Organisms? Better species…

Spugnòla

Erba di Sileno
Sclopit
Grisol
Schioppettini
…

Lombrico

Organisms? Better species…

Spugnòla

Morchella esculenta (L.) Pers.

Erba di Sileno

Sclopit

Grisol

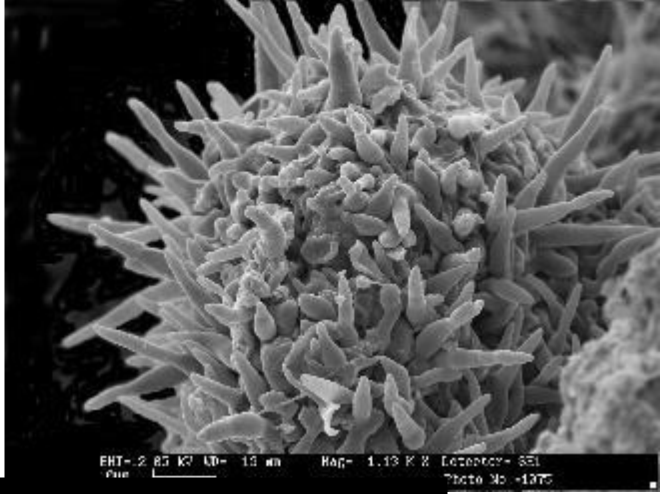
Schioppettini

Silene nutans L.

Lombrico

Lumbricus terrestris L.

What can you find in the web by typing the common name and what by typing the scientific name?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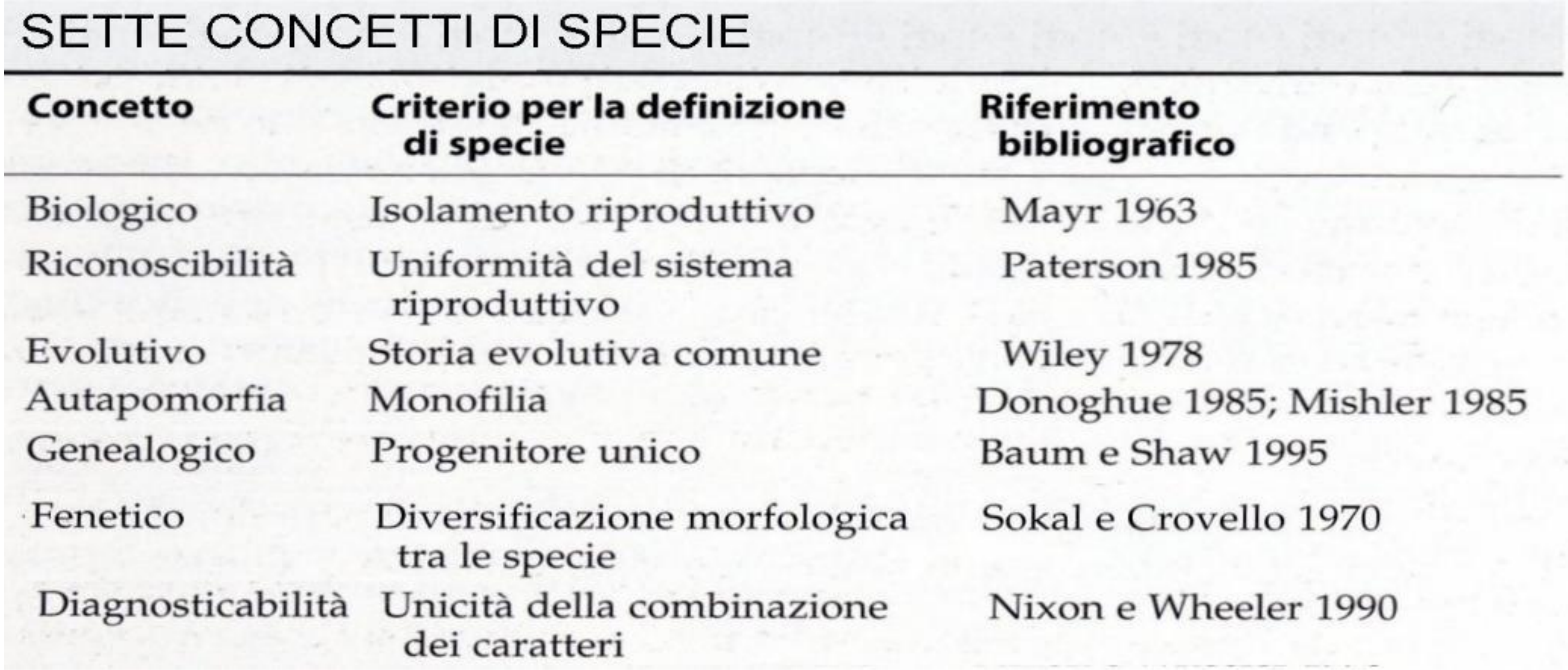
At least seven different SPECIES concepts apply in Biology



SETTE CONCETTI DI SPECIE

	Concetto	Criterio per la definizione di specie	Riferimento bibliografico
A	Biologico	Isolamento riproduttivo	Mayr 1963
	Riconoscibilità	Uniformità del sistema riproduttivo	Paterson 1985
B	Evolutivo	Storia evolutiva comune	Wiley 1978
	Autapomorfia	Monofilia	Donoghue 1985; Mishler 1985
	Genealogico	Progenitore unico	Baum e Shaw 1995
C	Fenetico	Diversificazione morfologica tra le specie	Sokal e Crovello 1970
	Diagnosticabilità	Unicità della combinazione dei caratteri	Nixon e Wheeler 1990

A = Biological/reproductive concept **C = Morphological concept**

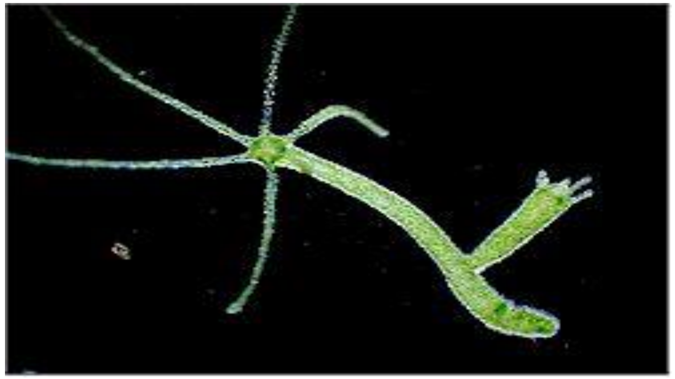
B = Evolutionary concept

This **BIOLOGICAL** concept of species emphasizes the importance of populations of individuals interconnected by genetic exchanges that occur following sexual reproduction, and which give rise to unlimitedly fertile offspring.

The guiding criterion is therefore the **REPRODUCTIVE ISOLATION** of the species compared to other species.

Sexual reproduction:
FUSION OF GAMETES (reproductive cells: e.g. egg cell + sperm)

Vegetative propagation:
From the name it is clear that it is particularly frequent among plant organisms.



- budding (e.g. in Hydra, but also in yeast cells);
- division or fragmentation of the individual mother;
- production of vegetative propagules;
- production of structures such as stolons, bulbils, rhizomes, etc.
- “apomixis””

Inapplicability for extinct organisms

"phylogenetic" or "evolutionary" species concept

"A species is a single lineage of populations formed by progenitor-descendants that is distinct from other lineages and which has its own evolutionary tendencies and a well-defined historical destiny."

Simpson 1951, 1961; Wiley, 1978

This broad definition is intended to define species in terms of evolutionary processes and has the advantage of including both living and extinct organisms, regardless of their reproductive modes.

This definition finds strong support from phylogenetic reconstructions based on genetic analysis

This definition of species has relatively recent roots: the idea of evolution appeared towards the second half of the 17th century, and only after the second half of the 19th century was it widely accepted. In previous times, on the contrary, it was believed that species were IMMUTABLE, having been created by God. Linnaeus himself, the most important systematist of the 18th century, and the young DARWIN supported the idea of the FIXITY of species.

The strongest objection concerns the fact that this concept is difficult to use when trying to identify species in nature, because the criteria - "evolutionary trends" and "historical fate" are at best vague and difficult to know.

The concept of "morphological" species

It is the basis of the oldest and most frequently used method for recognizing species; it is the one used daily by all of us.

"The smallest set of natural populations permanently separated from others by a distinct discontinuity of character."

Du Rietz 1930; Cain 1954; Mayr 1963; Shaw 1964

Problematic aspects of this species definition:

1) The comparative criteria underlying this species definition may not reflect the actual phylogenetic relationships between organisms (A and B are similar in those characters, but may NOT even be related [lookalike experience]).

2) The application of this definition leads, for example, to underestimating the frequency of the so-called CRYPTICAL species ("hidden" species), so defined because they are morphologically almost indistinguishable, often coexist in the same territory, but are genetically isolated from each other due to, for example, of a different reproductive biology.

Individual

Treccani:

The term individual (from the Latin individuus, "undivided, indivisible", composed of in- and dividuus, "divided", which corresponds etymologically to the Greek ἄτομος, composed of ἀ- privative and stem of τέμνω, "to cut") indicates every single entity as distinct from others of the same species.

In biology, an individual means any **animal or plant organism**, uni- or multicellular, which cannot be divided without (at the same time) losing its own structural and functional characteristics.

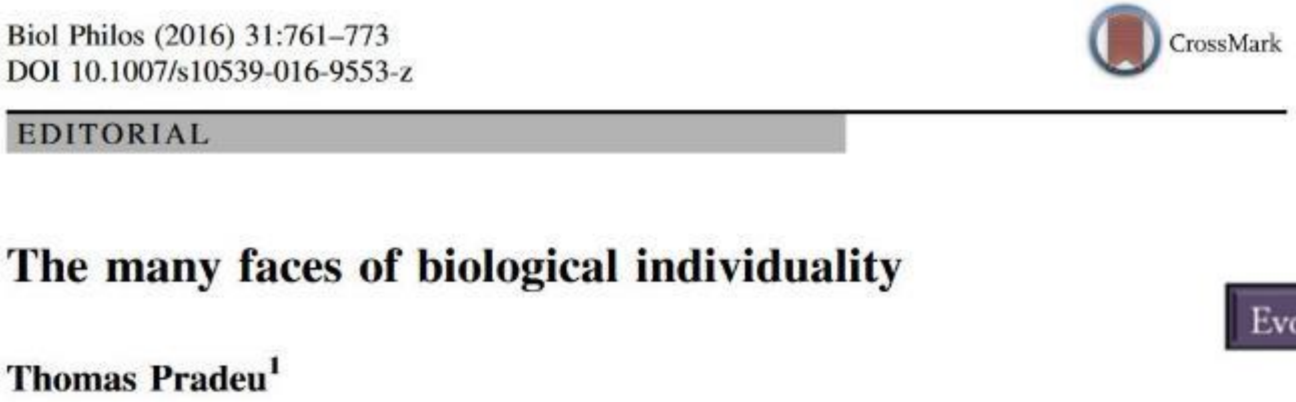
That is, every **animal or plant organism**, uni- or multicellular, which if divided would lose its own structural and functional characteristics.

Unitary organisms

Modular organisms

Is it always valid?

