



UNIVERSITÀ
DEGLI STUDI
DI TRIESTE



Dipartimento di
Scienze della Vita



Exploring lichen biodiversity data in ITALIC: the information system on Italian lichens and its interoperability with the R programming language

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Webinar outline:

- ❖ What is ITALIC, history of the website
- ❖ Data available in ITALIC
- ❖ Exploring the website
- ❖ Limitations of the website
- ❖ Ritalic
- ❖ Italic api and how to integrate them



Materials:

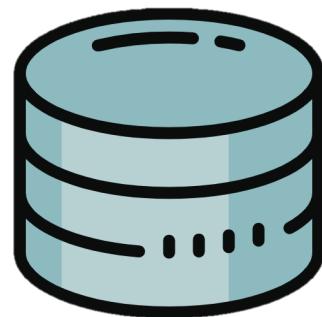
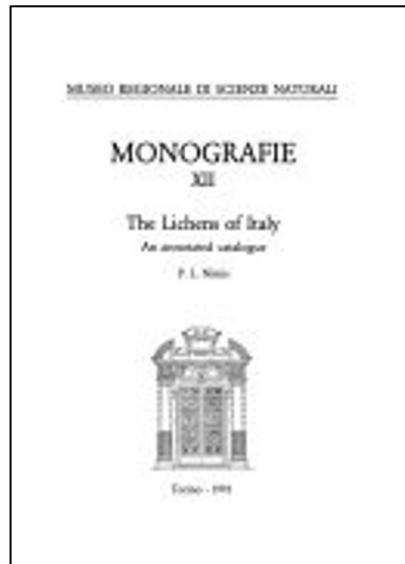
All materials are available online on github

❖ <https://github.com/Mattciao96/italic-webinar>



Creation of ITALIC

- ❖ 1993: first version of the checklist of the lichens of Italy
- ❖ 1997: digitized into an online database
- ❖ 2002: online website



Following versions

Added data about:

- ❖ Systematics
- ❖ Ecology
- ❖ Distribution

New tools:

- ❖ Image archive
- ❖ Identification keys
- ❖ Name match

Cetraria islandica (L.) Ach. subsp. *islandica*

Meth. Lich.: 399, 1803. Basionym: Lichen islandicus L. Sp. Pl.: 2: 1145, 1753.

Synonyms: *Cetraria islandica* f. *platynoides* Samb; *Cetraria islandica* var. *platyna* (Ach.) Ach.

Description: Thallus subfusco to subfuscous, loosely attached, often forming large tufts, consisting of dorsoventral, flattened, elongate, ascending, 1-3(-4) cm broad and up to 6(-10) cm tall, often sparingly branched laciniae with often in-cult margins bearing short (0.2-1 mm) marginal, pyrenia-bearing spinulose outgrowths. Upper surface dark brown in sunrooms to greyish in shade, or yellow-green, shiny, slightly granular, with large, moniform, irregular, white pycnothelia scattered throughout the surface and the margins. Cortex 2-layered, with an external layer of brownish, thick-walled, paraplectenchymatous cells, and an inner layer of peripherally arranged hyphae; medulla white. Apothecia extremely rare, lecanorine, mostly subterminal, with a dark brown disc and an often crenulate thalline margin. Epithelium brownish; hymenium and hypothecium colourless. Asci 8-spored, *Lecanora*-type. Ascospores 1-celled, hyaline, ellipsoid to oval, 6-10 x 3.5-5 µm. Conidia fusiform, multiseptate, colourless, 6-7 x c. 1 µm. Photobiont chlorococcoid. Spot test colour: K-, C-, KC-, P-, yellow to orange or P-, UV-. Chemistry: medulla with fumiprotocetraric acid, and variable amounts of protocetraric and protocetraricin acid.

Note: an arctic-alpine to boreal-montane, circumpolar lichen found on mineral and organic soil, amongst thick moss carpets, exceptionally on bark or lignum near the ground, with optimum near treeline; common and often abundant throughout the Alps, less frequent in the mountains of southern Italy. The subsp. *cristiformis* (Räsänen) Kärnefelt should be looked for in the Alps.

