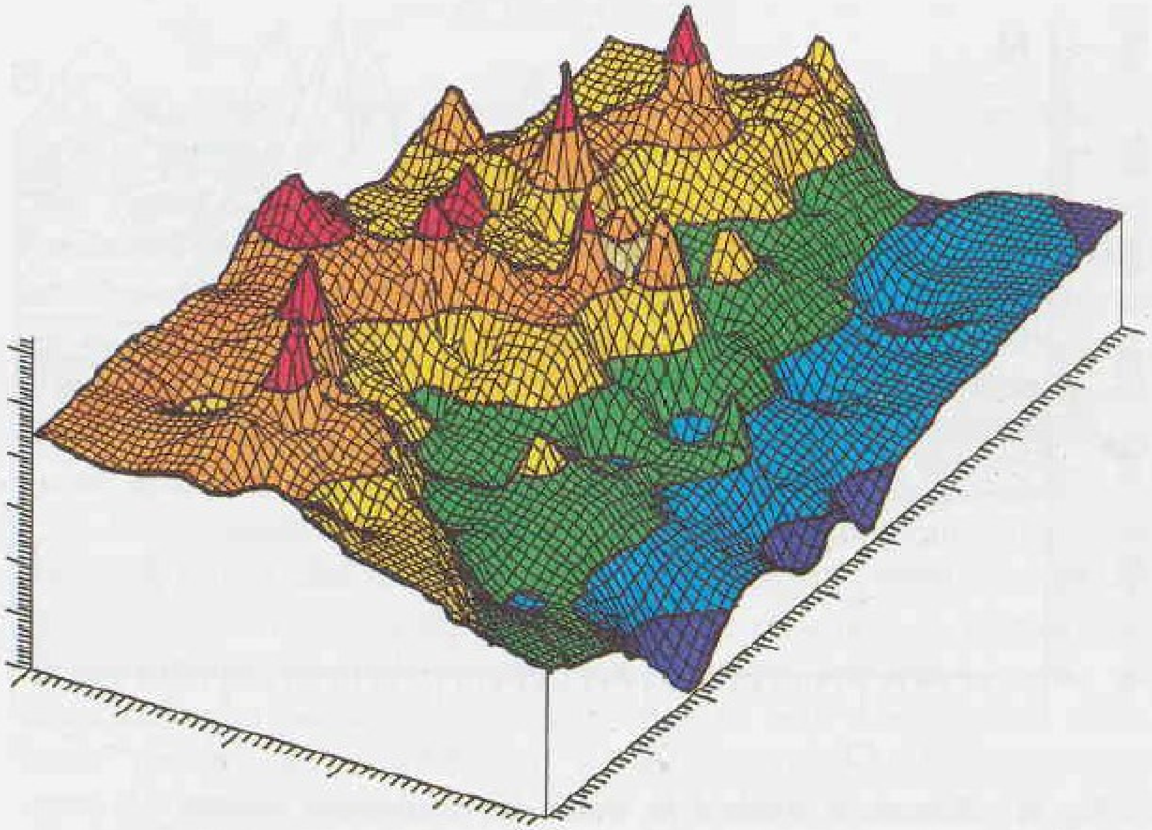


Fig. 1 - Rappresentazione schematica dell'area di studio. Il rettangolo tratteggiato interno indica i limiti dell'area interessata al campionamento dei metalli (v. figg. 35-44).



Tav. 1c



Tav. 1c

…soon extended to the whole Veneto Region

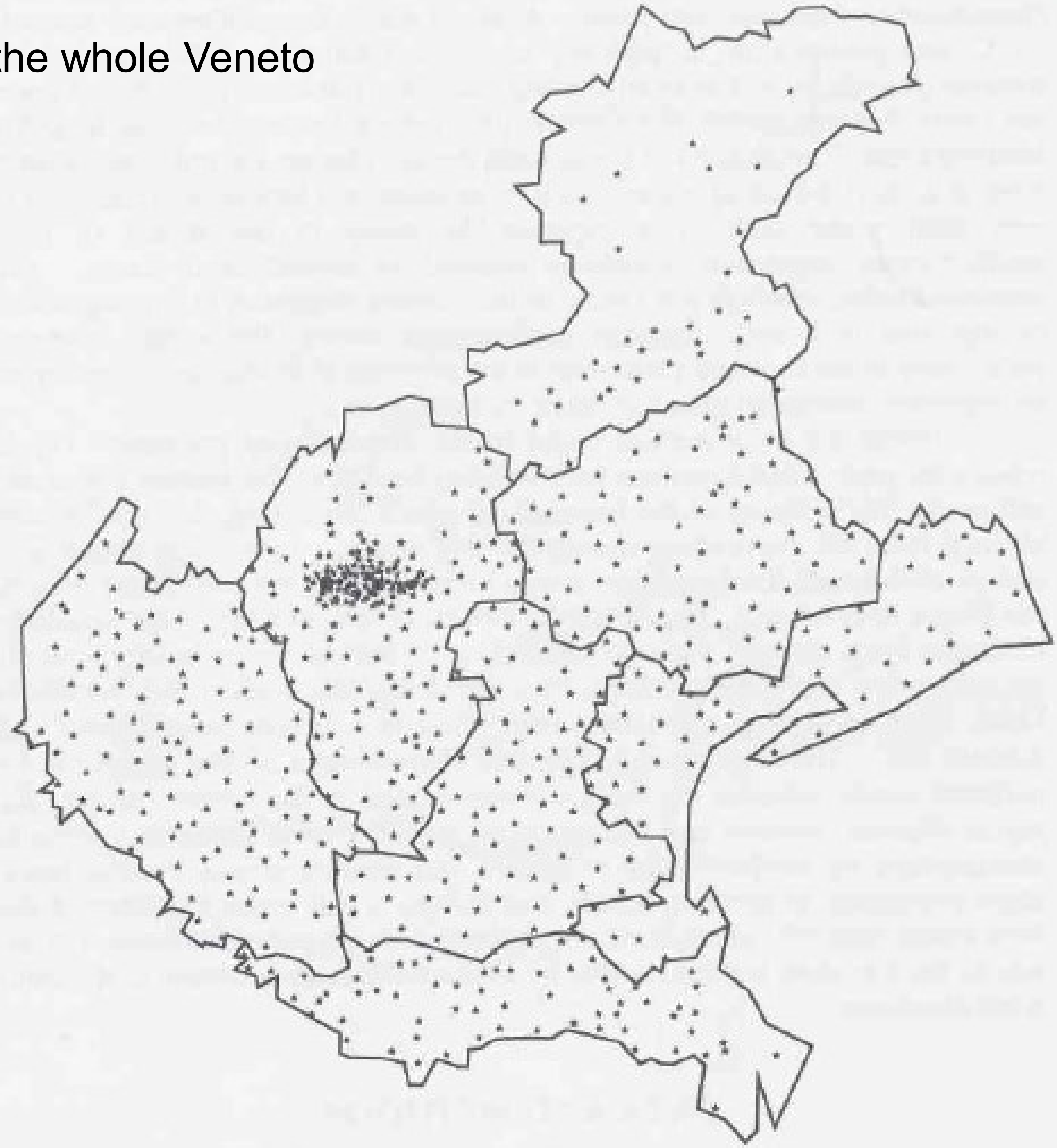
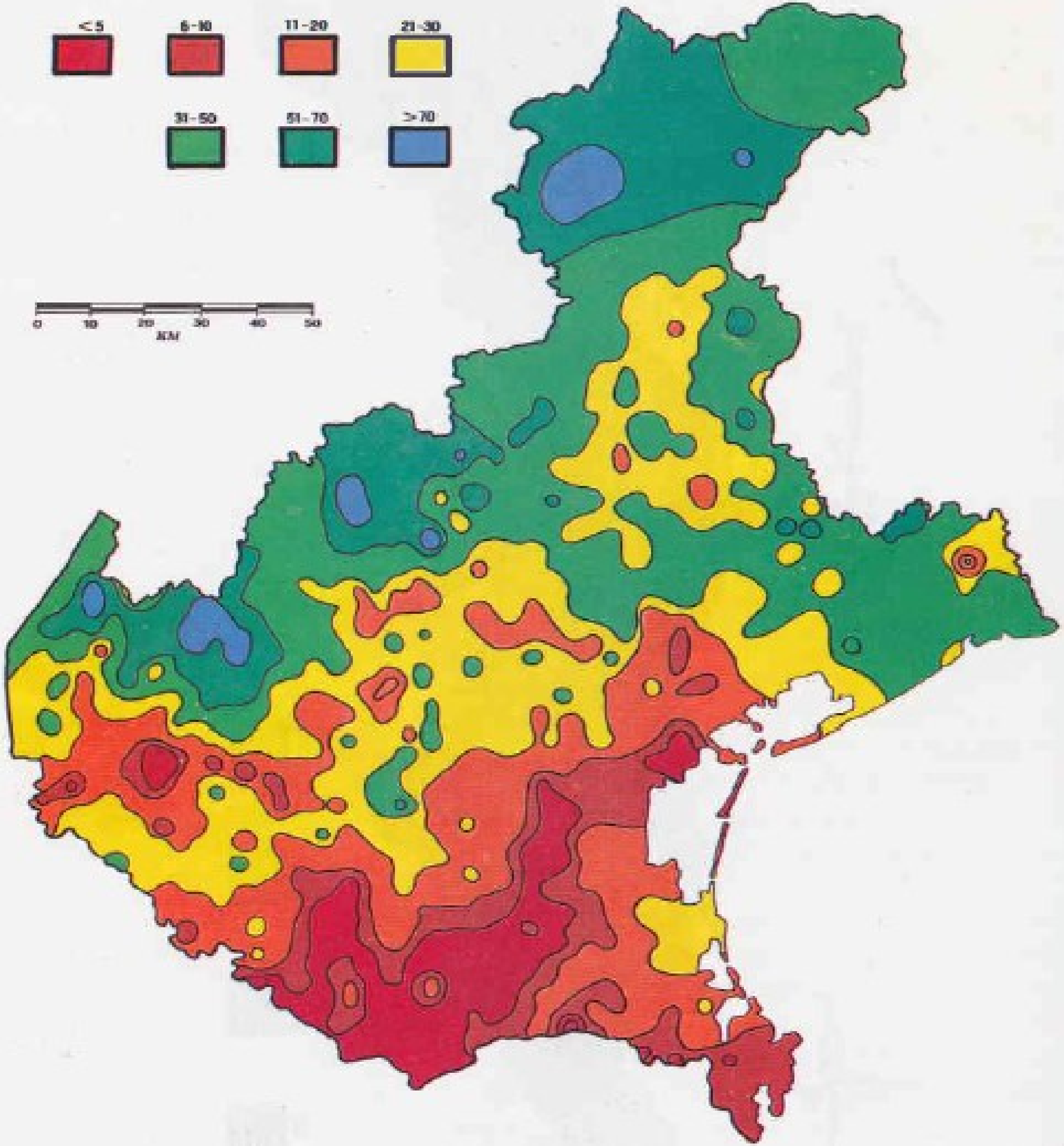


Fig. 3: location of the 662 sampling stations within the regional territory.