Individual



Biol Philos (2016) 31:761–773
DOI 10.1007/s10539-016-9553-z

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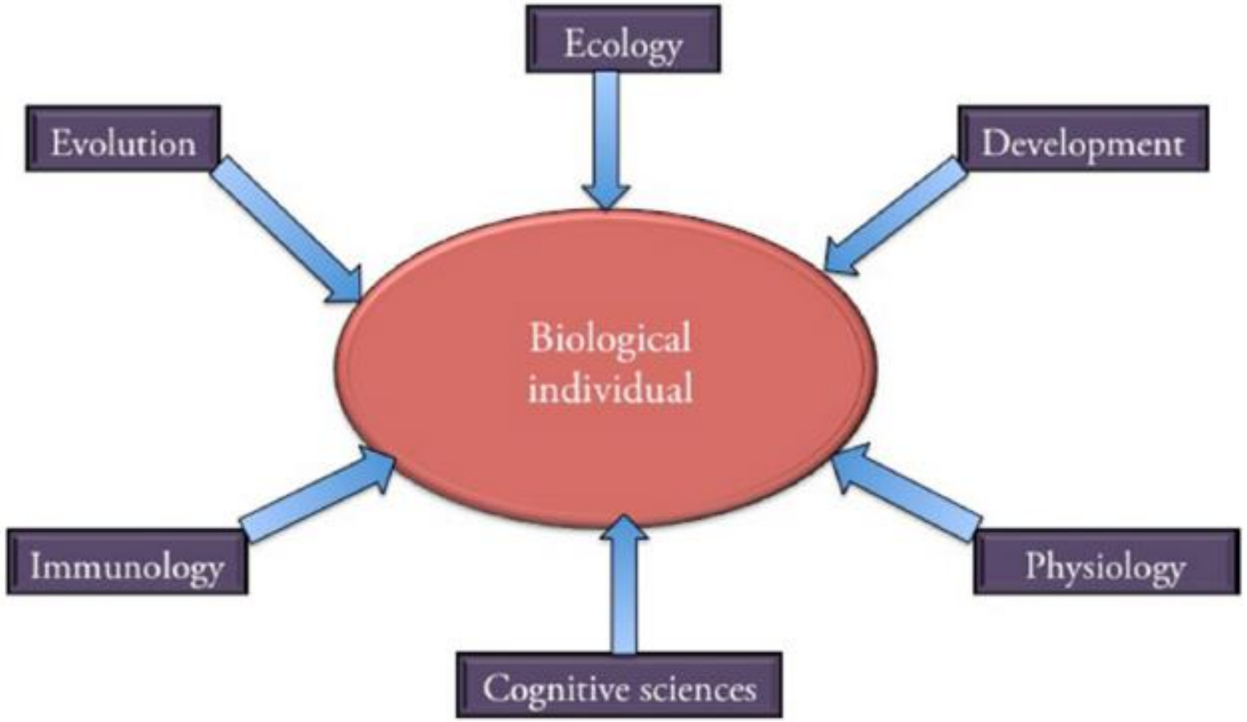
EDITORIAL

The many faces of biological individuality

Thomas Pradeu[1]



An accepted unifying concept/definition of biological individual does not exist

Many of the papers gathered in this special issue are interested in the monism–pluralism debate. Should we adopt several individuality criteria, or should we favor one criterion—and if so which one and with which arguments? Should we ground our concept of individuality in several biological domains or in one given domain—and, here again, if we opt for the monistic choice, on what basis should we do so?

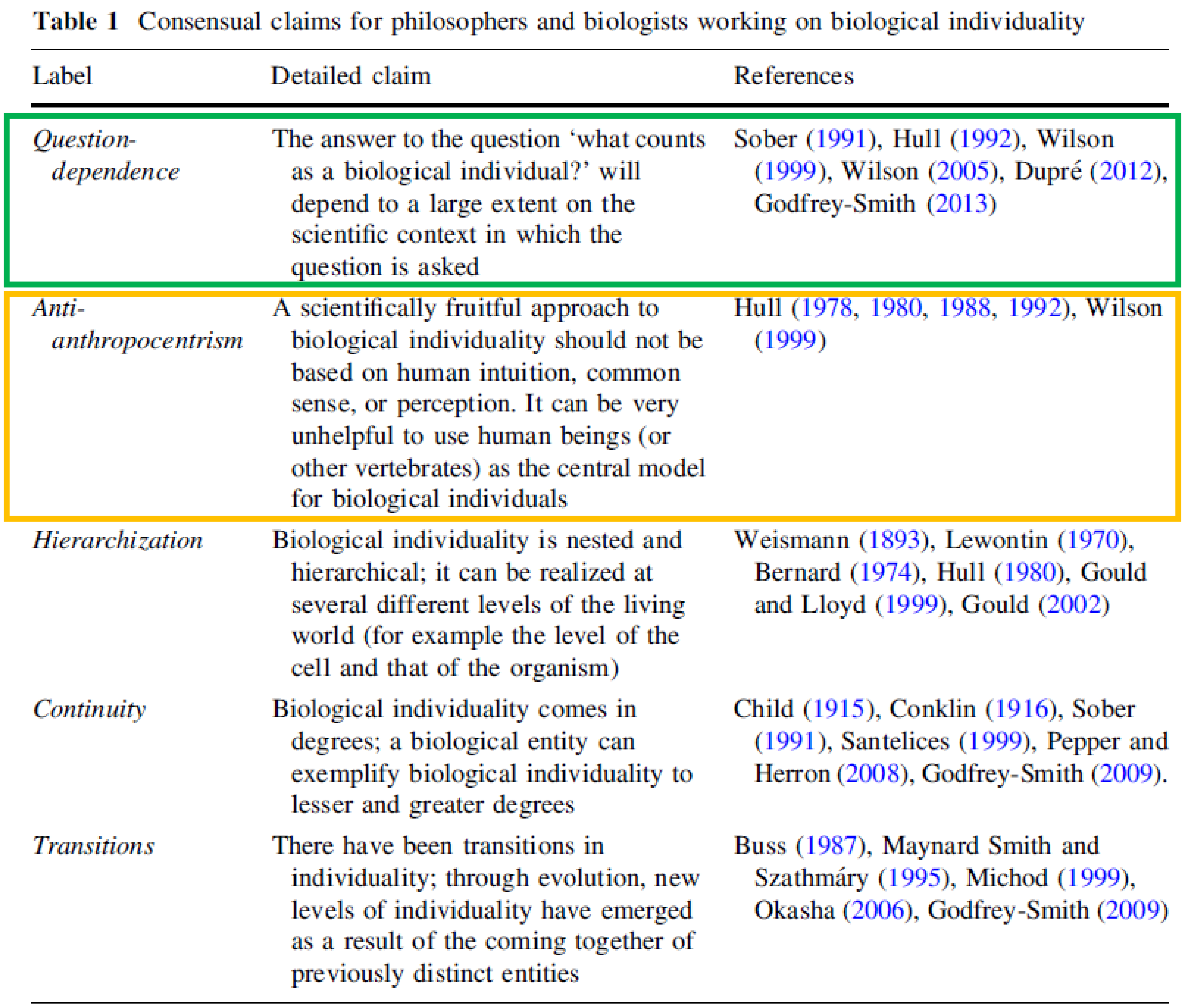


Table 1 Consensual claims for philosophers and biologists working on biological individuality

Label	Detailed claim	References
Question-dependence	The answer to the question 'what counts as a biological individual?' will depend to a large extent on the scientific context in which the question is asked	Sober (1991), Hull (1992), Wilson (1999), Wilson (2005), Dupré (2012), Godfrey-Smith (2013)
Anti-anthropocentrism	A scientifically fruitful approach to biological individuality should not be based on human intuition, common sense, or perception. It can be very unhelpful to use human beings (or other vertebrates) as the central model for biological individuals	Hull (1978, 1980, 1988, 1992), Wilson (1999)
Hierarchization	Biological individuality is nested and hierarchical; it can be realized at several different levels of the living world (for example the level of the cell and that of the organism)	Weismann (1893), Lewontin (1970), Bernard (1974), Hull (1980), Gould and Lloyd (1999), Gould (2002)
Continuity	Biological individuality comes in degrees; a biological entity can exemplify biological individuality to lesser and greater degrees	Child (1915), Conklin (1916), Sober (1991), Santelices (1999), Pepper and Herron (2008), Godfrey-Smith (2009).
Transitions	There have been transitions in individuality; through evolution, new levels of individuality have emerged as a result of the coming together of previously distinct entities	Buss (1987), Maynard Smith and Szathmáry (1995), Michod (1999), Okasha (2006), Godfrey-Smith (2009)

Population

A group of individuals of the **same species** that occupies a certain area in a certain time interval

- The individuals of a population are interfertile/interfecund and, therefore, they share a common gene pool.
- The reference to a defined spatial limit is implicit, e.g. the population of *Arnica montana* L. of the Bivera Mt.
- It is subject to changes over time, e.g. the Italian population after the Second World War was different from today’s population.

The interactions among individuals and the environment generate new properties typical of group of individuals and, thanks to them, the triggering of control and autoregulation processes occur.

The most important are:

- ☐ Abundancy of individuals in a population
- ☐ The spatial distribution of individuals
- ☐ The demographic structure
- ☐ The genetic composition

Very variable over time

The group composition changes due to births, deaths and movement of individuals, etc.

Population Ecology

Measuring these properties over time in nature means taking pictures of the population that will need to be contextualized with the time-corresponding environmental conditions.

Community

The community is defined as a group of indiduals belonging to different species who occupy a determined area and interact among them directly (e.g. predator – prey; symbioses; plant-pollinators) or indirectly (competition for resources).

Stable meadow (magredo)

Garden

A stable community is an association of populations of species sharing similar ecological requirements in an environment characterized by stable ranges of abiotic factors that **have reached equilibrium spontaneously**.

The stable community is thus our reference as it is the repository of information of the normal sinecology of that association of species.

Sinecology: chapter of general ecology, animal or plant, which deals with the relationships that exist between the environment and groups of species and individuals, such as communities

Disturbances of the abiotic or biotic factors characterizing the «X» community might result in a change of the community equilibrium, resulting in impairments of populations of species -> decrease in individuals and in the worst case, biodiversity loss.

Monitoring over time and space the community structure could give us the means to identify ongoing changes caused by unknown disturbances

Identifying the cause requires a strong knowledge of the species comprising the community especially in their auotoecology and sinecology

Autoecology: Chapter of animal or plant ecology which, in opposition to synecology, investigates the relationships between the environment and a species, a race or other systematic category; or between the environment and single individuals, regardless, as far as possible, of the relationships that are established between the groups investigated and other systematic groups and individuals.

Back to species!

Species Ecological Niche:

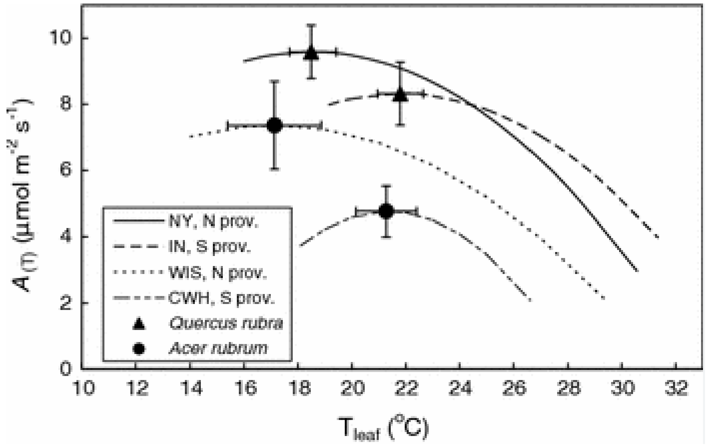
Ecological niche is a term for the position of a species within an ecosystem, describing both the range of conditions necessary for persistence of the species, and its ecological role in the ecosystem. Ecological niche encloses all of the interactions between a species and the biotic and abiotic environment.

Hutchinson (1957) expressed this concept to represent it "mathematically": Niche is an "**n-dimensional hypervolume**", where **the dimensions are environmental conditions and resources**, **that define the requirements of an individual or a species to practice its way of life**, more particularly, **for its population to persist**. The "hypervolume" defines the multi-dimensional space of resources (e.g. light, nutrients, structure etc.) available to (and specifically used by) organisms, and "all species other than those under consideration are regarded as part of the coordinate system".

To describe the species niche, we need to describe the species answer to a number of abiotic and biotic factors.