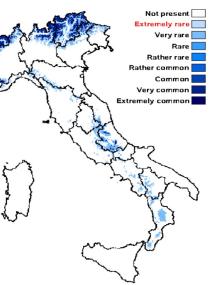
Growth form: Fruticose

Substrate: soil, terricolous mosses, and plant debris
Photobiont: green alga other than *Trentepohlia*
Reproductive strategy: mainly asexual, by thallus fragmentation

[CLASSIFICATION](#) [REFERENCES](#)

Commonness-rarity: (info)
Alpine belt: very common
Subalpine belt: extremely common
Demi-alpine/demi-belt: rare
Montane belt: very rare
Submediterranean belt: absent
Padanian area: absent
Humid submediterranean belt: absent
Humid Mediterranean belt: absent
Dry Mediterranean belt: absent

pH of the substrate:	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)	
Paleotolerance:	0	1	2	3		(info)	
Altitudinal distribution:	1	2	3	4	5	6	(info)



Parmotrema A. Massal.

Atti Ist. Ven. Sc. Lett. Arti, 5, 3: 4, 1860.

Systematics:

Phylum: Ascomycota Caval-Sm.

Subphylum: Pezizomycotina O.E.Erikss. & Winka

Class: Lecanoromycetes O.E.Erikss. & Winka

Subclass: Lecanoromycetidae P.M.Kirk, P.F.Cannon, J.C.David & Stalpers ex Miadl., Lutzoni & Lumbsch

Order: Lecanorales Nannf.

Family: Parmeliaceae Zenker

This genus of the Parmeliaceae is characterised by foliose thalli forming short and broad, often ciliate lobes, a pored epicortex, cylindrical conidia, a usually wide bare marginal zone on the lower surface, and the intermediate type of lichenan between Cetraria- and Xanthoparmelia-type lichenan. Currently the genus comprises c. 300 species which occur mostly in the tropics, especially in the Pacific Islands and South America. The genera Canomaclina, Concamerella, Rimelia, and Rimeliella were synonymised with Parmotrema by Blanco & al. (2005). Type: *P. perforatum* (Jacq.) A. Massal.

[KEY TO ITALIAN SPECIES](#)

[REFERENCES](#)

Modified from the original in: Lucking R., Hodkinson B., Leavitt S.D. - 2016 - The 2016 classification of lichenized fungi in the Ascomycota and Basidiomycota - Approaching one thousand genera. - Bryologist, 119, 4: 361-416.

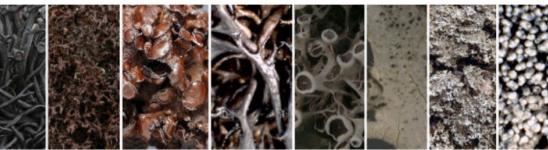


Dryads Home

Lichens of the Italian Alps occurring near and above tree-line: an interactive guide

[Back](#)

Remaining records
60



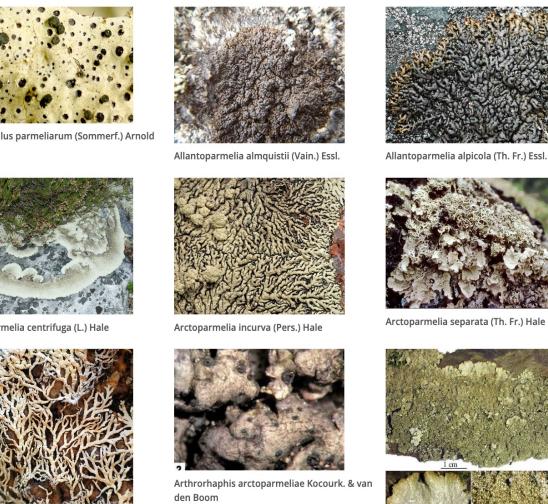
Thallus grey, brown or black, without usnic acid



Thallus green to yellowish green when dry, with usnic acid

[Start again](#) [Key to remaining taxa](#)