< 5
6-10
11-20
21-30
31-50
51-70
> 70
0 10 20 30 40 50
KM

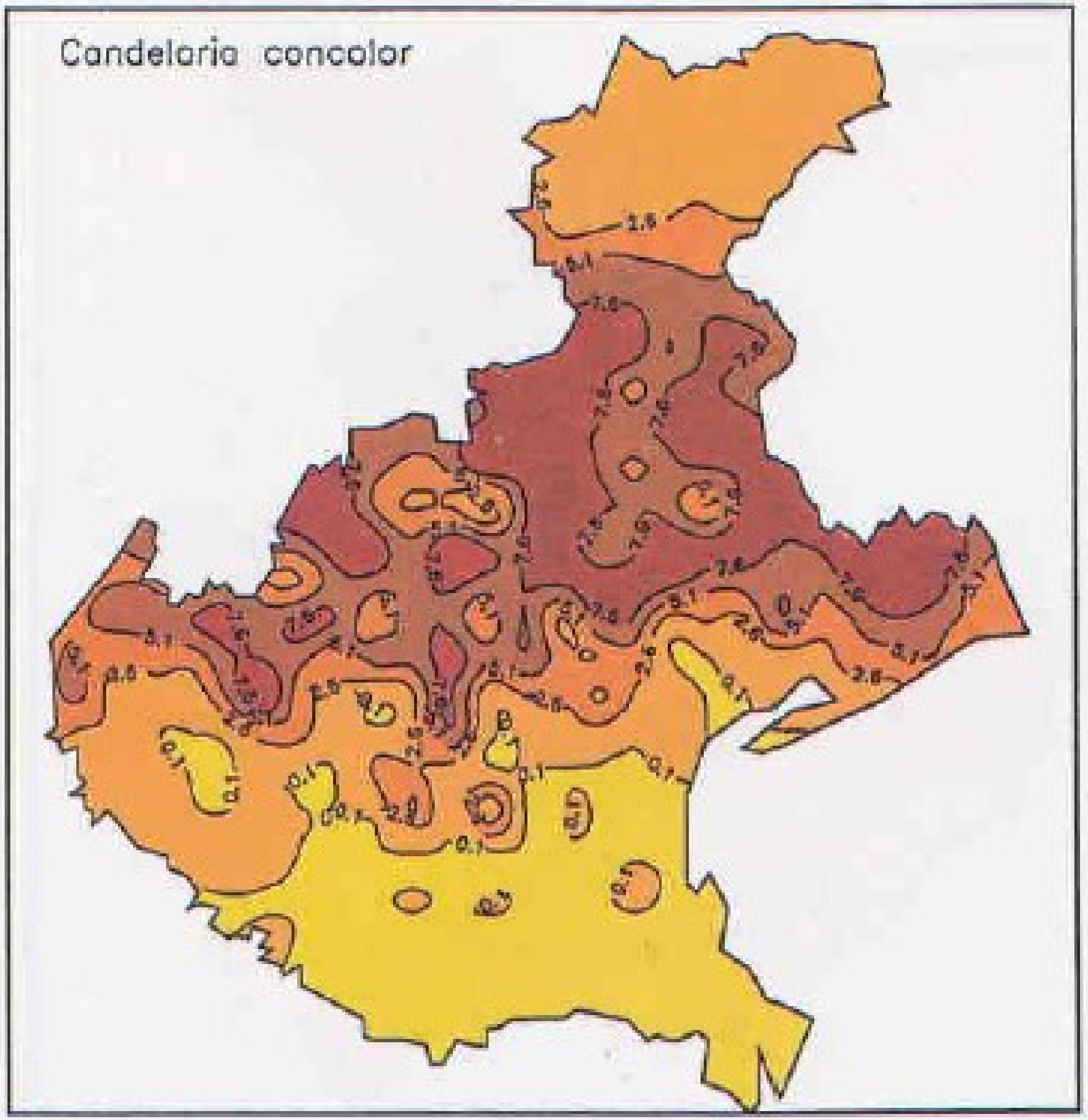


Fig. 22: distribution map of *Candelaria concolor* in the Region of Veneto, obtained by automatic processing of its frequency data in the 662 stations.

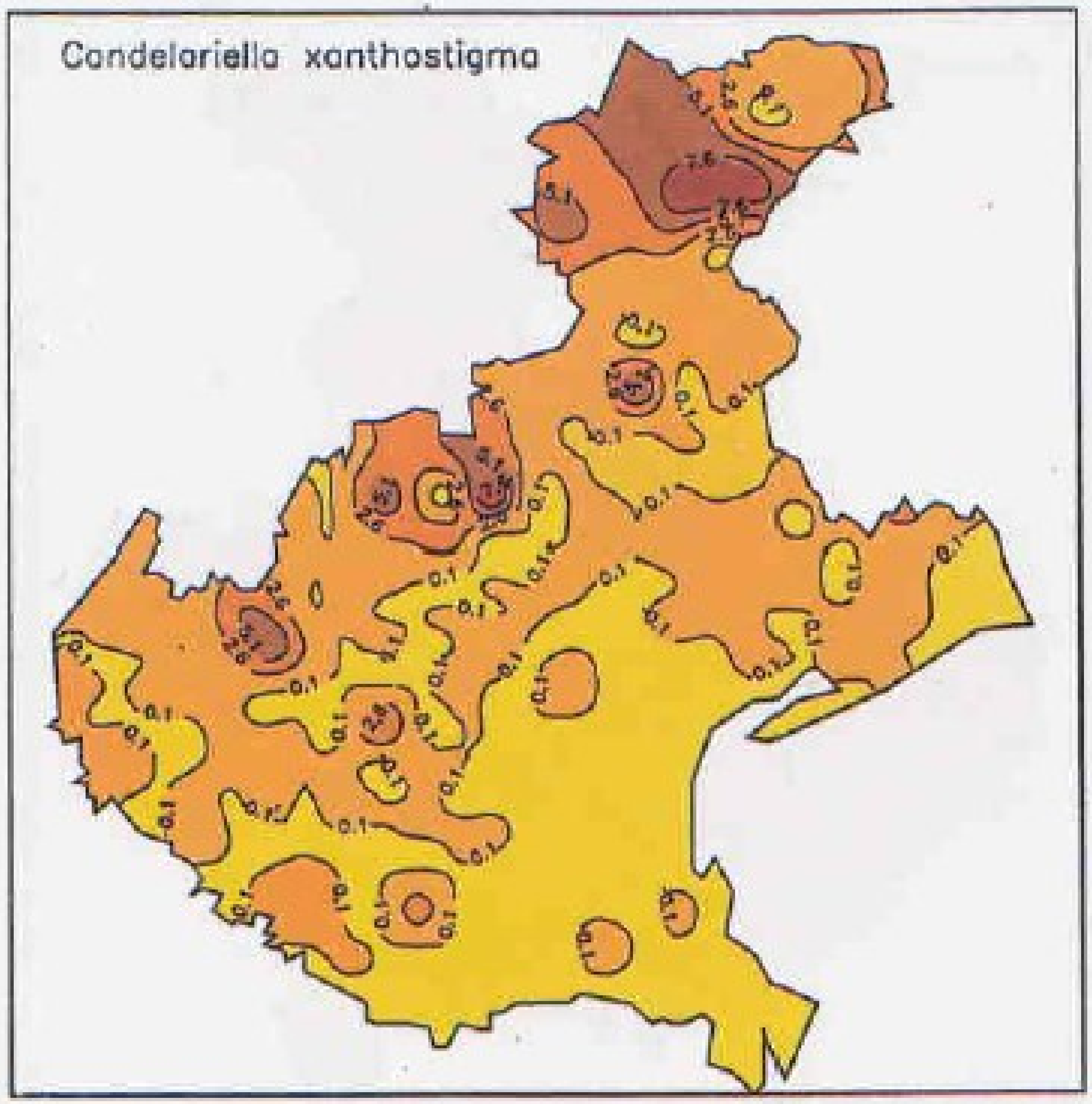


Fig. 23: distribution map of *Candelariella xanthostigma* in the Region of Veneto, obtained by automatic processing of its frequency data in the 662 stations.

Lichens, air pollution and lung cancer

29 May 1997

Lichens, air pollution and lung cancer

Cesare Cislaghi & Pier Luigi Nimis

Nature 387, 463-464 doi:10.1038/387463a0

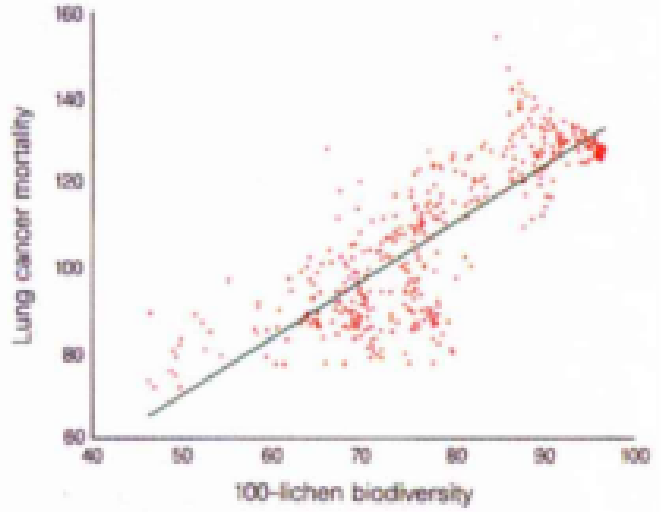


Figure 2 Scatter diagram relating lichen biodiversity (100 – sum of frequencies) and lung cancer mortality (observed/expected cases × 100; males aged under 55 years) in all municipalities of the Veneto region ($r = 0.82$, $F = 845.9$, $P < 0.0001$).

Cislaghi, C., Nimis, P.L. (1997). *Lichens, air pollution and lung cancer*. Nature 387, 463-464.

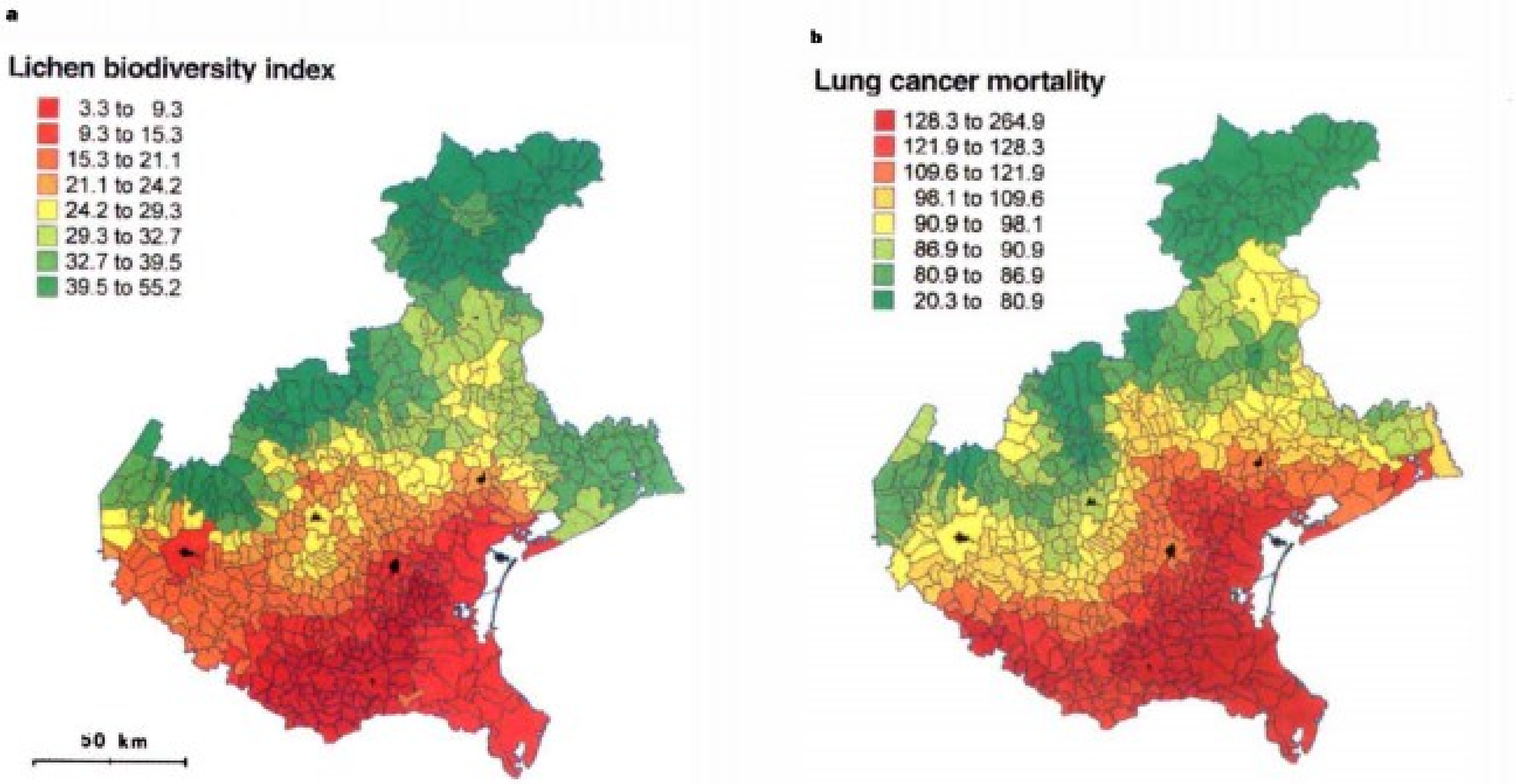


Figure 1 a, Lichen biodiversity, calculated as the sum of frequencies of all epiphytic species in a sampling grid of 10 units; and **b,** lung cancer mortality in young male residents (expressed as observed/expected cases × 100), in the region of Veneto. Scale intervals are based on percentiles of values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