PLANT ← ECOLOGICAL FACTORS
SPECIES → (biotic and abiotic)

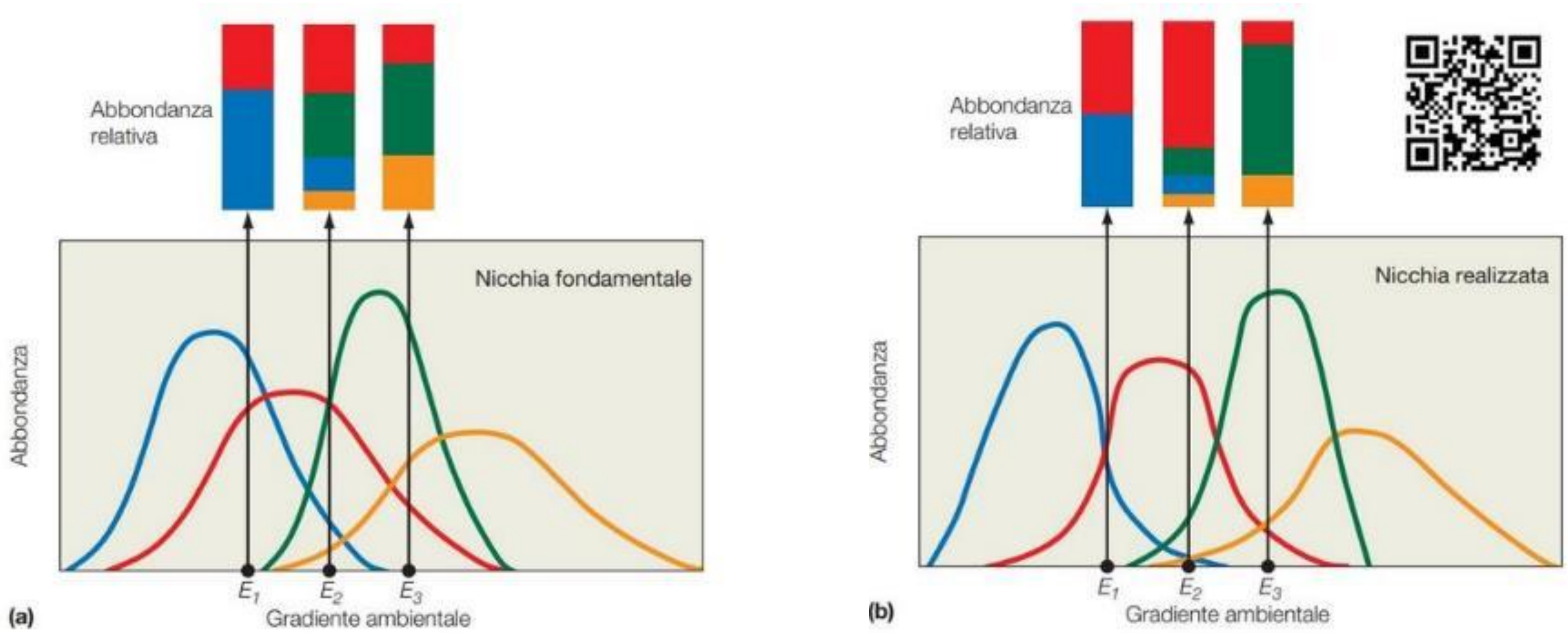
Following a typical physiological approach, the response of a plant to single factors, or combination of factors is investigated, typically with measurements that are carried out in the lab, in highly artificial conditions, on a number of individuals; the results are used to interpret e.g. the answer to specific abiotic factors (e.g. light, temperature) and/or stressors (e.g. drought, nutrients), inferring the effects in terms of distribution limits of the species, or the survival ability of that species vs. other species.



An ecophysiological approach is applied when the measures are carried out directly in the field, under natural conditions, and from its results, more sound-based implications on the competition performance can be derived, particularly if more species of the same community are directly compared.

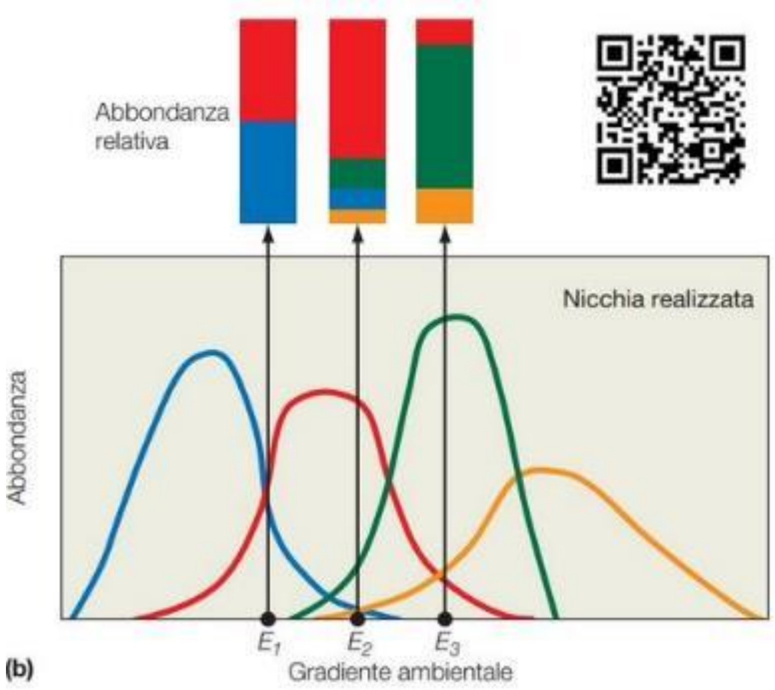
However, ecologists were able to overturn the perspective, i.e. to derive environmental relevant information from the presence of species whose precise ecological requirements are known.

An organism free of interference from other species could use the full range of conditions (biotic and abiotic) and resources in which it could survive and reproduce which is called its **fundamental niche**.



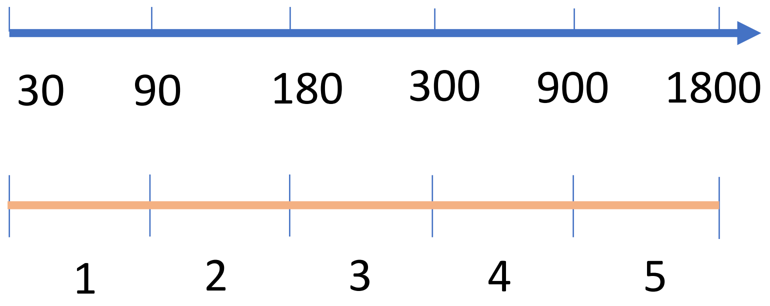
As a result of pressure from, and interactions with, other species are usually forced to occupy a niche that is narrower than this (i.e. inter-specific competition), or larger (i.e. facilitation and mutualism) and to which they are mostly highly **adapted**; this is termed the **realized niche**, whereas the fundamental niche describes the performance in monoculture.

The comparison of the answer to the single ecological factor allows to recognize **steno**- and **eurioecious species**, and to define the **ecological optimum** for that single factor.



The following step is to attribute a value in an arbitrary ordinary scale to represent numerically this.

Single ecological factor: e.g. light

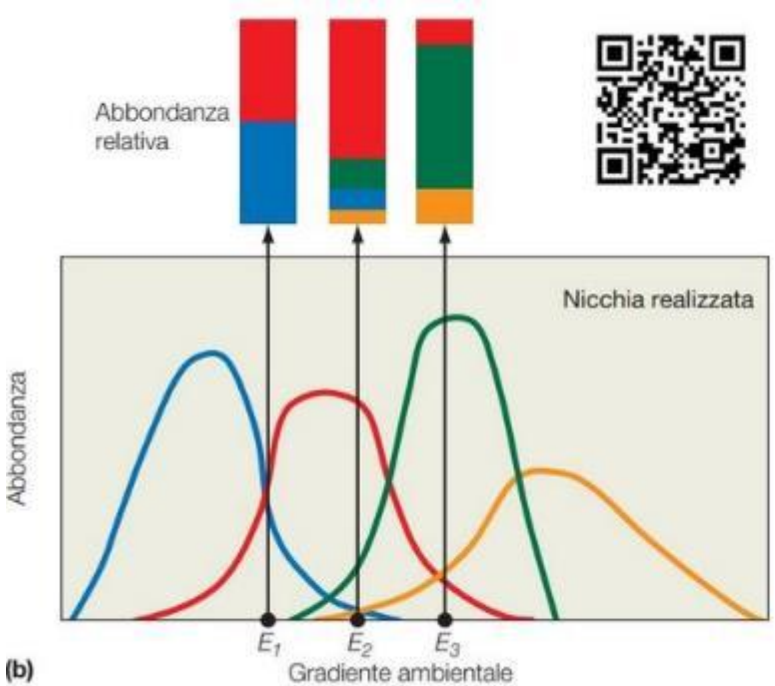


μmol photons m^{-2} d^{-1}
x 86,400

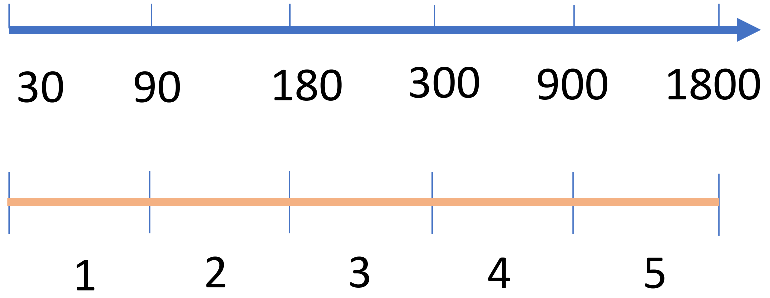
Species 1: 1-(2)
Species 2: 2-3
Species 3: 3-4
Species 4: 3-5

Plant species are assigned so-called **ecological indicator values (EIVs)** on ordinal scales based on the "optima" or "centres" of their realised ecological niches along given environmental gradients (niche dimensions).

Direct lab or field measurements are not available for all the species, but EIVs of species **X** can be inferred from that of species **Y** if the two species occur together in the same plant communities.



Single ecological factor: e.g. light



30 90 180 300 900 1800

µmol photons m^{-2} d^{-1} x 86,400

1 2 3 4 5

Species 1: 1-(2)
Species 2: 2-3
Species 3: 3-4
Species 4: 3-5

According to the optimum

Species 1: 1
Species 2: 2
Species 3: 3?
Species 4: 4

The idea of using the presence of plants to assess site conditions by qualitatively matching the most probable occurrence of plant species with environmental conditions was originally introduced to vegetation ecology by **Cajander (1926)** and **Iversen (1936)**.

Subsequently, Ellenberg (1950a, 1950b, 1952) introduced the first explicitly quantitative approach within an agricultural context, to specify quantitatively the needs of specific crops for e.g. nutrients and temperature.
Later on, **Ramensky et al. (1956)** for the European part of the former USSR and **Ellenberg (1974)** for Central Europe, proposed comprehensive EIV systems for the wild vascular plants of larger territories.

Ramensky et al. (1956) published indicator values for grazing intensity, soil moisture and a combination of soil fertility and salinity.

Ellenberg (1974; new edition by Ellenberg et al. 1991) covered seven ecological variables: light regime, temperature, continentality, moisture, reaction (pH), nutrient status and soil salinity.

Ellenberg's indicator values were the first model of bioindication proposed and applied to the **flora of Central Europe**, and they have a long tradition in interpretation and understanding of plant communities and their evolution.

The latest edition of Ellenberg's indicator values applies a **9-point scale** for each of seven gradients:

R - reaction (soil or water acidity/pH);
N - nitrogen (but really soil fertility or productivity, and not mineral nitrogen; perhaps better «soil nutrients»)
F - soil humidity or moisture
S - salt (soil salinity)
K - climatic continentality
L - light availability
T - temperature

ATTENTION! Since 1997, the term has also been used to refer to **Dufrêne & Legendre's indicator value**, which is a quantitative index measuring the statistical alliance of a species to any one of the classes in a classification of sites. In this context we can neglect this second definition, of scarce value for us.