IMAGES OF LICHENS



1 cm

❖ Occurrence data from Italian herbaria

Herbarium	Index Herbariorum Code	Number of Records
Erbario del Museo Civico di Storia Naturale Giacomo Doria	GDOR	2782
Erbario Lichenologico Fiorentino	FI	416
Erbario Lichenologico Università della Calabria	CLU	16,956
Flora Montis Oropae	ORO	320
Herbarium Gheza		948
Herbarium Lucanum	HLUC	600
Herbarium Nascimbene		7871
Herbarium Ravera		5363
Herbarium Universitatis Genuensis	GE	831
Herbarium Universitatis Senensis	SI	3460
Herbarium Universitatis Taurinensis	TO	3428
Herbarium Universitatis Tergestinae	TSB	40,908
Herbarium von Brackel		3943



Let's explore the website

<https://italic.units.it>



ITALIC 7.0, THE INFORMATION SYSTEM ON ITALIAN LICHENS

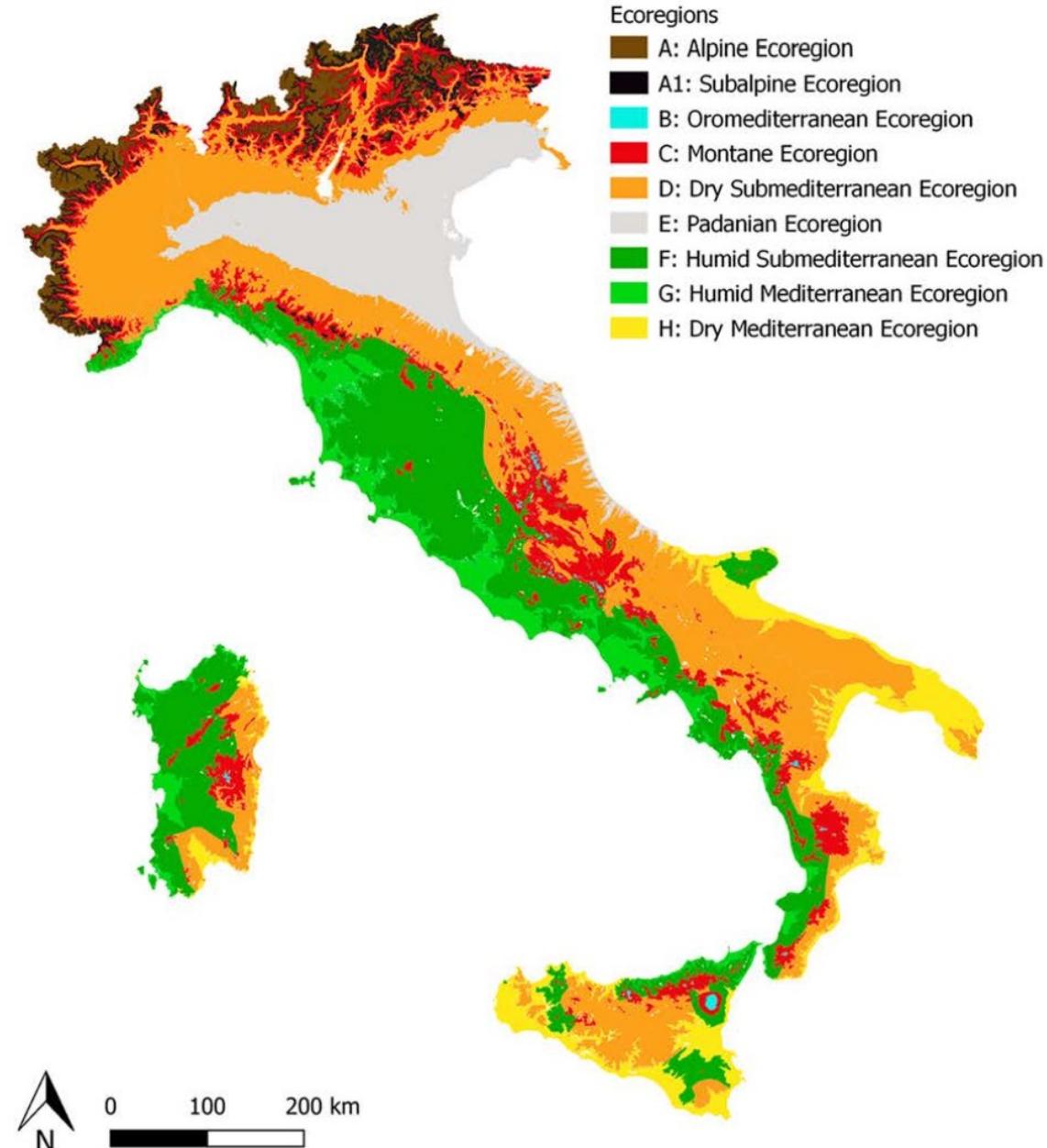
P.L. Nimis & S. Martellos

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 thirteen, 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.

Nine ecoregions based on several environmental factors (altitude, precipitations)