Atti del Workshop "Biomonitoraggio della qualità dell'aria sul territorio nazionale"
Roma, 26-27 novembre 1998

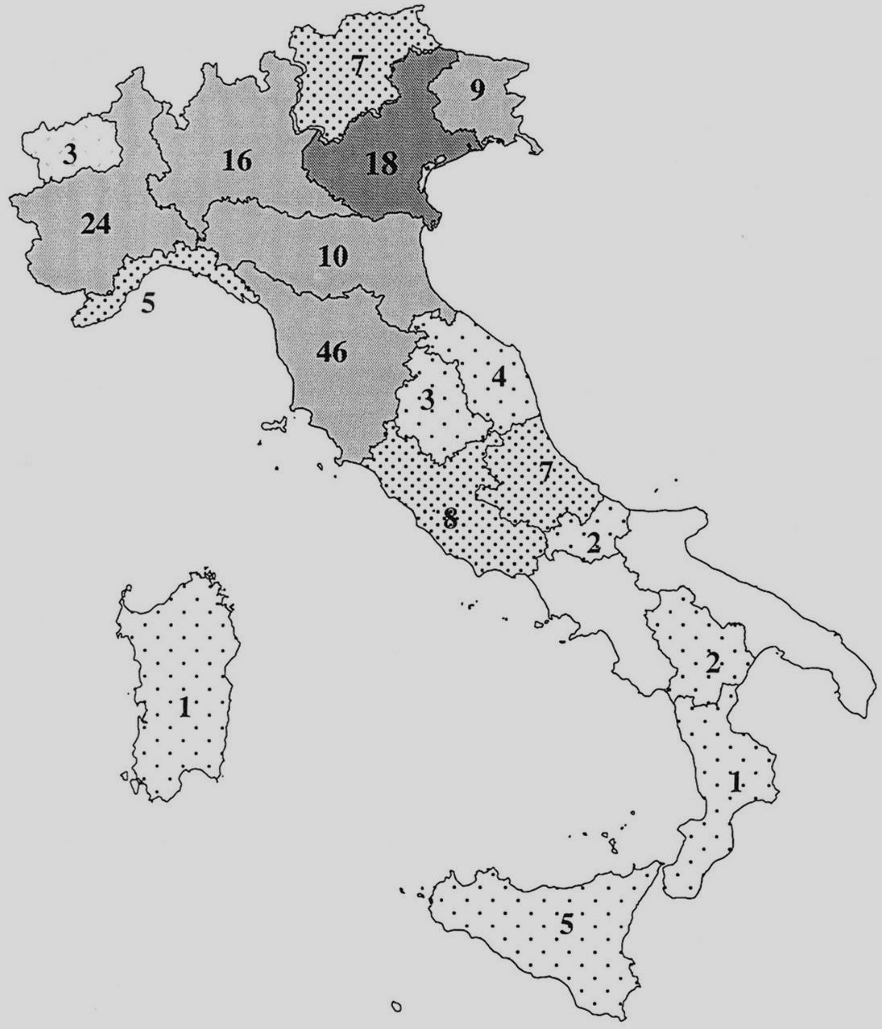
LICHENI COME BIOINDICATORI DELLA QUALITÀ DELL'ARIA: STATO DELL'ARTE IN ITALIA[1]

Rosanna Piervittori
Dipartimento di Biologia Vegetale, Università di Torino
Viale P.A. Mattioli 25, 10125 Torino

Riassunto

Viene presentata una sintesi delle ricerche sinora svolte in Italia utilizzando i licheni come bioindicatori di inquinamento atmosferico, comprensiva delle principali metodologie adottate e delle principali aree del Paese investigate. Viene fornito un elenco bibliografico esaustivo che riporta 227 lavori, la maggior parte dei quali pubblicati dopo il 1987.

Analisi dei dati al 1998



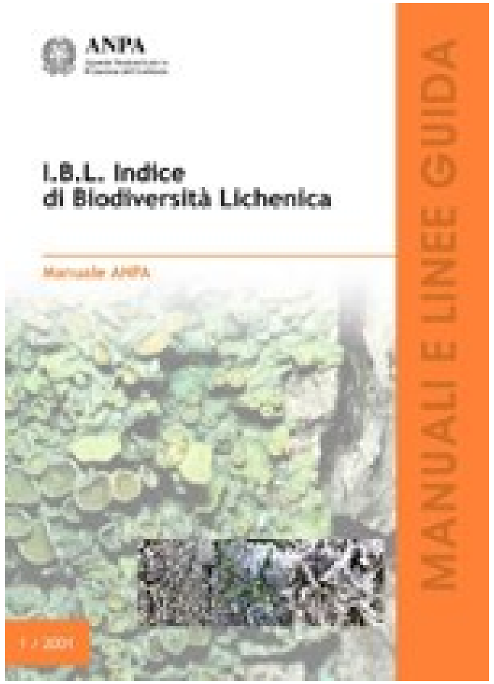
2. Distribuzione geografica e frequenza degli studi di bioindicazione in Italia. I numeri si riferiscono alle pubblicazioni reperibili per regione, le tonalità di grigio alla superficie di territorio esaminato.

Towards the standardization

A central aspect of the development of bioindication methods with epiphytic lichen communities has concerned the standardization of procedures.

Piccini C., Salvati S. (Eds.): Atti Workshop Biomonitoraggio Qualità dell'aria sul territorio Nazionale. ANPA, Ser. Atti, 2.

Nimis, P.L. (1999). *Linee guida per la bioindicazione degli effetti dell'inquinamento tramite la biodiversità dei licheni epifiti*. Ibid., pp. 267-277.



ICS 13.040.20 — VDI-RICHTLINIEN — Dezember 2005 / December 2005

VEREIN DEUTSCHER INGENIEURE	Biologische Messverfahren zur Ermittlung und Beurteilung der Wirkung von Luftverunreinigungen mit Flechten (Bioindikation) Kartierung der Diversität epiphytischer Flechten als Indikator für Luftgüte Biological measurement procedures for determining and evaluating the effects of ambient air pollutions by means of lichens (bioindication) Mapping the diversity of epiphytic lichens as an indicator of air quality	VDI 3957 Blatt 13 / Part 13 Ausg. deutsch/englisch Issue German/English

2005

AFNOR

Asta, J., Erhardt, W., Ferretti, M., Fornasier, F., Kirschbaum, U., Nimis, P.L., Purvis, O.W., Pirintsos, S., Scheidegger, C., van Haluwyn, C. , Wirth, V. (**2002**). *Mapping lichen diversity as an indicator of environmental quality*. In: Nimis P.L., Scheidegger C., Wolseley P. (Eds.). Monitoring with lichens – Monitoring lichens. NATO Science Series, IV, vol. 7. Kluwer, Dordrecht, pp. 273 -279.

Towards the standardization

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

FINAL DRAFT
FprEN 16413

September 2013

ICS 13.040.20

English Version

Ambient air - Biomonitoring with lichens - Assessing epiphytic lichen diversity

Air ambiant - Biosurveillance à l'aide de lichens - Evaluation de la diversité de lichens épiphytes

Außenluft - Biomonitoring mit Flechten - Kartierung der Diversität epiphytischer Flechten

This draft European Standard is submitted to CEN members for formal vote. It has been drawn up by the Technical Committee CEN/TC 264.

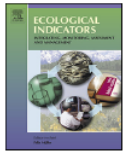
Ecological Indicators 45 (2014) 63–67

Contents lists available at ScienceDirect

ELSEVIER

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind



Towards the adoption of an international standard for biomonitoring with lichens—Consistency of assessment performed by experts from six European countries

CrossMark

F. Cristofolini[a,*], G. Brunialti[b], P. Giordani[c], J. Nascimbene[d], A. Cristofori[a], E. Gottardini[a], L. Frati[b], P. Matos[e], F. Batič[f], S. Caporale[g], M.F. Fornasier[h], L. Marmor[i], S. Merinero[j], J. Nuñez Zapata[k], T. Tõrra[i], P. Wolseley[l], M. Ferretti[b]

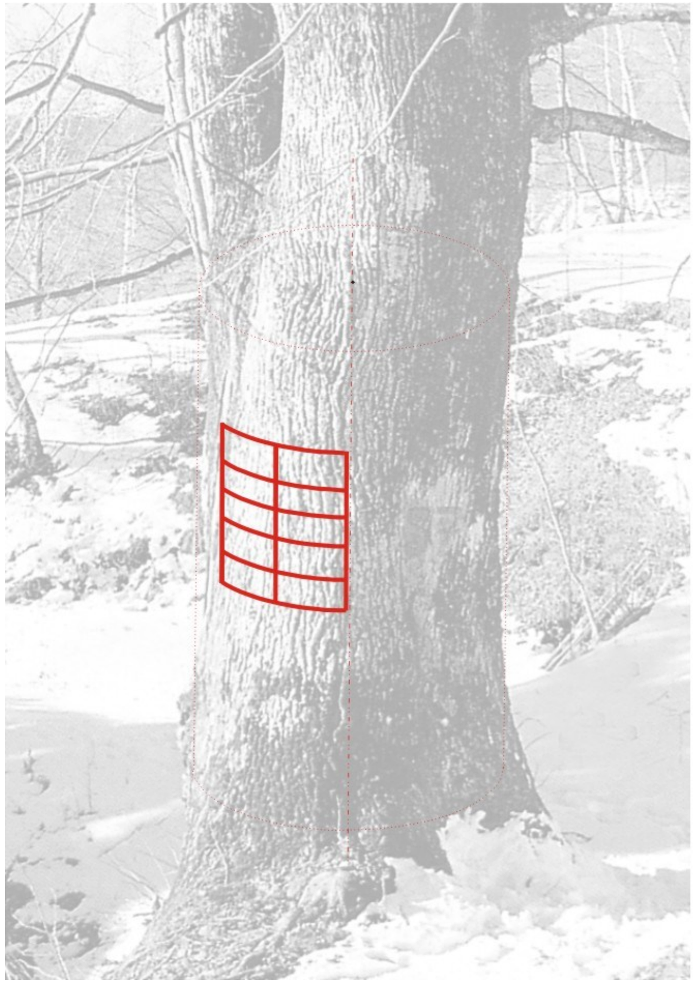
…some confusion caused by terminological changes:

IAP **«Ammann»** or **IAP**$_{18}$ became:

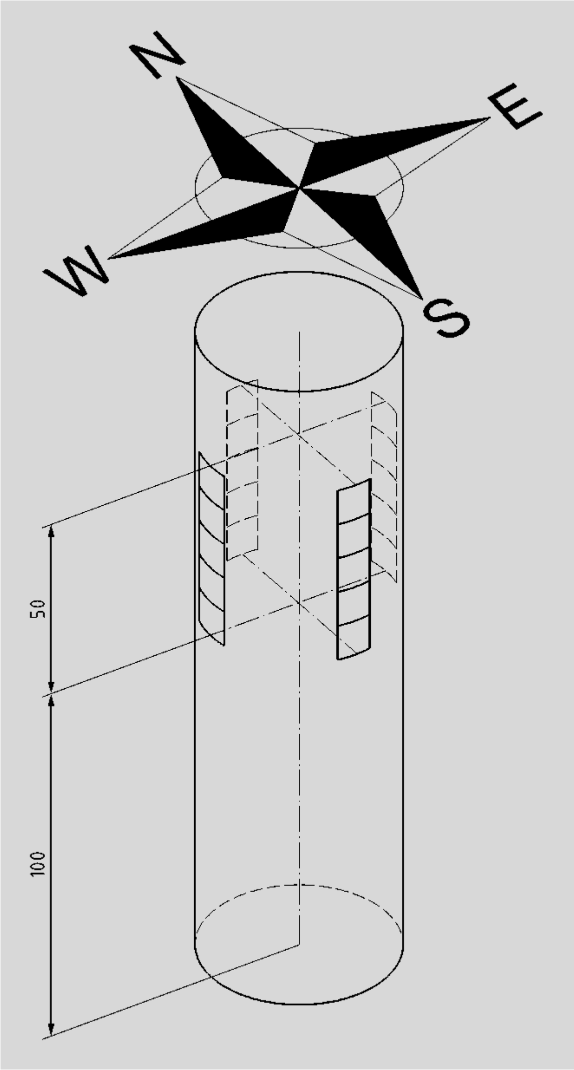
LBI o **IBL** («Lichen Biodiversity Index»), then:

VBL o **LBV** («Lichen Biodiversity Value»), then:

LDV («Lichen Diversity Value»)



On the area of maximum coverage of the lichen community on the trunk, defined based on the operator's experience



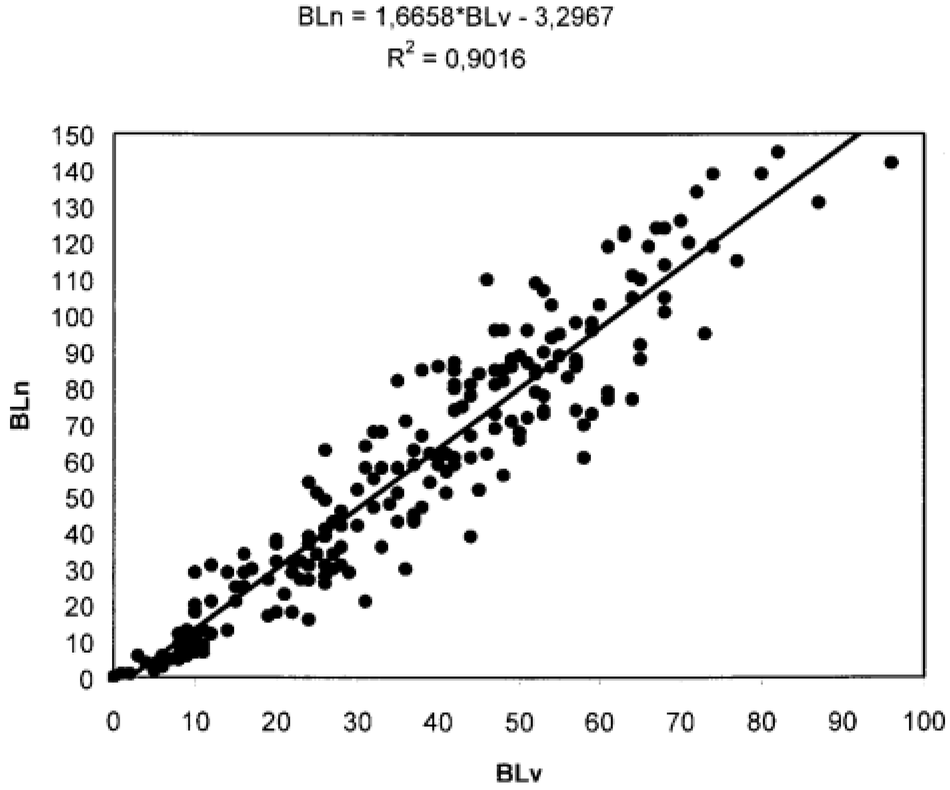
At the four cardinal points, adopting a smaller grid (5 square areas of 10x10 cm)

There is a correlation between the values provided by the old grid (10 meshes of 10x15 cm), corresponding to the "old" IAP_{18} and those of the new grid (5 meshes of 10x10 cm, moved to the four cardinal points of the trunk), corresponding to the new LDV?

Castello M., Skert N. (**2005**). *Evaluation of lichen diversity as an indicator of environmental quality in the North Adriatic submediterranean region*. Science of the Total Environment 336: 201-214.

The survey was carried out in **61** sampling sites of two areas of the Friuli Venezia Giulia region (Italy) and Slovenia, characterized by similar climatic conditions and a wide range of anthropic pressure.

Biodiversity values obtained with **the two sampling methods are highly statistically correlated**;
this suggests an interpretative continuity of lichen diversity data for biomonitoring purposes.



In biomonitoring studies it is necessary to respect a protocol when choosing trees, in order to avoid anomalies that could negatively affect the data.

Avoid trunks with an inclination greater than 20° or with large knots…

Avoid trunks with bryophyte or climbing plant coverage greater than 20%...

Table 2.1 List of features to of a standard tree (see EN 16413 2014; Asta et al. 2002)

Feature	Description
Suitable tree species	The sampling tree belongs to one of the groups with similar bark physicochemical properties (EN 16413 2014; Asta et al. 2002). Indicatively, species belonging to the same group can be used interchangeably
Trunk circumference	The sampling tree has a trunk circumference (at 130 cm from the ground level) between 50 and 250 cm
Trunk inclination	Each exposition (N, E, S, W) has an inclination (at the center of each grid) <20°
Bark damage	The area of the trunk that is unsuitable for recording (damage, decortication, branching, knots and/or other epiphytes or climbing plants such as ivy, preventing growth of lichens) within each of the 4 grids when summed <20 %

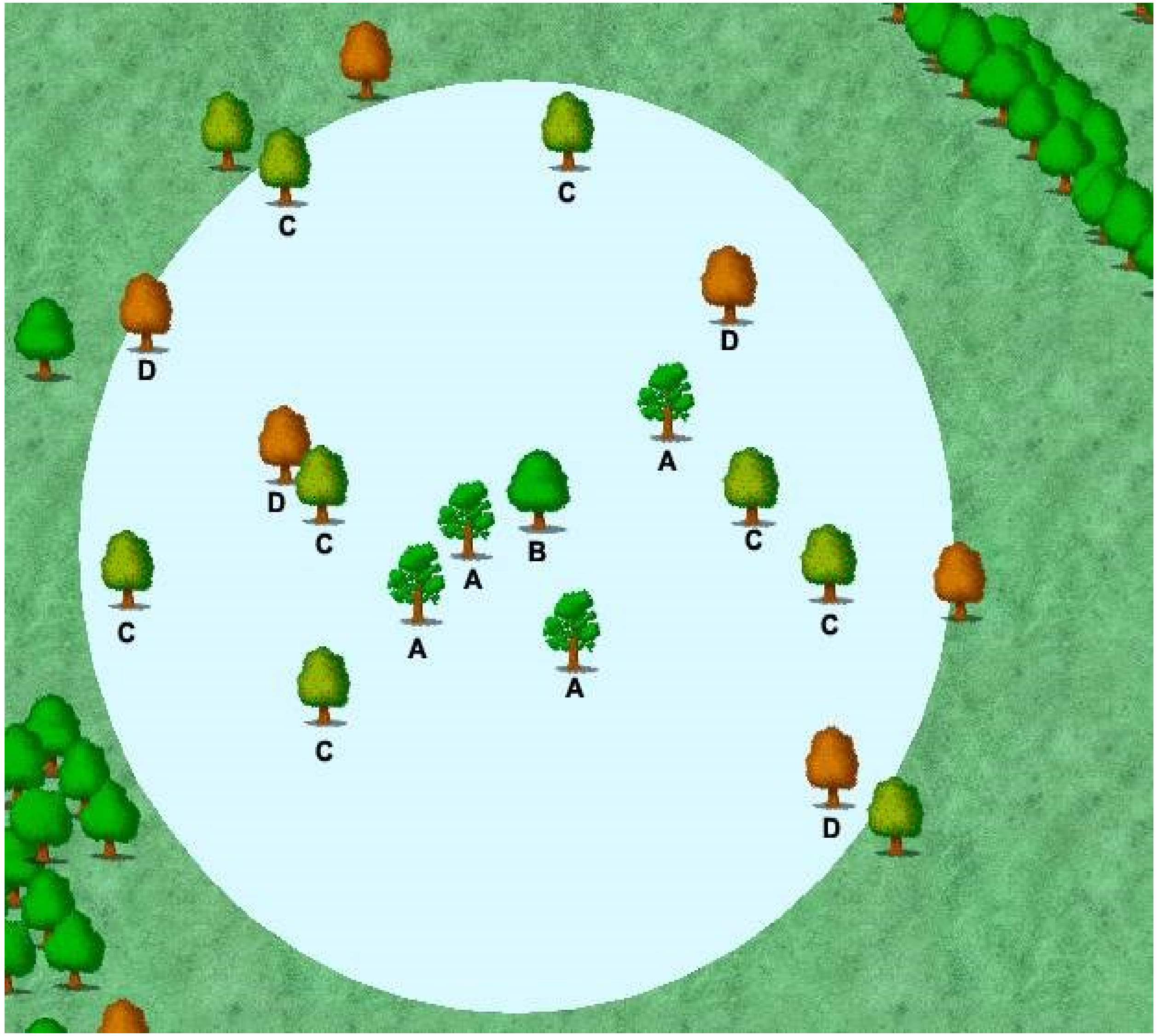
Elements of variability: the tree species

Table C.1 — Suitable tree species

Group I	Group II	Group III	Group IV	Group V	To be tested	Excluded
Acer spp.	*Olea spp.*	*Abies alba*	*Alnus glutinosa*	*Fagus spp.*	*Robinia pseudoacacia*	Araucaria spp.
Ceratonia siliqua	*Prunus spp.*	*Larix decidua*	*Betula pendula*	*Carpinus spp.*	*Ailanthus altissima*	Platanus spp.
Fraxinus spp.	*Quercus spp.*	microthermic *Pinus spp.*			*Celtis spp.*	*Taxus baccata*
Juglans spp.	*Castanea sativa*	*Picea abies*			*Salix spp.*	*Cycas spp.*
Pyrus communis[a]				*Ostrya carpinifolia*	"Palms"	
Tilia spp.[a]				*Cupressus sempervirens*	mediterranean *Pinus spp.*	
Ulmus spp.	*Malus spp.*				*Alnus cordata*	
Populus spp.	*Ostrya carpinifolia*				*Ginkgo biloba*	
Ficus spp.	*Sorbus spp.*				*Magnolia spp.*	
					Citrus spp.	
					Crataegus spp.	
					Pseudotsuga menziesii	
					"other exotic cultivated plants"	
					Any other species not explicitly reported in Table C.1	

[a] According to VDI Guidelines indications ([29], [30]) *Tilia spp.* and *Pyrus communis* can be used in both groups because they hold a middle position with regard to their bark properties.