The high utility of these indicator values led to an expansion to other regions, with more than **30 EIV systems being published so far.** E.g., indicator values were published in 1977 for Switzerland (Landolt’s Indices), Great Britain (Hill and coworkers), France and several other national or regional floras.

Some of the more recent EIV systems not only expanded the approach to new regions, but also added other taxonomic groups (e.g. bryophytes, lichens), other niche dimensions (e.g. mowing tolerance, hemeroby, CSR strategy, organic content of the soil, soil texture) or assessed niche width in addition to niche position.

Very recently, new systems with a focus on Europe as a whole have been published: Hájek et al. (2020) published niche position, minimum and maximum (niche width) for hydrological parameters for a comprehensive set of vascular plants and bryophytes occurring in mires, while Midolo et al. (2023) derived a set of five **disturbance** indicators for more than 6,000 European vascular plants. Recently, Tichý et al. (2023) presented a harmonized dataset of six of the original Ellenberg indicator values for **almost 9,000** European vascular plant taxa.

Indicator values are widely applied in vegetation science and global change studies. They are suitable to indirectly assess environmental conditions and the drivers of observed vegetation differences in time or space (see review by Diekmann 2003).

The use of «ecological indicator values» is widespread, representing a useful instrument for an indirect characterization of the environment on the basis of the information provided by the species present in a specific area, community or habitat. E.g., to assess the site conditions of a vegetation plot or a plant community, the EIVs of all species present in that plot or community can be averaged for each niche dimension of interest.

EIV are particularly useful for checking the variation on both local and national scale, if the data source (vegetation data, list of species, and EIV themselves) are «robust».

In favour of EIVs….

Several factors can explain the success of their application. First, environmental variables may fluctuate strongly in time and space (e.g. Sercu et al. 2017), making one-time measurements scarcely representative of average conditions or critically limiting extremes (Shipley et al. 2017). Thus, the appropriate assessment of environmental variables often requires repeated measurements (not feasible in many projects) or is costly if to be done across numerous plots. Additionally, measurements obtained at different times and with different techniques and equipment may not be directly comparable.

In contrast, the plant species composition of a site is an expression of the species' responses to the prevailing environmental conditions integrated across the study area (e.g. a plot) over longer time periods (several months to several years). Therefore, bioindication using EIVs offers a less time-consuming and cheaper alternative to the direct measurement of local environmental variables.

Finally, most historical vegetation data do not contain measurements of environmental data.
The ability to reconstruct past environmental conditions from historical relevés or floristic occurrence data can thus be very valuable in assessing trends in environmental change and their effects on biodiversity.

Against EIVs…

The use of EIVs have also been criticised.

- One line of criticism holds that indicator values have been assigned to plant species mainly based on expert judgement, rather than on accurate measurements.
- Secondly, although large regional differences in the niches of species have been demonstrated, EIVs have often been applied outside the region for which they were developed. This could potentially lead to misinterpretations, but also explains why so many authors proposed their own EIVs for their specific area of interest.
- Another line of critique has warned against averaging indicator values and subjecting them to parametric statistics, since they were defined on ordinal scales. However, analysing mean EIVs does not lead to statistical issues, since the arithmetic means of values of any distribution per se follow a normal distribution.

Ewald (2003) demonstrated the robustness of the correlation of weighed mean of EIVs with environmental measurements, even when species lists were incomplete

One time more, being based on species, the correct identification of species is of paramount importance.

However, the more than 30 national and regional EIV systems lack consistency in scaling and coding of the ecological indicators, as well as in plant nomenclature, impeding analyses at the continental scale.
These issues have partly been solved by the recently published **pan-European EIV systems** (Hájek et al. 2020; Midolo et al. 2023; Tichý et al. 2023) but their coverage of indicators and taxa, respectively, is far from complete.
Thus, there is still an urgent need for an integrated and comprehensive EIV system for Europe.

Very recently (2023), Dengler et al. published «Ecological Indicator Values for Europe (EIVE) 1.0», a consistent ecological indicator value system for Europe for five of the main plant niche dimensions: soil moisture (M), soil nitrogen (N), soil reaction (R), light (L) and temperature (T).

- They rescaled the indicator values of each dimension to a continuous scale, in which 0 represents the minimum and 10 the maximum value present in Europe.
- Taxon names were harmonised to the Euro+Med Plantbase.
- For each of the five dimensions, European values for niche position and niche width were calculated by combining the values from the individual EIV systems.
- Using T values as an example, we externally validated our European indicator values against the median of bioclimatic conditions for global occurrence data of the taxa.

In total, the Authors derived European indicator values of niche position and niche width for 14,835 plant taxa.

The newly developed **Ecological Indicator Values for Europe (EIVE) 1.0**, together with all source systems, is available in a flexible, harmonised **open access database**.

For more detail: https://vcs.pensoft.net/issue/4448/

Examples of other datasets:

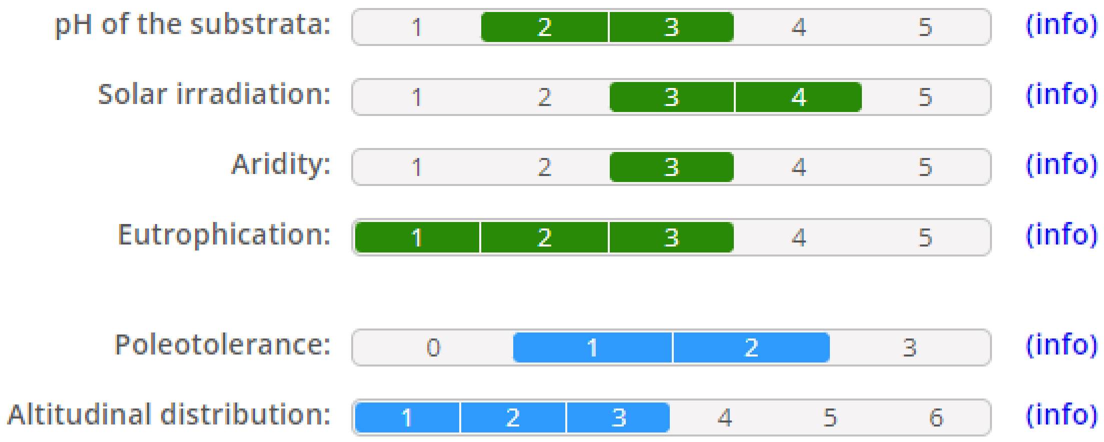
Italic 7.0, the information system of Italian lichens (**https://italic.units.it/index.php**)

ITALIC 7.0, THE INFORMATION SYSTEM ON ITALIAN LICHENS

P.L. Nimis & S. Martellos

ITALIC 7.0, the latest version of the Information System on Italian Lichens, has been published online on June, 28th, 2022. The system makes available information and resources about the lichens known to occur in Italy. It is maintained and updated by the Research Unit of Professor Pier Luigi Nimis, at the University of Trieste (NE Italy), Department of Life Sciences. Most of the data are derived from the Checklist of the Lichens of Italy by Nimis (2016), but nomenclatural and distributional data are being continuously updated online, and complete identification keys for some areas of the country, as well as for genera or groups of genera, are published online for testing.

In addition, species descriptions are available in ITALIC 7.0 for more than 3.200 infrageneric taxa (several of which are not known from Italy but do occur in neighbouring countries, e.g. in the Alps and in the Mediterranean Region). Further, a searchable archive of images curated by P.L. Nimis and F. Schumm, not limited to taxa occurring in Italy, presently includes more than 45.000 images for more than 6.000 taxa. Additionally, a project for georeferencing all samples collected in Italy from thirteeen, mainly modern herbaria was started and completed in the first half of 2022. These herbaria are now searchable online, and dot-maps of herbarium samples are visible in the taxon pages of ITALIC 7.0, and are downloadable in Darwin Core format.



pH of the substrata: 1 [✓ 2] [✓ 3] 4 5 (info)

Solar irradiation: 1 2 [✓ 3] [✓ 4] 5 (info)

Aridity: 1 2 [✓ 3] 4 5 (info)

Eutrophication: [✓ 1] [✓ 2] [✓ 3] 4 5 (info)

Poleotolerance: 0 [✓ 1] [✓ 2] 3 (info)

Altitudinal distribution: [✓ 1] [✓ 2] [✓ 3] 4 5 6 (info)

Solar irradiation (5 states)

1 in very shaded situations, e.g. deep gorges, closed evergreen forests
2 in shaded situations, such as on the northern side of boles in close-canopied deciduous forests
3 in sites with plenty of diffuse light but scarce direct solar irradiation, such as in rather open-canopied deciduous woodlands
4 in sun-exposed sites, but avoiding extreme solar irradiation
5 in sites with very high direct solar irradiation, e.g. on the southern side of isolated boles

Studia Geobotanica, Vol. 15: 73-89 (1996)

BIODIVERSITY OF EPIPHYTIC LICHENS AND AIR QUALITY IN THE PROVINCE OF GORIZIA (NE ITALY)

Giorgio BADIN and Pier Luigi NIMIS

Dipartimento di Biologia, Università di Trieste, Via Giorgieri 10, I-34127 Trieste

- Biodiversity of Epiphytic Lichens in the province of Gorizia -

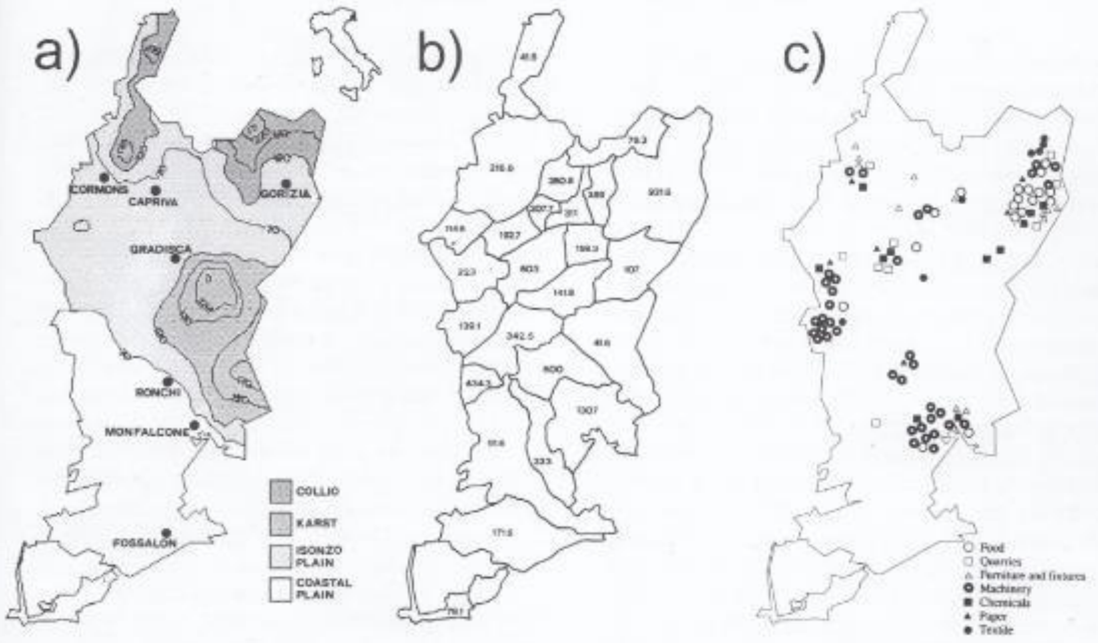


Fig. 1 - Subdivision of the province of Gorizia into four main geomorphological districts: A: Collio, B: Isonzo Plain, C: Karst, D: Coastal Plain; the altitude is indicated by isolines, the main urban centres by circles (Fig. a). Population density (inhabitants/km²) in the municipalities of the province of Gorizia (Fig. b). Location of the main industrial activities in the province of Gorizia (Fig. c).

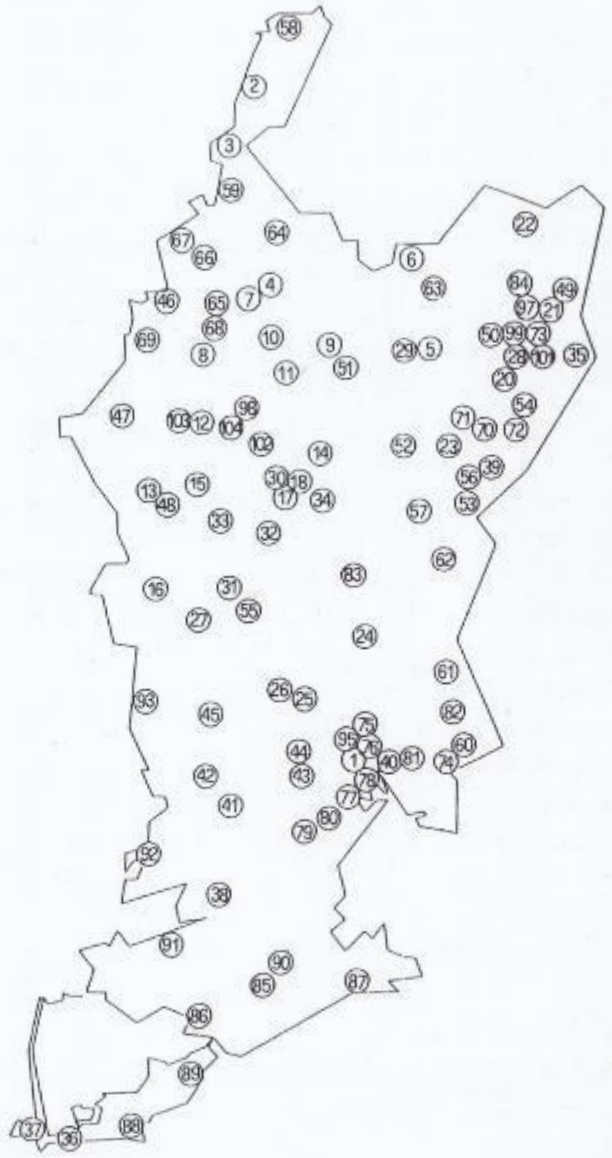
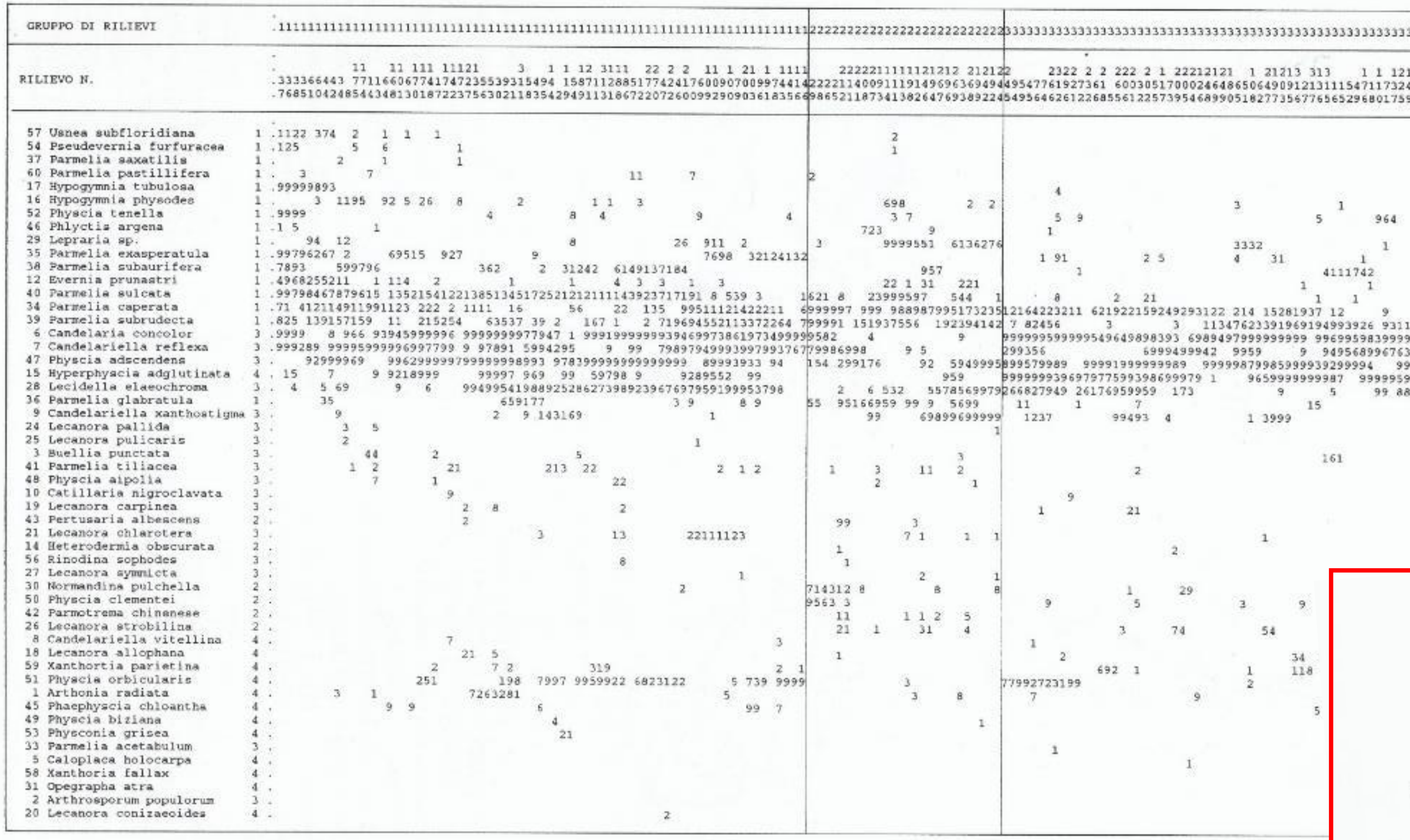


Fig. 4 - Location of the 104 sampling stations in the survey area. The stations are numbered as in Tab. 2.



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                                .7685104248544348130187223756302118354294911318672207260099290903618356698652118734138264769389224549564626122685561225739546899051827735677656529680175977467 76

57 Usnea subfloridiana        1 .1122 374  2   1  1   1                                                            2
54 Pseudevernia furfuracea    1 .125       5   6         1                                                         1
37 Parmelia saxatilis         1 .        2     1         1
60 Parmelia pastillifera      1 .   3        7                                  11      7               2
17 Hypogymnia tubulosa        1 .99999893                                                                                                4
16 Hypogymnia physodes        1 .     3  1195  92 5 26   8       2         1 1   3                                698        2  2                                3              1
52 Physcia tenella            1 .9999                        4          8   4            9           4             3 7                   5  9                                5       964
46 Phlyctis argena            1 .1 5          1                                                                723      9               1
29 Lepraria sp.               1 .    94  12                             8             26  911  2         3        9999551  6136276                               3332                 1        1
35 Parmelia exasperatula      1 .99796267 2     69515  927         9                      7698  32124132                               1 91          2 5         4    31          1
38 Parmelia subaurifera       1 .7893    599796             362     2  31242  6149137184                               957                  1                                4111742
12 Evernia prunastri          1 .4968255211   1 114   2          1       1     4  3  3   1  3                     22 1 31   221                                           1        1
40 Parmelia sulcata           1 .99798467879615 135215412213851345172521212111143923717191 8 539 3     1621 8   23999597   544   1       8       2   21                     1    1
34 Parmelia caperata          1 .71 412114911991123 222 2 1111  16      56    22  135  99511121422211  6999997 999 98898799517323512164223211 621922159249293122 214 15281937 12     9
39 Parmelia subrudecta        1 .825 139157159  11  215254    63537 39 2   167 1   2 719694552113372264799991 151937556  192394142 7 82456      3        3   11347623391969194993926 9311263
 6 Candelaria concolor        3 .9999   8 966 93945999996 9999999977947 1 9991999999939469973861973499999582    4           9     999999599999549649898393 6989497999999999 99699598399998996929
 7 Candelariella reflexa      3 .999289 99995999996997799 9 97891 5994295     9 99  7989794999399799376779986998     9 5          299356             6999499942  9959     9  9495689967639  3249
47 Physcia adscendens         3 .    92999969   996299999799999998993 978399999999999999  89993933 94   154 299176     92  5949995899579989  99991999999989  99999879985999939299994   9949 9999
15 Hyperphyscia adglutinata   4 . 15    7     9 9218999     99997 969  99  59798 9     9289552  99                        959     999999939697977599398699979 1    965999999987   99999599999779
28 Lecidella elaeochroma      3 .  4   5 69      9   6    9949954198892528627398923967697959199953798       2   6 532   5578569979266827949 26176959959  173           9      5     99 889739999
36 Parmelia glabratula        1 .      35                      659177                 3 9      8 9      55  95166959 99 9  5699      11      1       7                      15
 9 Candelariella xanthostigma 3 .        9                     2  9 143169                 1                    99     69899699999   1237        99493  4          1 3999                    1
24 Lecanora pallida           3 .         3   5                                                                                  1
25 Lecanora pulicaris         3 .         2                                              1                                                                                                     6
 3 Buellia punctata           3 .            44       2                   5                                                 3                                                 161
41 Parmelia tiliacea          3 .          1  2         21           213  22                2  1 2         1     3      11  2                       2
48 Physcia aipolia            3 .             7       1                       22                                 2            1
10 Catillaria nigroclavata    3 .                       9                                                                                  9
19 Lecanora carpinea          3 .                         2   8                2                                                       1          21                                          4
43 Pertusaria albescens       2 .                         2                                                 99        3
21 Lecanora chlarotera        3 .                                   3         13        22111123                     7 1     1   1                                   1
14 Heterodermia obscurata     2 .                                                                           1                                            2
56 Rinodina sophodes          3 .                                              8                             1
27 Lecanora symmicta          3 .                                                              1                       2         1
30 Normandina pulchella       2 .                                                      2                714312 8         8       8                 1      29
50 Physcia clementei          2 .                                                                       9563 3                          9           5             3       9
42 Parmotrema chinanese       2 .                                                                           11       1 1 2   5
26 Lecanora strobilina        2 .                                                                           21   1     31    4                    3      74          54
 8 Candelariella vitellina    4 .                       7                                           3                                 1
18 Lecanora allophana         4                           21  5                                             1                             2                              34
59 Xanthortia parietina       4 .                     2       7 2          319                      2  1                                       692  1              1     118
51 Physcia orbicularis        4 .                   251        198  7997 9959922 6823122      5 739 9999             3            77992723199                      2
 1 Arthonia radiata           4 .        3    1            7263281                           5                        3     8         7                     9
45 Phaephyscia chloantha      4 .                9  9                6                           99  7                                                                       5
49 Physcia biziana            4 .                                     4                                                        1
53 Physconia grisea           4 .                                      21
33 Parmelia acetabulum        3 .                                                                                                        1
 5 Caloplaca holocarpa        4 .                                                                                                                          1
58 Xanthoria fallax           4 .
31 Opegrapha atra             4 .
 2 Arthrosporum populorum     3 .
20 Lecanora conizaeoides      4 .                                                    2
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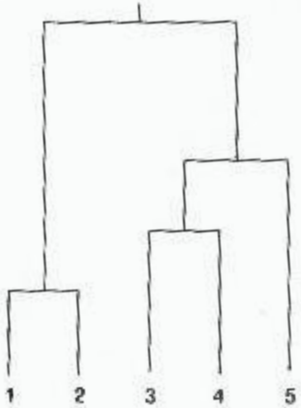

Fig. 5 - Dendrogram of the relevés, based on the data of Tab.1, showing only the five main clusters (minimum variance clustering, correlation coefficient).