Elements of variability: the tree species



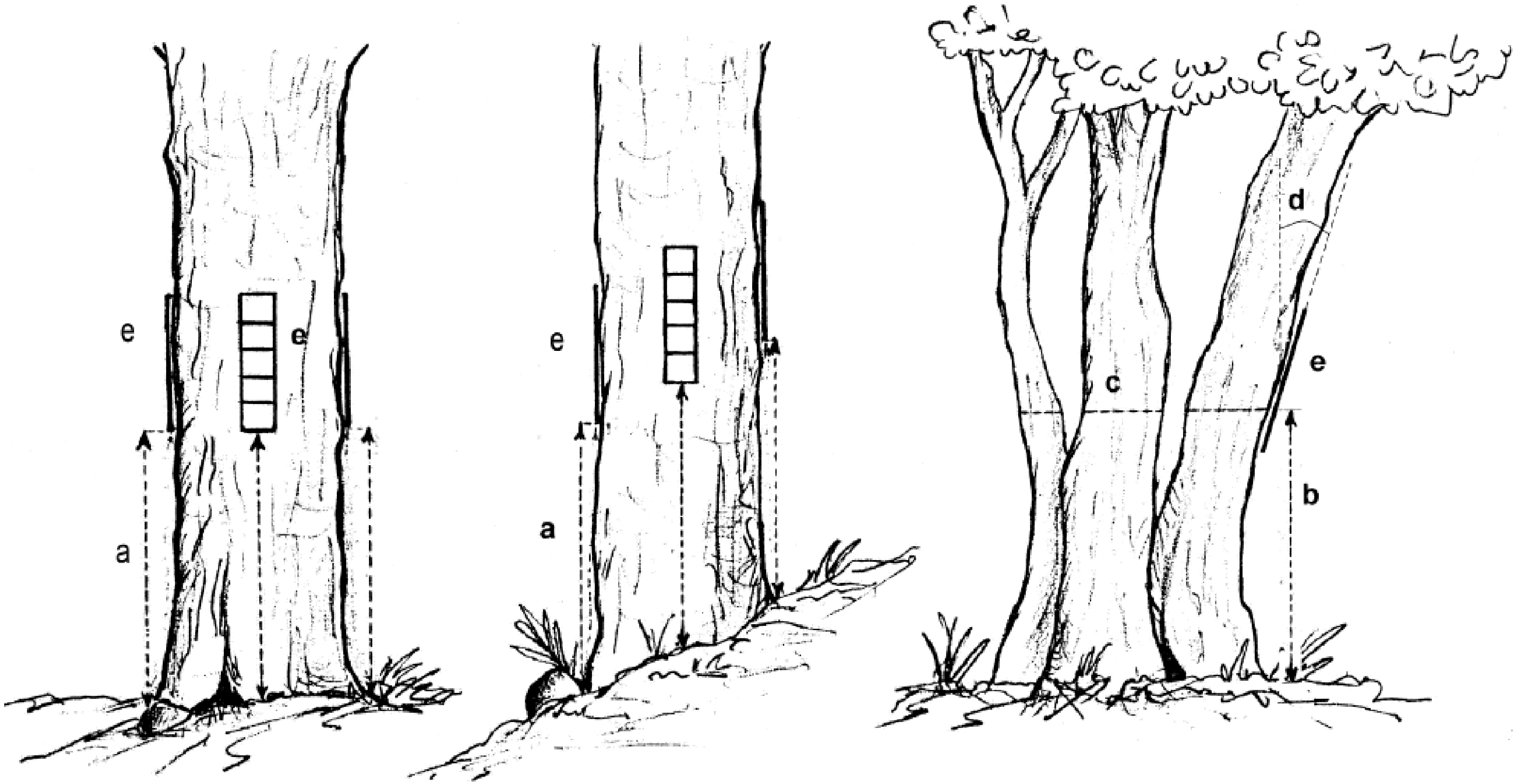
When choosing tree species (in preference order):

i. A single tree species within the whole study area (e.g. A).

ii. Different tree species, within the same bark-type group (e.g. A and B).

iii. Different tree species within different bark-type groups (e.g. A, B and C), excluding unsuitable taxa, e.g. some Conifers, *Platanus* - D).

Elements of variability: the individual trees



Società Lichenologica Italiana

XXVII Convegno Annuale

Montecatini Terme, 15-17/10/2014

Iscrizione

Invio abstract

Date da ricordare:
- **31 Maggio 2014**: scadenza invio riassunti poster/comunicazioni orali
- **20 Giugno 2014**: comunicazione accettazione contributi
- **30 Giugno 2014**: scadenza registrazione e pagamento quota iscrizione
- **30 Giugno 2014**: pubblicazione programma definitivo

- La SLI
- Attività
- Bandi
- Gruppi di Lavoro
- Pubblicazioni
- Home page soci
- Personalia
- Comunicare con la SLI
- Sezione riservata

Mi piace Piace a 42 persone.

Tweet

La Società Lichenologica Italiana

La Società Lichenologica Italiana (S.L.I.) è dedicata alla diffusione e al progresso degli studi lichenologici in Italia.
La S.L.I. ogni anno organizza un convegno, corsi introduttivi e di specializzazione, riunioni scientifiche, escursioni e pubblica un Notiziario.
La S.L.I. collabora con altre società scientifiche aventi finalità analoghe, sia in Italia che all'estero.

The Italian Lichen Society (S.L.I.) is devoted to the diffusion and progress of lichenological studies in Italy.
The S.L.I. every year organizes a congress, introductive and specialization courses, scientific meetings, field excursions and publishes a bulletin.
The S.L.I. cooperates with other scientific societies having similar aims, both in Italy and abroad.

http://www.lichenologia.eu/

News

2014-04-29

Disponibile la locandina definitiva del Workshop "PROBLEMATICHE DI DETERIORAMENTO LICHENICO: PERCEZIONE E ASPETTATIVE DA PARTE DELLE ISTITUZIONI", che si terrà a Brescia nei giorni 8 e 9 maggio 2014.
http://www.lichenologia.eu/pdeffi/locandina_Brescia_def.pdf

Gruppo di Lavoro per il Biomonitoraggio

Coordinatore: Paolo Giordani - email: biomonitoraggio@lichenologia.eu

URL:

Il gruppo di lavoro nasce per condividere e promuovere attività di biomonitoraggio mediante i licheni. Il gruppo è aperto a tutti i soci che manifestino interessi in tale ambito.
Attraverso le attività del GdL ci si propone di:
- far conoscere le potenzialità dei licheni negli studi di biomonitoraggio (bioindicazione e bioaccumulo);
- sviluppare e testare procedure operative standard di bioindicazione e bioaccumulo mediante licheni attraverso la partecipazione attiva a processi di normazione presso enti di certificazione nazionali (UNI, AFNOR) e internazionali (CEN, ISO);
- promuovere corsi nazionali e internazionali di formazione e aggiornamento.

2013-09-11

Relazione annuale delle attività del Gruppo di Lavoro: 2013
Documenti relativi a questa attività (pdf)

2012-09-10

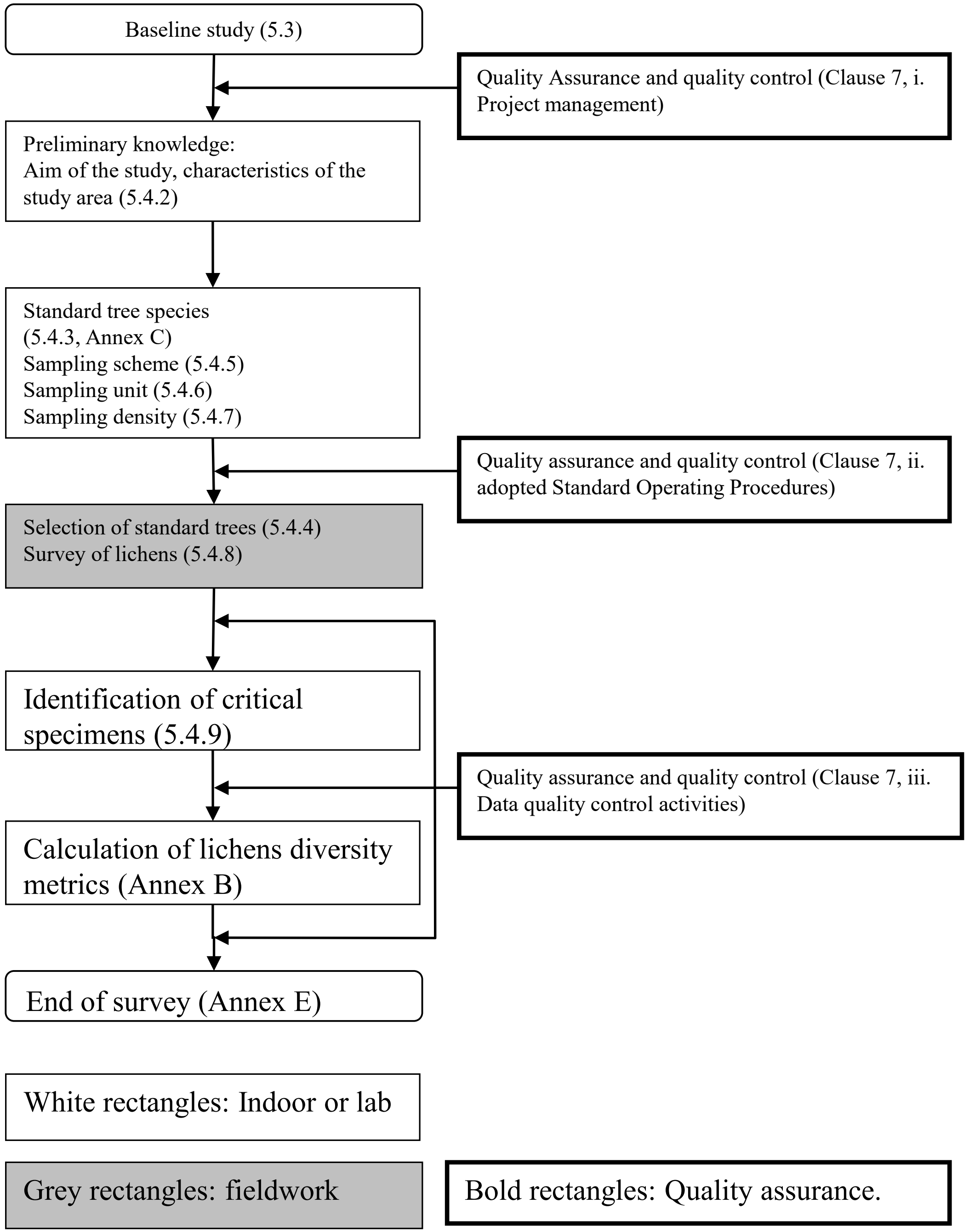
Relazione annuale delle attività del Gruppo di Lavoro
Documenti relativi a questa attività (pdf)

Biomonitoring in environmental litigation
Research to support standardization

- Greater objectivity, with the verification of some sampling methods on a probabilistic basis.
- Study of the between-site spatial variability of lichen diversity for the optimization of sample size.
- Investigation of within-site variability for the definition of natural background noise, to obtain a better interpretation of the data.
- Definition of Quality Assurance procedures to evaluate and minimize non-sampling errors due to operators.
- Interpretation of data

- Cline, S.P., Burkman, W.G. (1989). *The role of quality assurance in ecological programs*. In: Bucher, J.B., Bucher-Wallin, J. (Eds.): Air pollution and forest decline. IUFRO, Birmensdorf, 361 pp.
- EPA (2002). Guidance for Quality Assurance Project Plans. EPA QA/G-5.

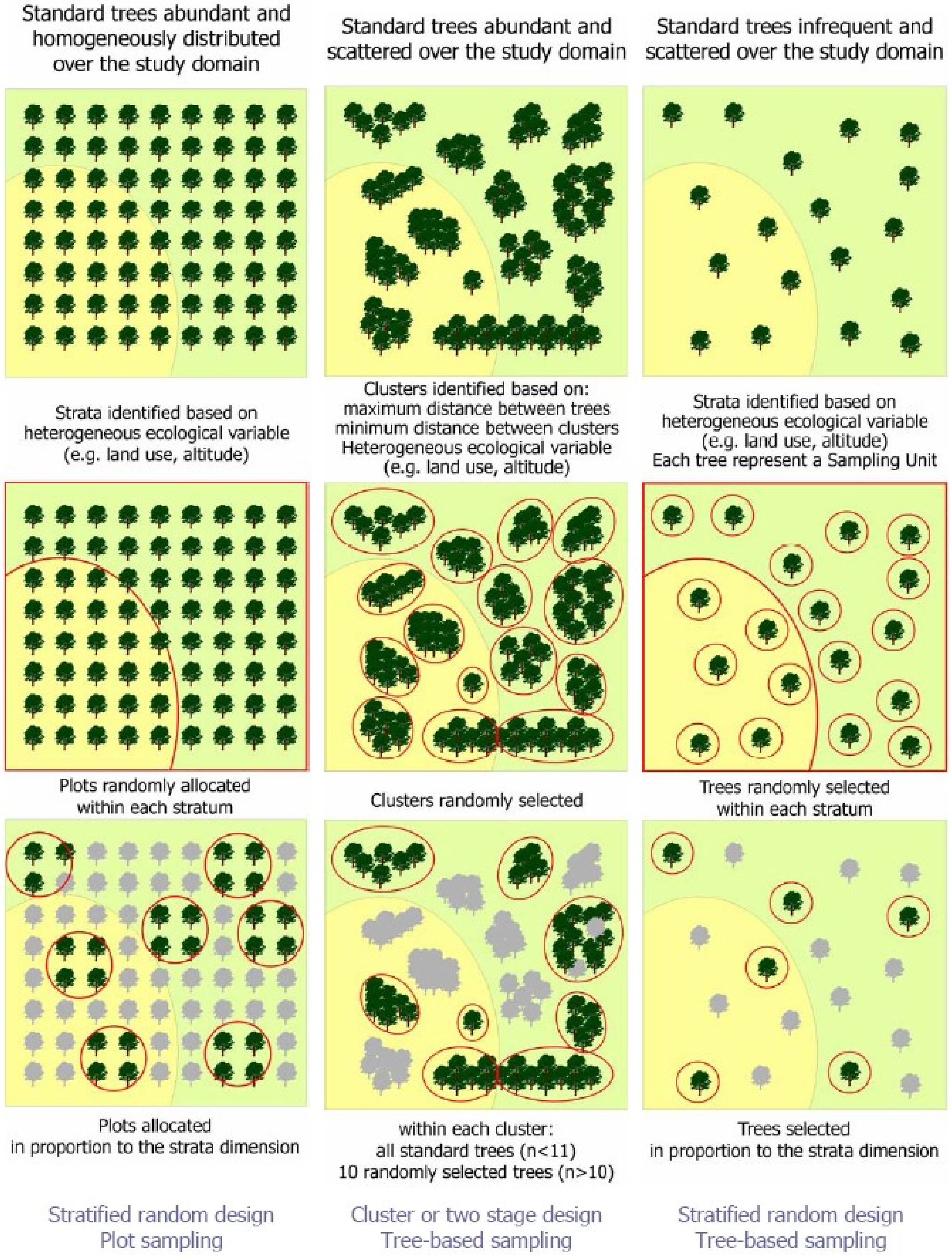
- Brunialti, G., Giordani, P., Ferretti, M. (2004). *Discriminating between the good and the bad: quality assurance is central in biomonitoring studies*. In: Wiersma, B. (Ed.): Environmental Monitoring. CRC Press LLC, pp. 443-464.
- Brunialti, G., Giordani, P., Isocrono, D., Loppi, S. (2002). *Evaluation of data quality in lichen biomonitoring studies: the Italian experience*. Environmental Monitoring and Assessment 75, 271-280.


Baseline study (5.3)
Quality Assurance and quality control (Clause 7, i. Project management)
Preliminary knowledge:
Aim of the study, characteristics of the study area (5.4.2)
Standard tree species
(5.4.3, Annex C)
Sampling scheme (5.4.5)
Sampling unit (5.4.6)
Sampling density (5.4.7)
Quality assurance and quality control (Clause 7, ii. adopted Standard Operating Procedures)
Selection of standard trees (5.4.4)
Survey of lichens (5.4.8)
Identification of critical specimens (5.4.9)
Quality assurance and quality control (Clause 7, iii. Data quality control activities)
Calculation of lichens diversity metrics (Annex B)
End of survey (Annex E)
White rectangles: Indoor or lab
Grey rectangles: fieldwork
Bold rectangles: Quality assurance.

Biomonitoring in environmental litigation

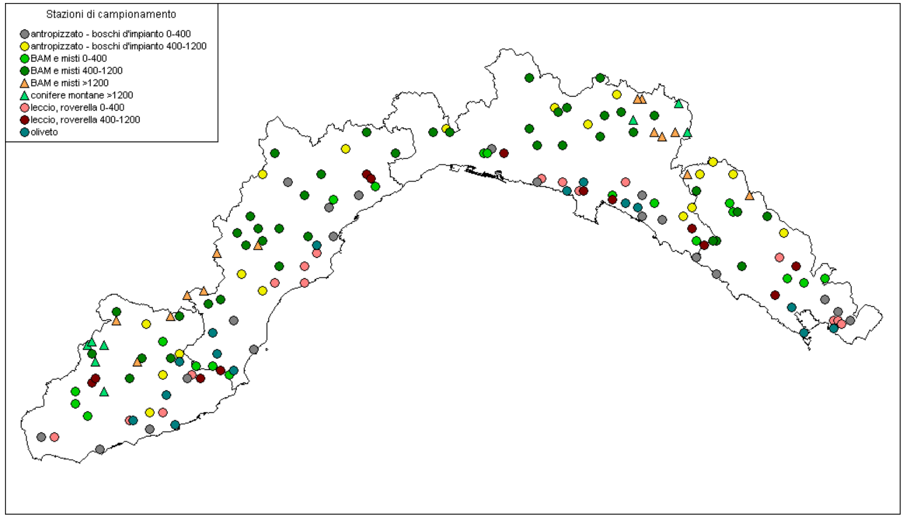
Standardization of sample designs

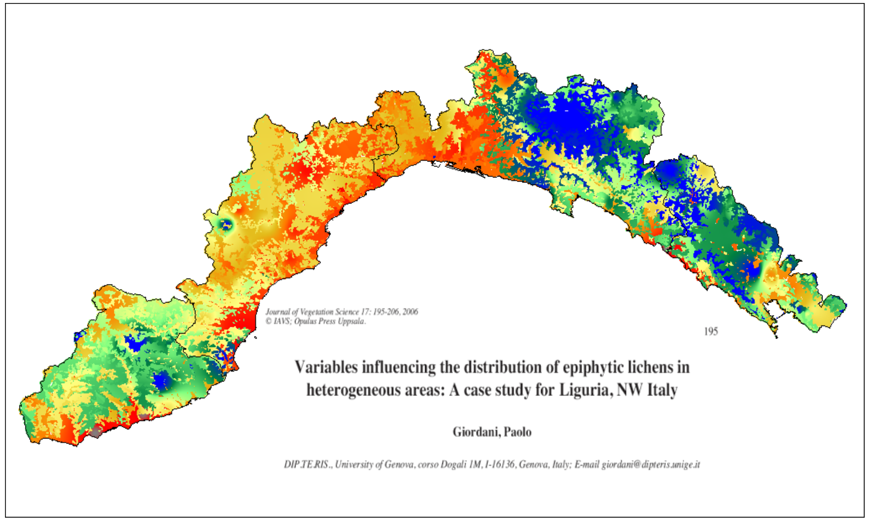
Sampling schemes in ecologically heterogeneous areas



From preferential to probabilistic sampling

Preferential sampling





Probabilistic sampling

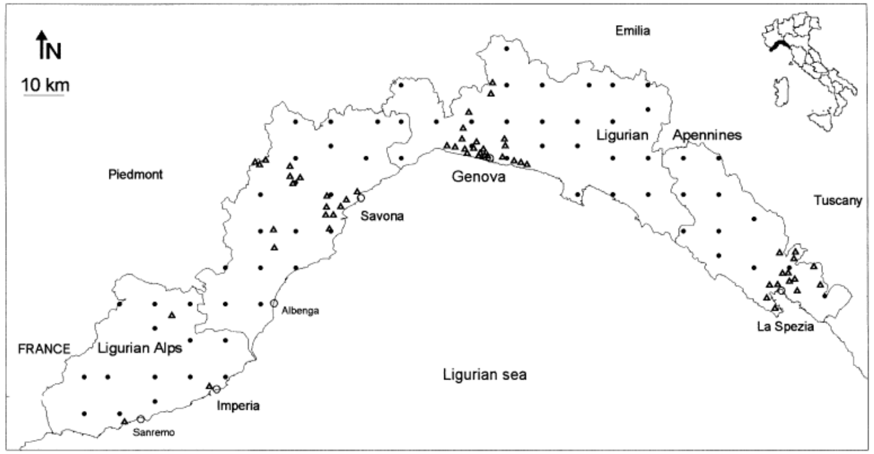
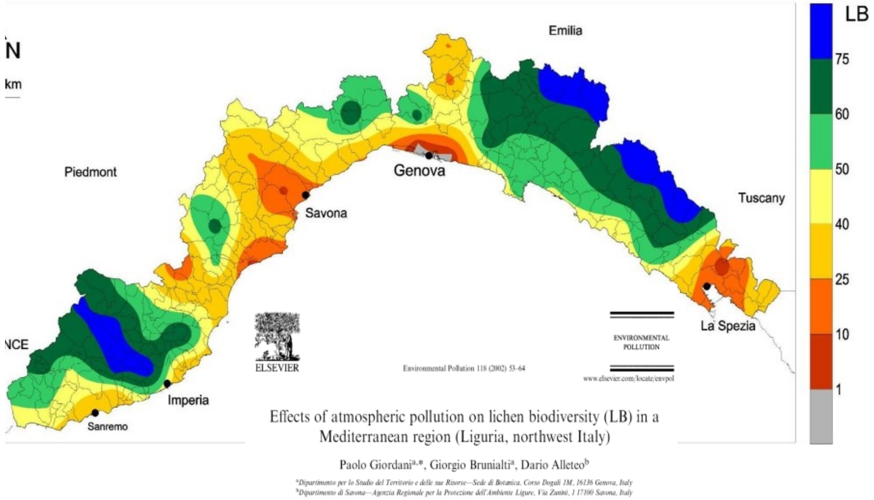
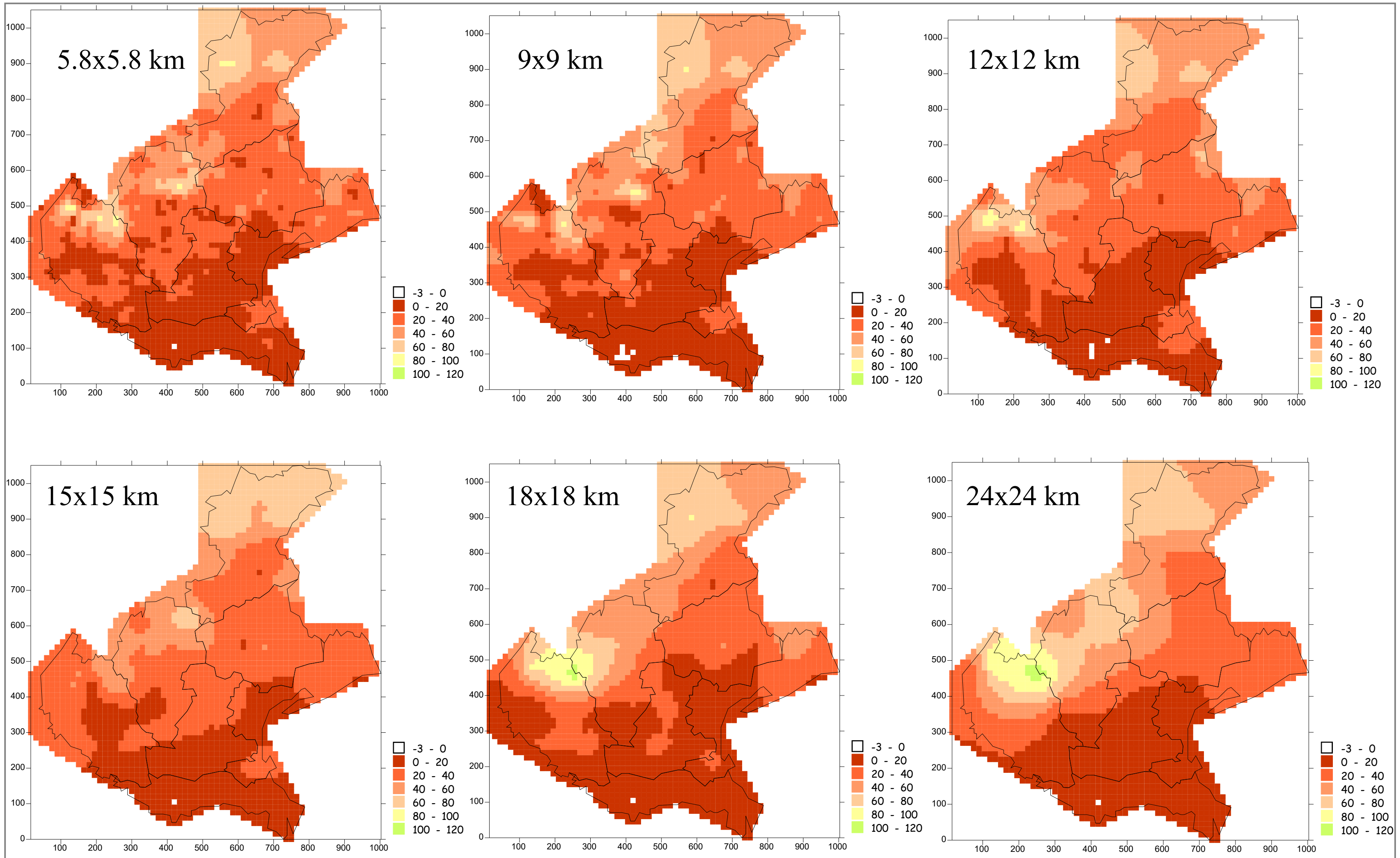