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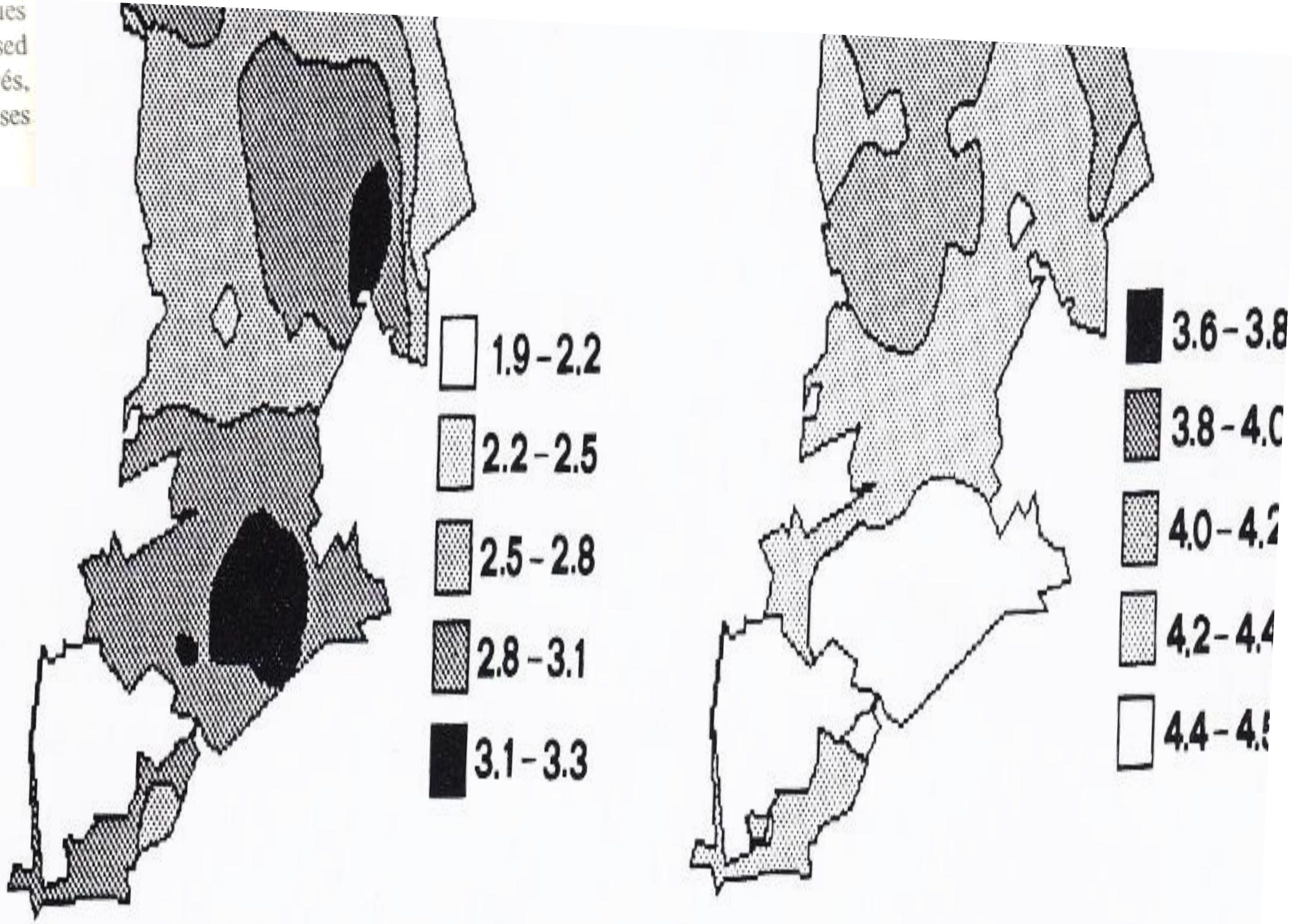
                                .
GRUPPO DI RILIEVI               .3333333333333333333333333444444444444444444444444444444444444444444444444444444455555555555555555555555555555555555555555555555555555555555555555555555555555555
                                .
                                .212  222 2 221 12111  23223221221112111 1 111 22222221 111112 1322222222321 2    2 11131 1  1 111  11  3111  3 2111222222221 22321 22222 221  222111  213321332
RILIEVO N.                      .7122233355212385532221507506374253337 93 2 652 98877736762322978098595366055488435880005858856443995588008 69 0920619978899889121261883858662844358862616101700 7
                                .75842390030904081097192560806836021570335409310895431271492055709378872119585109541674172563801887763225540933347821920431414944306447484389108632537560939768
                                .
57 Usnea subfloridiana        1 .
54 Pseudevernia furfuracea    1 .
37 Parmelia saxatilis         1 .
60 Parmelia pastillifera      1 .
17 Hypogymnia tubulosa        1 .
16 Hypogymnia physodes        1 .                                                                                                          1      5
52 Physcia tenella            1 .                                                                                                                                             415
46 Phlyctis argena            1 .
29 Lepraria sp.               1 .
35 Parmelia exasperatula      1 .        2                               2                                                     1                             9
38 Parmelia subaurifera       1 .                                                            133
12 Evernia prunastri          1 .                                                       1   1
40 Parmelia sulcata           1 .                       1           3   1                                                                                                       1
34 Parmelia caperata          1 .                              551             1       11  121111                                 2 2     1                       15            2           9
39 Parmelia subrudecta        1 .    4                             2112   1  3 1               1          1                       94 11     32191311            8111   322
 6 Candelaria concolor        3 .  99993991979939    993    794599  9389 539979      99927841219999395999969939992999999999999999 989989999899199951   11 99999999999995999 99   9969856  85
 7 Candelariella reflexa      3 .2964558273896392                5 8      7   3         57399 64                       6         1          79999995                         99 1943635
47 Physcia adscendens         3 .6999998999983969    9659499599999999 99979999989    99599 9999999699899999997999            2      98976 3899499199     99449299959989899 519999  97 59   9
15 Hyperphyscia adglutinata   4 .999998   99999989699999692               9    37    1     9999 995999 297699979978589998955964  4  99999767  9889799999 999    885999335699999 22   496      9
28 Lecidella elaeochroma      3 .            9885          9799999999692429971885699399957 5199997424499997971299       38  332268  98           7        1       9                           1
36 Parmelia glabratula        1 .                1                  2     1                 61
 9 Candelariella xanthostigma 3 .                               9     92412                    1                                                            22                    5 3
24 Lecanora pallida           3 .
25 Lecanora pulicaris         3 .                                    1
 3 Buellia punctata           3 .                                                                                                                  1
41 Parmelia tiliacea          3 .                                   2 1        2             1 21                                                                       14
48 Physcia aipolia            3 .                               1         11                    3  31                                                                     13