Fig. 1. Survey area: Liguria Region, Italy. Location of the 69 sampling stations in correspondence of the 9×9 km grid (black spots) and of the 50 automatic gauges (triangles).



Biomonitoring in environmental litigation

Spatial variability 'between sites'



ELSEVIER

Available online at www.sciencedirect.com

SCIENCE @ DIRECT®

Environmental Pollution 127 (2004) 249–256

ENVIRONMENTAL POLLUTION

www.elsevier.com/locate/envpol

Reliability of different sampling densities for estimating and mapping lichen diversity in biomonitoring studies

M. Ferretti[a,*], E. Brambilla[a], G. Brunialti[b], F. Fornasier[c], C. Mazzali[a], P. Giordani[b], P.L. Nimis[d]

The application of the bioindication method with lichens in its first forms (IAP18, IBL) immediately met with great success.
Since the early days, values (in themselves continuous) were represented on the basis of an attribution to scales divided into classes, originally defined empirically, and associated with different colors (and definitions) to allow an effective graphic representation.

In their original interpretation, these scales had a certain reference in the "zero" value represented by the so-called "lichen desert", while the highest class, particularly large, remained undetermined in its absolute maximum value.

For a decade, each operator proposed the most varied classes, associating them with non-standardised colours, creating quite a bit of confusion when comparisons were made between the various studies, also because not all of them reported the values for individual stations.

Workshop "Biomonitoraggio della qualità dell'aria sul territorio nazionale"
Roma, 26-27 novembre 1998

With the publication of the proceedings of this workshop it is proposed to standardize:

- CLASS SIZE (n=7)
- DEFINITIONS OF THE SAME CLASSES in terms of NATURALITY/ALTERATION
- ASSOCIATED COLORS FOR THE CARTOGRAPHIC REPORT
- DEFINITION OF RANGES DEFINED ON A STATISTICAL BASIS

6. Interpretazione e presentazione dei risultati

6.1 - Nella valutazione dei valori di BLs a fini di biomonitoraggio, si propone la seguente scala, ricavata da numerosi studi precedenti svolti in Italia, divisa in sette classi che esprimono il grado di deviazione da condizioni "naturali" (non inquinate):

1) naturalità molto alta: valori di BLs maggiori di 50.
2) naturalità alta: valori compresi tra 41 e 50.
3) naturalità media: valori compresi tra 31 e 40.
4 naturalità bassa/alterazione bassa: valori compresi tra 21 e 30.
5) alterazione media: valori compresi tra 11 e 20.
6) alterazione alta: valori compresi tra 1 e 10.
7) alterazione molto alta: BLs pari a 0 (deserto lichenico) .

Questa scala è valida per aree site nella fascia submediterranea (vegetazione potenziale: boschi con querce decidue). Scale relative alla fascia mediterranea, a quella montana (vegetazione potenziale: boschi di faggio), o a eventuali ulteriori suddivisioni fitoclimatiche del Paese verranno introdotte non appena sufficientemente calibrate sulla base dei progressi della ricerca.

Nimis P.L., Linee-guida per la bioindicazione degli effetti dell'inquinamento tramite la biodiversità dei licheni epifiti. In: Atti del Workshop… AMPA, Atti 2, 1999

La presentazione cartografica dei risultati ha due scopi principali:

1) fornire una suddivisione del territorio in aree con biodiversità lichenica diversa, ove le differenze tra fasce devono essere statisticamente significative;

2) visualizzare la struttura dei dati, evidenziando eventuali patterns geografici.

Per il primo scopo, il più rilevante a fini applicativi, non è sempre possibile suddividere il territorio in fasce corrispondenti esattamente alle classi riportate al punto precedente. L'ampiezza delle fasce dipende infatti dalla variazione della BLs nella specifica area di studio dal numero di alberi esaminati per ogni stazione.

Per fornire un prodotto affidabile, l'ampiezza delle fasce deve essere tale che fasce non contigue siano statisticamente diverse. Un esempio di definizione corretta dell'ampiezza delle fasce è proposto da Wirth (1995):

· L'ampiezza delle fasce va determinata sulla base della deviazione standard media di tutte le stazioni, e si ricava dalla seguente formula:

$$t_p \frac{S_p}{\sqrt{n_p}}$$

dove:

Sp è la deviazione standard media di tutte le stazioni
np è il numero medio di rilievi per stazione
tp è il valore critico della distribuzione di Student per *np*-1 gradi di libertà.

Una carta che suddivida il territorio in fasce la cui ampiezza è stata determinata con questa procedura va sempre allegata ai risultati.

BL	CLASSI
>50	1 nat. molto alta
46-50	2 nat. alta
41-45	2 nat. alta
36-40	2 nat.alta
31-35	3 nat. media
26-30	3 nat. media
21-25	4 nat./alter.bassa
16-20	4 nat./alter.bassa
11-15	5 alter.media
6-10	6 alter.alta
1-5	6 alter.alta
0	7 alter.molto alta

Inevitably, with the increase in the number of investigations also extended to non-urban environments, we realized that:

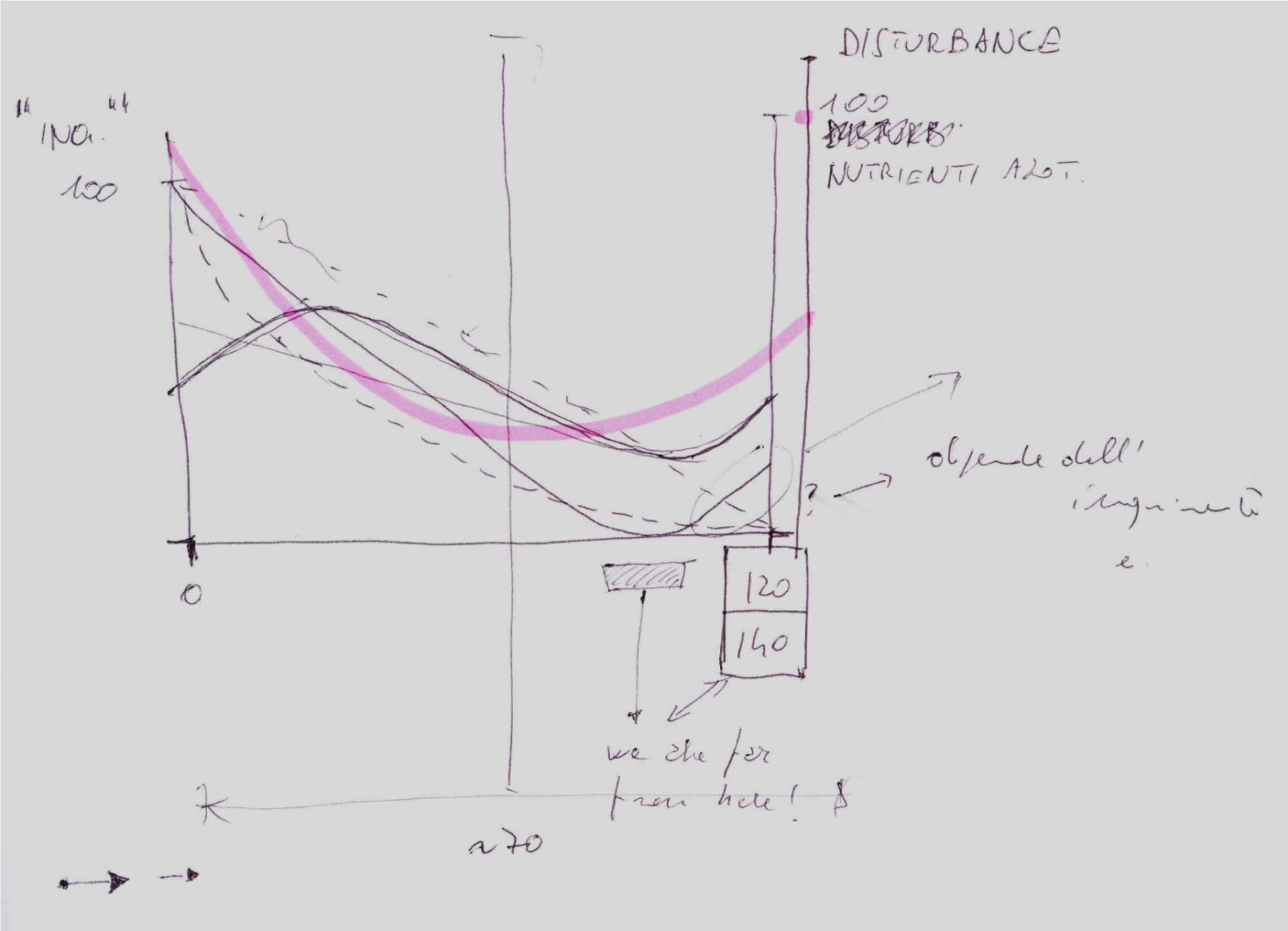
1. in relatively remote areas, particularly in forest environments, the values were often "surprisingly" low (the environmental typology is very different, many ecological factors can intervene to limit the development of lichen vegetation...).

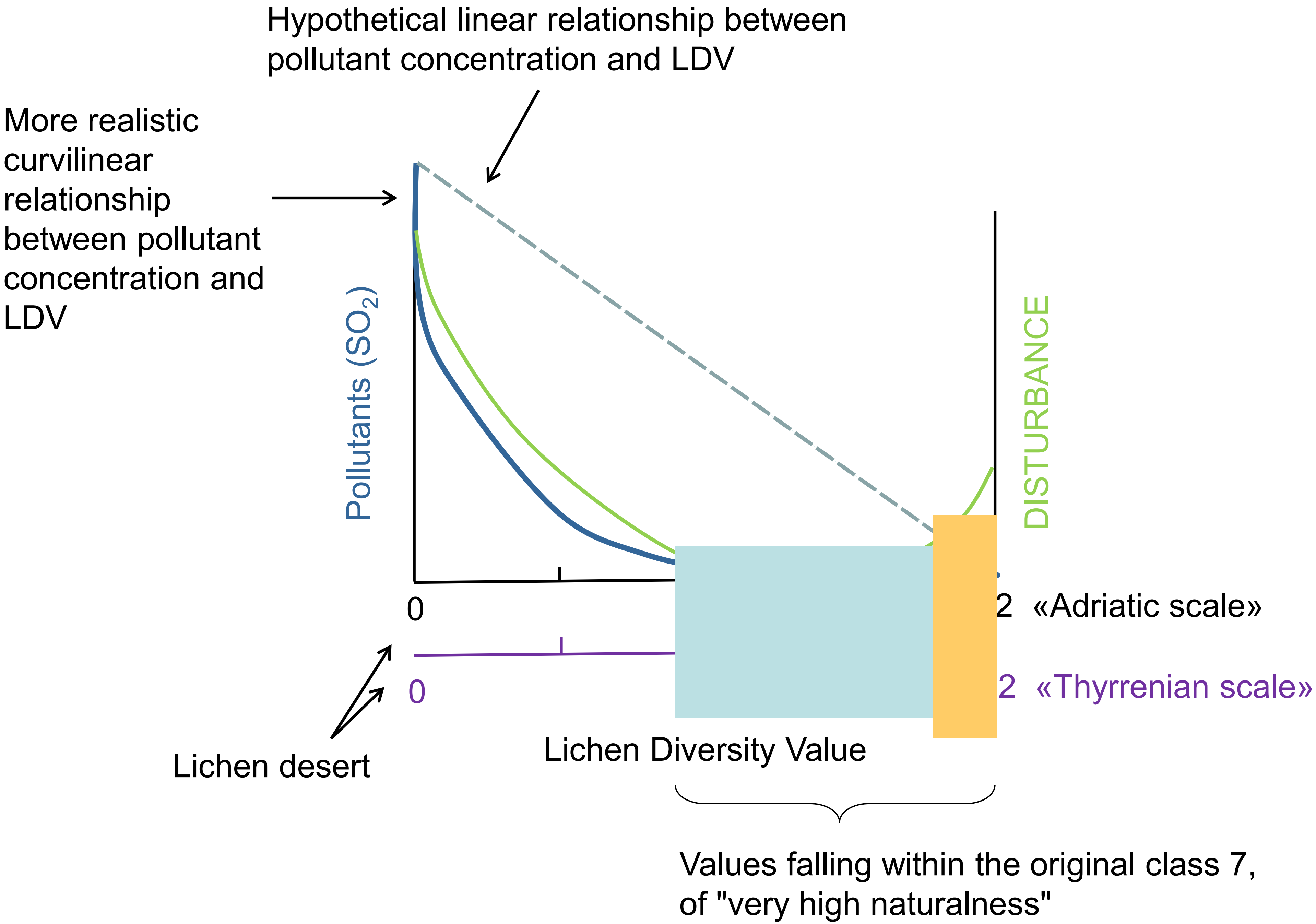
2) However, there are substantial differences in the maximum values that can be recorded in the different areas of the country ("who finds the highest value? And where?"). Strong differences in the maximum values were reported from different areas of our country, because also the climate has its own effect on the LDVs.

3) The maximum values are typical of a rural landscape with relatively isolated trees or trees present in poorly closed (therefore bright) forest consortia, characterized by a slight anthropic disturbance; an inevitable consequence was the extension of the scale to higher values, previously included in the definition of "high naturalness" because they were higher than 50 (>50).

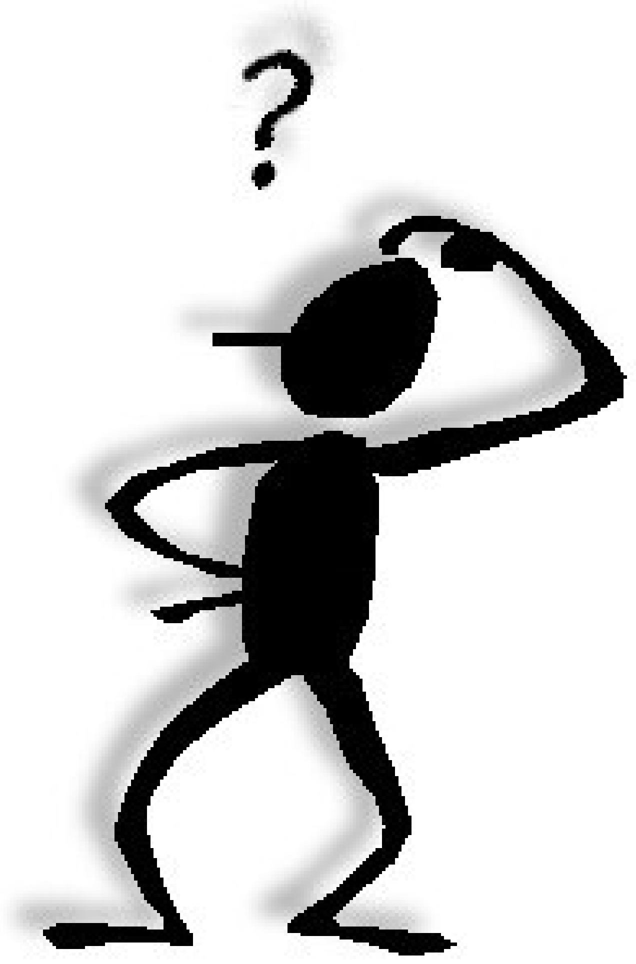
…...but is it correct to consider the highest LDV values found in a territory as those that describe the "maximum" naturalness?

In other words, are we sure that the maximum LDV is necessarily associated with the total absence of anthropic disturbance?




Hypothetical linear relationship between pollutant concentration and LDV
More realistic curvilinear relationship between pollutant concentration and LDV
Pollutants (SO_2)
DISTURBANCE
0
2 «Adriatic scale»
0
2 «Thyrrenian scale»
Lichen desert
Lichen Diversity Value
Values falling within the original class 7, of "very high naturalness"

IBL	Classi
>120	Alterazione trascura
80-120	Alterazione bassa
41-80	Alterazione modera
1-40	Alterazione alta
0	Alterazione molto a



	Valori BL	Colore
alta	> 75	Blu
	61 - 75	Verde scuro
	46 - 60	Verde chiaro
er. Bassa	31 - 45	Giallo
a	16 - 30	Arancione
	1 - 15	Rosso
alta	0	Cremisi

aturalità/alterazione in relazione ai valori di BL

Classi	Sottoclassi		
1. Naturalità	1.Naturalità		
2. Semi -naturalità	2a.Naturalità media		
	2b.Naturalità bassa		
3.Semi -alterazione	3a.Alterazione bassa		
	3b.Alterazione media		
4. Alterazione	4a.Alterazione alta	16-40	Rosso chiaro
	4b.Alterazione molto alta	1-15	Rosso scuro
5.Deserto lichenico	5. Deserto lichenico	0	Grigio

Giordani, 2004

	Classe	Colore
	Naturalità molto alta	
	Naturalità alta	
	Naturalità media	
	Naturalità/alterazione bassa	
63-93	Alterazione media	
32-62	Alterazione alta	
0-31	Alterazione molto alta	

But what does the CEN standard say?

CEN/TC 264
Date: 2012-03
prEN 16413:2012
CEN/TC 264
Secretariat: DIN

Air quality — Biomonitoring with lichens — Assessing epiphytic lichen diversity
Luftqualität — Biomonitoring mit Flechten — Kartierung der Diversität epiphytischer Flechten
Qualité de l'air — Biosurveillance à l'aide de lichens — Evaluation de la diversité de lichens épiphytes

Document type: European Standard

This document (prEN 16413:2012) has been prepared by Technical Committee CEN/TC 264 “Air quality”, the secretariat of which is held by DIN.

Contents

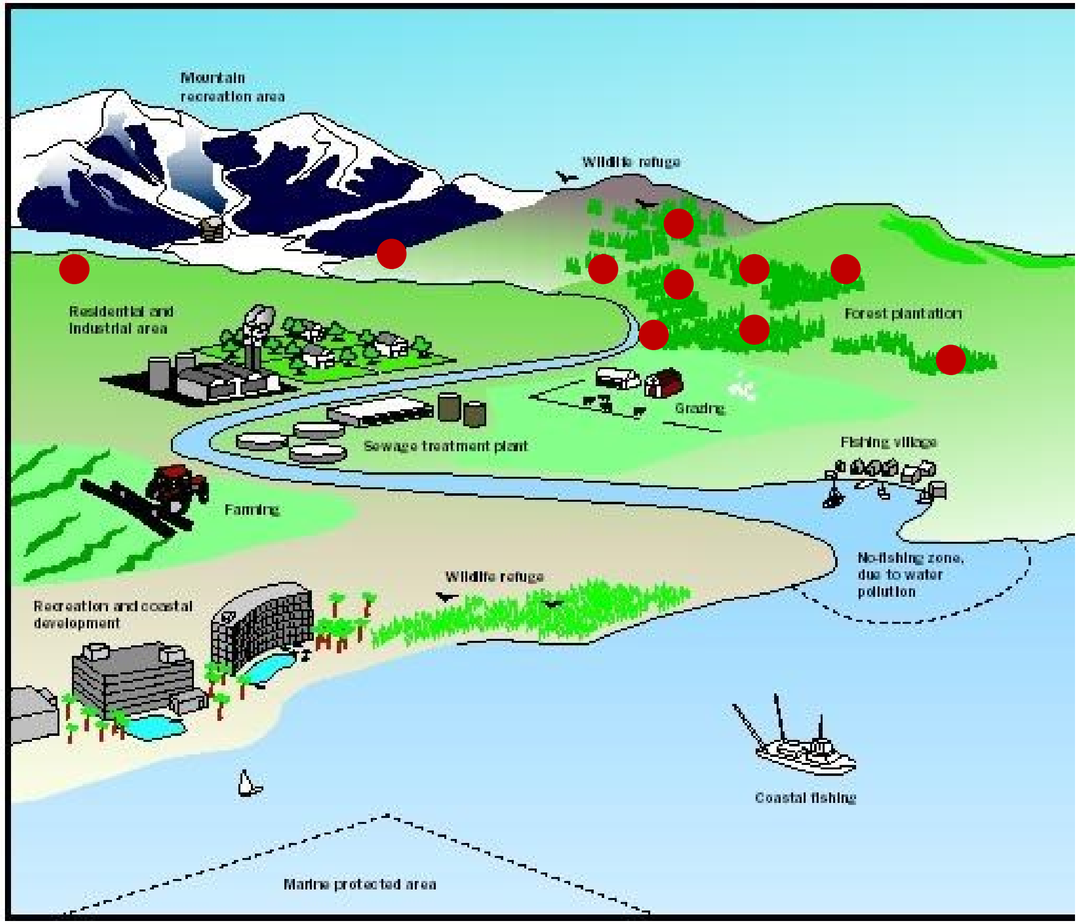
Page

Unfortunately, the CEN document says nothing about the interpretation of the results, simply because this topic was removed when no convergence was found between the participants at the technical discussion table.

Rather than proceed with a vote by strict majority, it was decided to postpone the production of an *ad hoc* document to a later date, which never arrived.

How to establish the level of "naturalness"?

It would seem logical to calculate an average value of n surveys carried out within a specific biogeographical area in remote, presumed near-natural areas.



The interpretation scale could be developed based on the percentage deviation from the level of naturalness.

The **current proposal**, not yet shared by everyone, is the following: taking into account the variability of biological data, the influence of the operator in data collection, the condition of naturalness would be included in a range of 25 percentage points, i.e. 0-25% deviation from average value of values higher than the 98th percentile of values observed in a large climatically homogeneous area.
In this way a scale of 4 or 5 classes would be obtained which in turn could be divided into smaller intervals

TABLE 1. Scale of deviation from naturality.

% deviation from natural conditions	Interpretation
100	Lichen desert
75–99	Alteration
50–75	Semi-alteration
25–50	Semi-naturality
0–25	Naturality