10 Catillaria nigroclavata    3 .                                        2
19 Lecanora carpinea          3 .                3             2 223    6                       2 1         21                      31
43 Pertusaria albescens       2 .                                4
21 Lecanora chlarotera        3 .                            1  11123          623211   6    3          1111   57                                                      2      4
14 Heterodermia obscurata     2 .
56 Rinodina sophodes          3 .                                   1                           9          1
27 Lecanora symmicta          3 .                                   212
30 Normandina pulchella       2 .                                                                                      1                                               3
50 Physcia clementei          2 .
42 Parmotrema chinenese       2 .                                                                                                                                                           1
26 Lecanora strobilina        2 .                                     1
 8 Candelariella vitellina    4 .                                       1                        4
18 Lecanora allophana         4 .                                  2                             414 5                2    12
59 Xanthortia parietina       4 .2 1816 5                         4       6 79  9991 3792911456217595942 28 39534 5                   92            98799869   295929914
51 Physcia orbicularis        4 .      2                               5  999955      89998999512  9        19991199939699599975999 9 99  992928994999 998899599999979 98889593 199999899299 992
 1 Arthonia radiata           4 .         9  6  43                 5        1 2      2     2                            29888       1135  1                       1           3
45 Phaephyscia chloantha      4 .                                                            3                     919596192 9589399126569226 6814                                          5
49 Physcia biziana            4 .                                       11222115 1                                                     2               99125
53 Physconia grisea           4 .                                                            6                                     5  6
33 Parmelia acetabulum        3 .                                                               1
 5 Caloplaca holocarpa        4 .      2                        1                                49
58 Xanthoria fallax           4 .                                                                                58                    2
31 Opegrapha atra             4 .                                  1                                                               5                                1  4
 2 Arthrosporum populorum     3 .                                   1           51
20 Lecanora conizaeoides      4 .                                                                            3                3               1
```

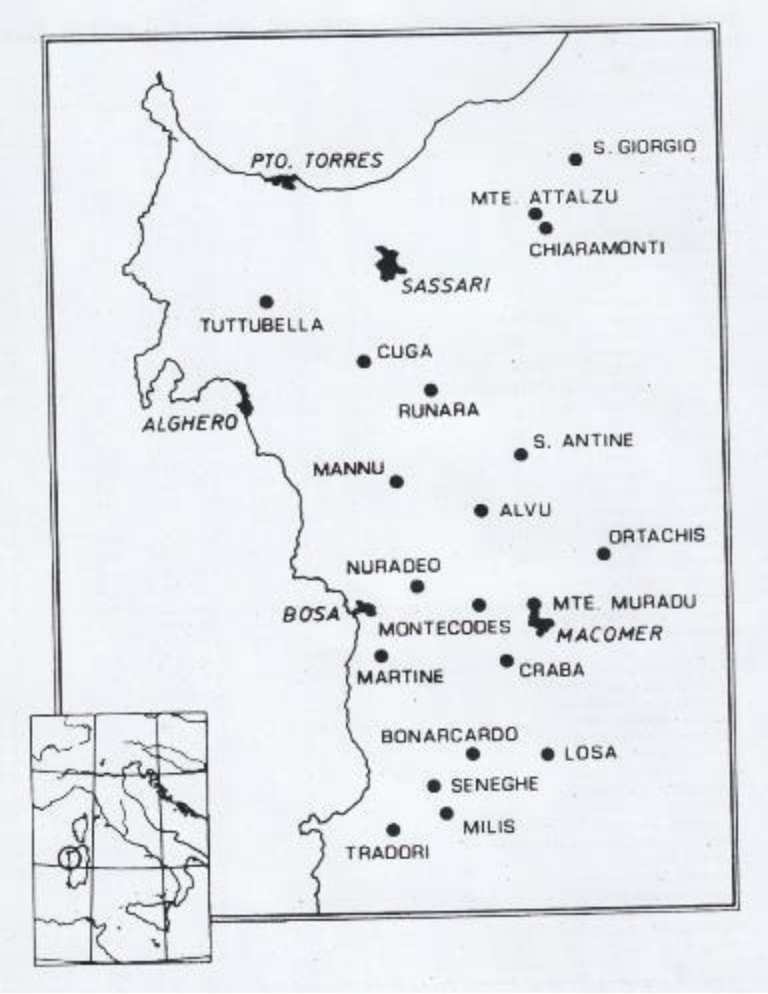
The values of the ecological indices proposed by Wirth (1980), transformed into an ordinal scale as suggested by Nimis *et al*. (1987), were associated to each species. The weighed averages of these values per relevé, using presence-absence data, were used to characterize the ecology of the clusters of relevés, and, in the case of stations, for mapping purposes (see results section).

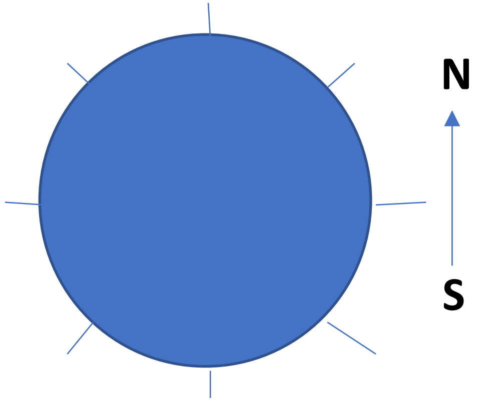


distributions of the weighted averages of Wirth's index of nitrophytism (a) and of hyg

Not all EIVs have been given on the basis of an expert's assessment…

Nuraghe Nieddu, Codrongianos





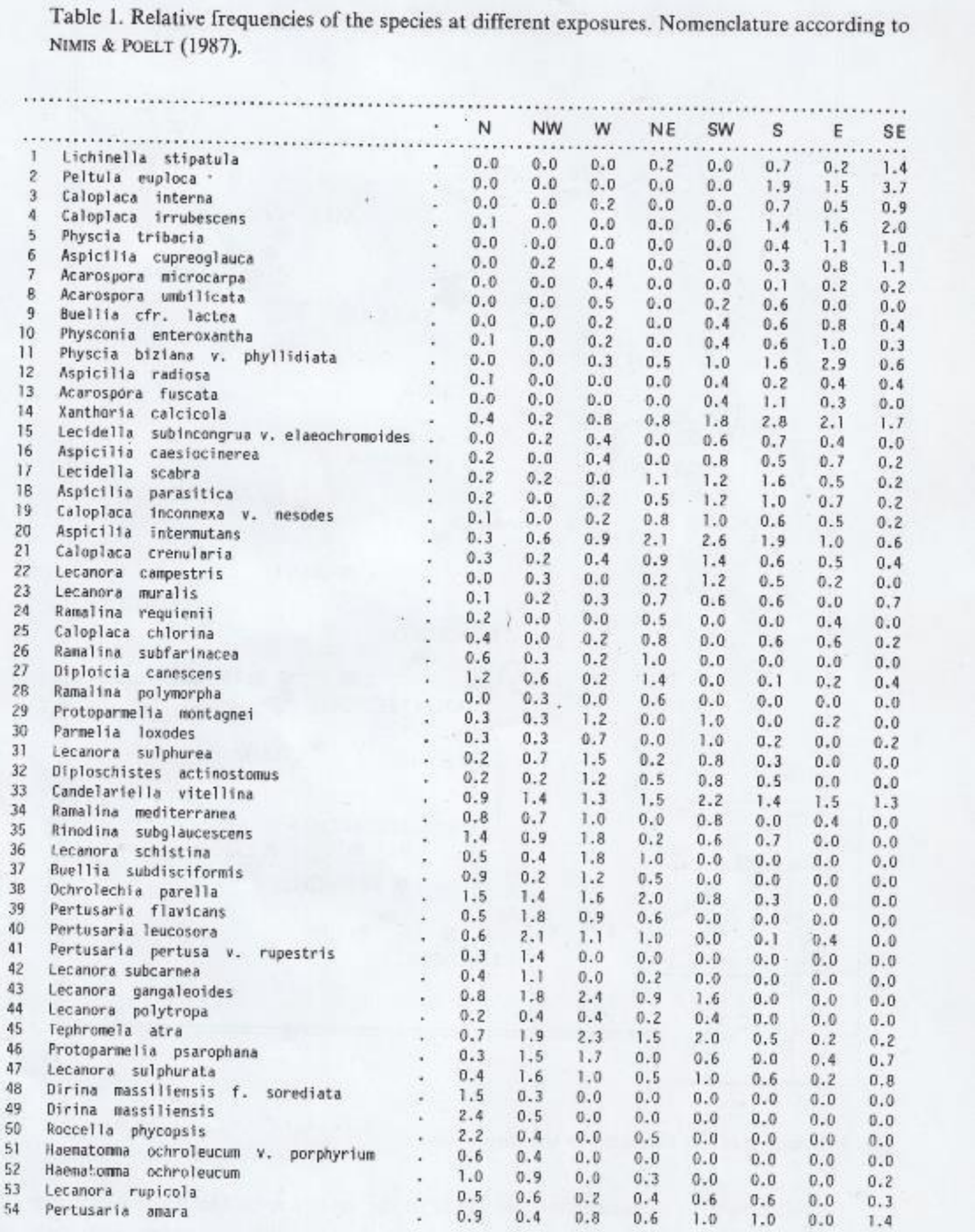
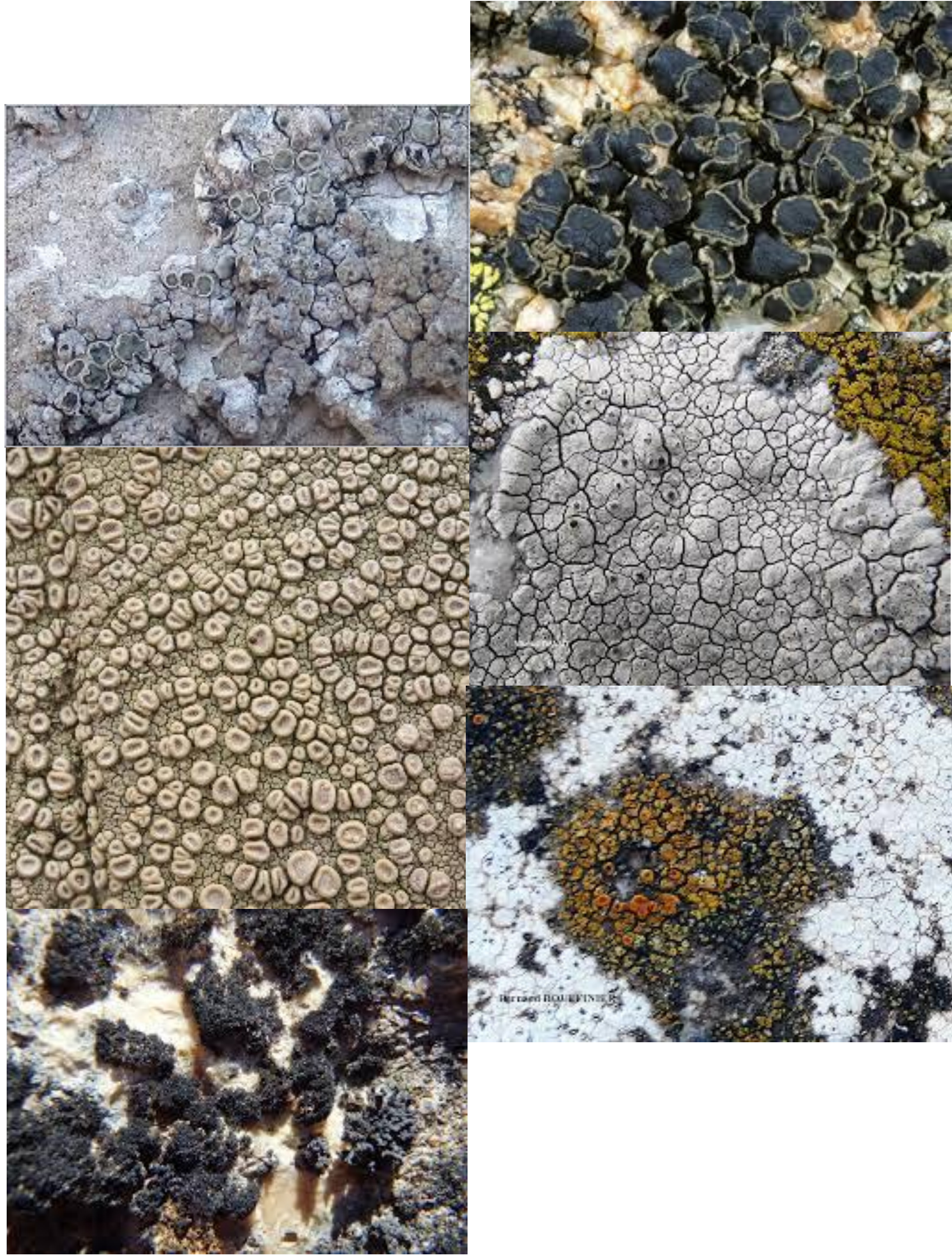
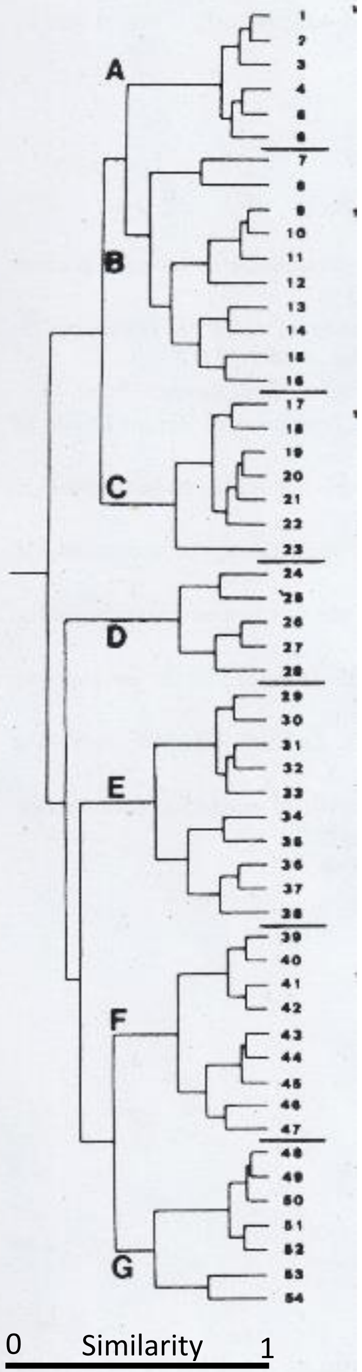


Table 1. Relative frequencies of the species at different exposures. Nomenclature according to NIMIS & POELT (1987).

		N	NW	W	NE	SW	S	E	SE
1	Lichinella stipatula	0.0	0.0	0.0	0.2	0.0	0.7	0.2	1.4
2	Peltula euploca	0.0	0.0	0.0	0.0	0.0	1.9	1.5	3.7
3	Caloplaca interna	0.0	0.0	0.2	0.0	0.0	0.7	0.5	0.9
4	Caloplaca irrubescens	0.1	0.0	0.0	0.0	0.6	1.4	1.6	2.0
5	Physcia tribacia	0.0	0.0	0.0	0.0	0.0	0.4	1.1	1.0
6	Aspicilia cupreoglauca	0.0	0.2	0.4	0.0	0.0	0.3	0.8	1.1
7	Acarospora microcarpa	0.0	0.0	0.4	0.0	0.0	0.1	0.2	0.2
8	Acarospora umbilicata	0.0	0.0	0.5	0.0	0.2	0.6	0.0	0.0
9	Buellia cfr. lactea	0.0	0.0	0.2	0.0	0.4	0.6	0.8	0.4
10	Physconia enteroxantha	0.1	0.0	0.2	0.0	0.4	0.6	1.0	0.3
11	Physcia biziana v. phyllidiata	0.0	0.0	0.3	0.5	1.0	1.6	2.9	0.6
12	Aspicilia radiosa	0.1	0.0	0.0	0.0	0.4	0.2	0.4	0.4
13	Acarospora fuscata	0.0	0.0	0.0	0.0	0.4	1.1	0.3	0.0
14	Xanthoria calcicola	0.4	0.2	0.8	0.8	1.8	2.8	2.1	1.7
15	Lecidella subincongrua v. elaeochromoides	0.0	0.2	0.4	0.0	0.6	0.7	0.4	0.0
16	Aspicilia caesiocinerea	0.2	0.0	0.4	0.0	0.8	0.5	0.7	0.2
17	Lecidella scabra	0.2	0.2	0.0	1.1	1.2	1.6	0.5	0.2
18	Aspicilia parasitica	0.2	0.0	0.2	0.5	1.2	1.0	0.7	0.2
19	Caloplaca inconnexa v. nesodes	0.1	0.0	0.2	0.8	1.0	0.6	0.5	0.2
20	Aspicilia intermutans	0.3	0.6	0.9	2.1	2.6	1.9	1.0	0.6
21	Caloplaca crenularia	0.3	0.2	0.4	0.9	1.4	0.6	0.5	0.4
22	Lecanora campestris	0.0	0.3	0.0	0.2	1.2	0.5	0.2	0.0
23	Lecanora muralis	0.1	0.2	0.3	0.7	0.6	0.6	0.0	0.7
24	Ramalina requienii	0.2	0.0	0.0	0.5	0.0	0.0	0.4	0.0
25	Caloplaca chlorina	0.4	0.0	0.2	0.8	0.0	0.6	0.6	0.2
26	Ramalina subfarinacea	0.6	0.3	0.2	1.0	0.0	0.0	0.0	0.0
27	Diploicia canescens	1.2	0.6	0.2	1.4	0.0	0.1	0.2	0.4
28	Ramalina polymorpha	0.0	0.3	0.0	0.6	0.0	0.0	0.0	0.0
29	Protoparmelia montagnei	0.3	0.3	1.2	0.0	1.0	0.0	0.2	0.0
30	Parmelia loxodes	0.3	0.3	0.7	0.0	1.0	0.2	0.0	0.2
31	Lecanora sulphurea	0.2	0.7	1.5	0.2	0.8	0.3	0.0	0.0
32	Diploschistes actinostomus	0.2	0.2	1.2	0.5	0.8	0.5	0.0	0.0
33	Candelariella vitellina	0.9	1.4	1.3	1.5	2.2	1.4	1.5	1.3
34	Ramalina mediterranea	0.8	0.7	1.0	0.0	0.8	0.0	0.4	0.0
35	Rinodina subglaucescens	1.4	0.9	1.8	0.2	0.6	0.7	0.0	0.0
36	Lecanora schistina	0.5	0.4	1.8	1.0	0.0	0.0	0.0	0.0
37	Buellia subdisciformis	0.9	0.2	1.2	0.5	0.0	0.0	0.0	0.0
38	Ochrolechia parella	1.5	1.4	1.6	2.0	0.8	0.3	0.0	0.0
39	Pertusaria flavicans	0.5	1.8	0.9	0.6	0.0	0.0	0.0	0.0
40	Pertusaria leucosora	0.6	2.1	1.1	1.0	0.0	0.1	0.4	0.0
41	Pertusaria pertusa v. rupestris	0.3	1.4	0.0	0.0	0.0	0.0	0.0	0.0
42	Lecanora subcarnea	0.4	1.1	0.0	0.2	0.0	0.0	0.0	0.0
43	Lecanora gangaleoides	0.8	1.8	2.4	0.9	1.6	0.0	0.0	0.0
44	Lecanora polytropa	0.2	0.4	0.4	0.2	0.4	0.0	0.0	0.0
45	Tephromela atra	0.7	1.9	2.3	1.5	2.0	0.5	0.2	0.2
46	Protoparmelia psarophana	0.3	1.5	1.7	0.0	0.6	0.0	0.4	0.7
47	Lecanora sulphurata	0.4	1.6	1.0	0.5	1.0	0.6	0.2	0.8
48	Dirina massiliensis f. sorediata	1.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0
49	Dirina massiliensis	2.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0
50	Roccella phycopsis	2.2	0.4	0.0	0.5	0.0	0.0	0.0	0.0
51	Haematomma ochroleucum v. porphyrium	0.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0
52	Haematomma ochroleucum	1.0	0.9	0.0	0.3	0.0	0.0	0.0	0.2
53	Lecanora rupicola	0.5	0.6	0.2	0.4	0.6	0.6	0.0	0.3
54	Pertusaria amara	0.9	0.4	0.8	0.6	1.0	1.0	0.0	1.4



Dendrogram of species, to identify groups of species with similar frequencies at different aspects (N, NE, E, SE etc.)



Ordination of exposures (on a floristic basis)

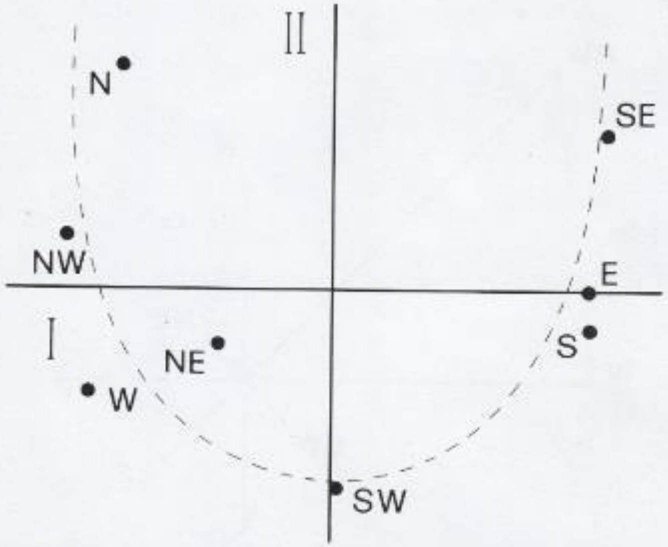


Fig. 2. Ordination of exposures, based on the data in Table 1.

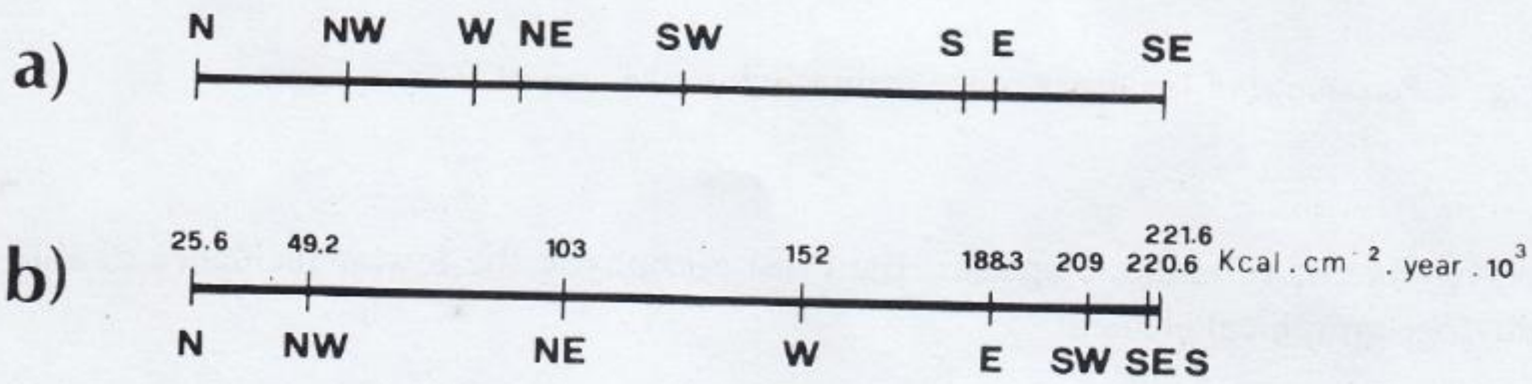


Fig. 3. Arrangement of the exposures according to: a, Angular seriation in the ordination of Fig. 2; b, Potential Solar Irradiation.

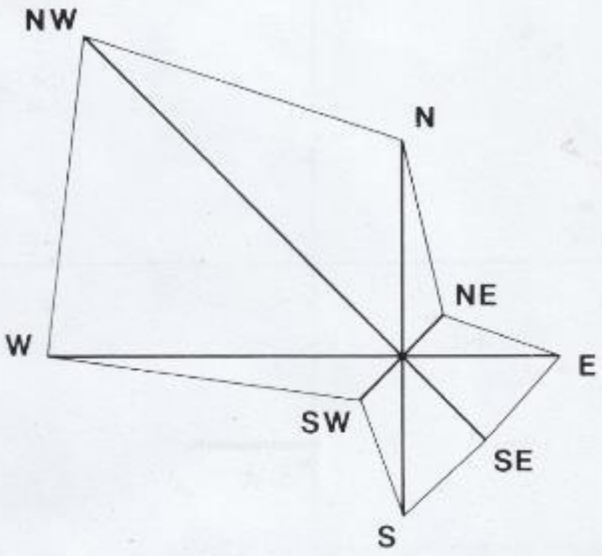


Fig. 4. Percentage of frequency of the main winds in the area of Macomer (see Fig. 1).

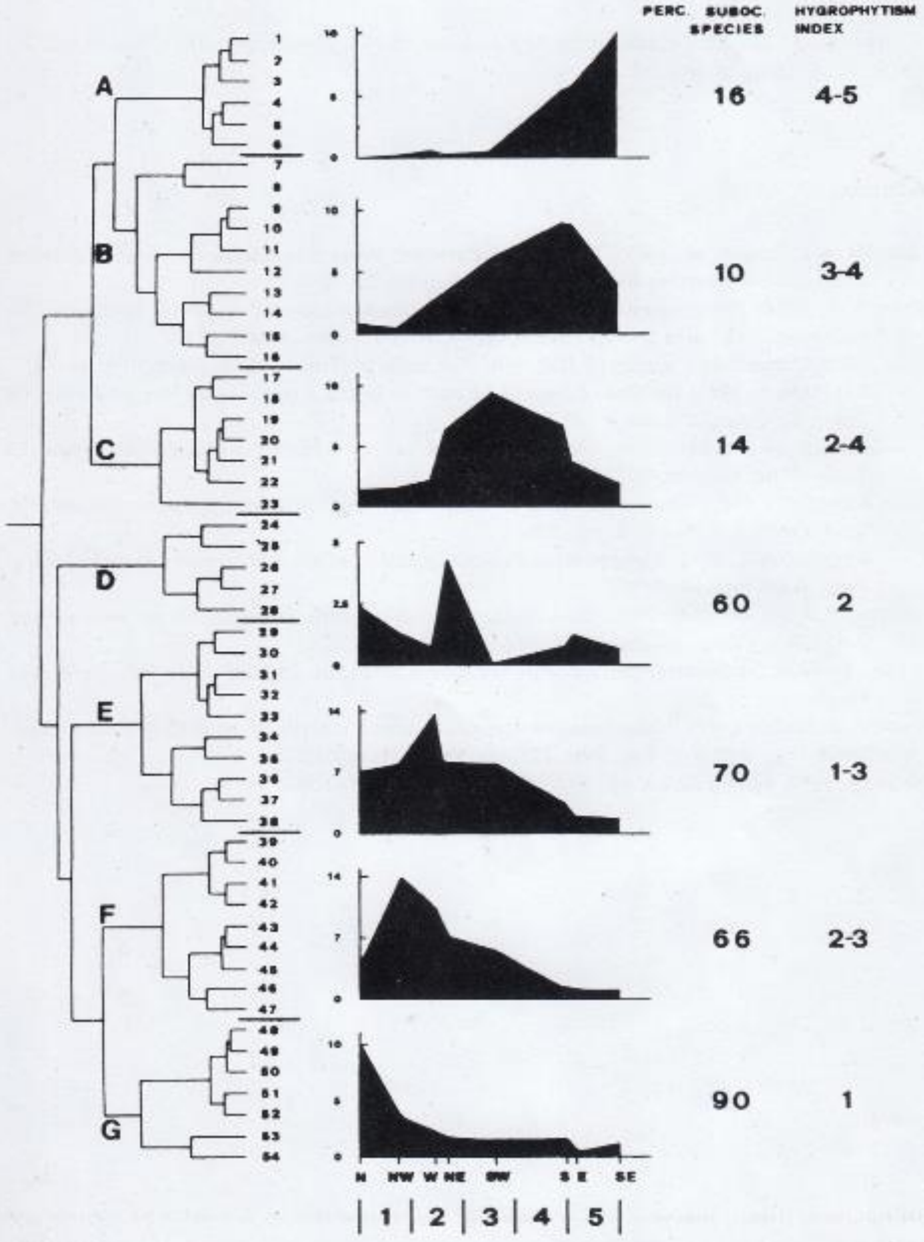


Fig. 5. Dendrogram of the species, based on the data in Table 1, frequency distribution of the species groups along the hygrophytism axis (exposures ordered as in Fig. 3a), percentage of suboceanic species in each group, and indices of hygrophytism.

After such premises, we must discuss why we want to make use of biomonitoring techniques, based on organisms, to characterize or detect or predict possible environmental changes. The discussion is open…