- A: Alpine (above treeline in the Alps)
- A1: Subalpine (near treeline in the Alps)
- B: Oromediterranean (above treeline outside the Alps)
- C: Montane (beech forests)
- D: Dry submediterranean (deciduous oaks, excluding SmedH)
- E: Padanian the most heavily anthropised part of Italy
- F: Humid submediterranean
- G: Humid Mediterranean (mostly Tyrrhenian)



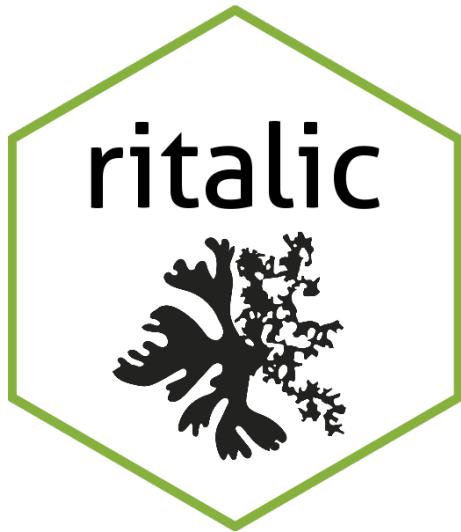
Limits of the website

Interface to be comprehensible at glance

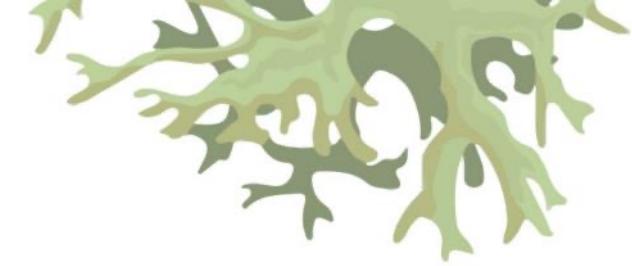
Real time data

	A	B	C	D	E
1	pH of the substrata:				
2		1		4	5
3					
4					
5	(info)				
6	Solar irradiation:				
7		1		4	5
8					
9					
10	(info)				
11	Aridity:				
12			2	3	4
13					
14					
15	(info)				
16	Eutrophication:				
17				3	4
18					
19					
20	(info)				
21	Poleotolerance:				
22			1	2	3
23					

ritalic



Data and tools from ITALIC to R

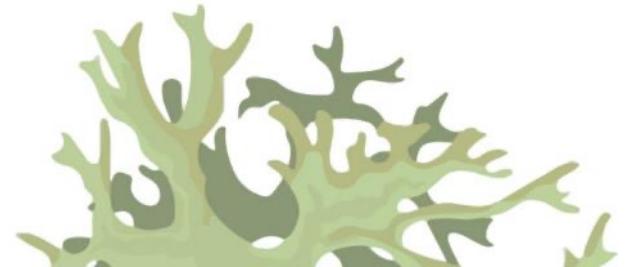


ITALIC APIs

What is an API?



moz://a Is a set of commands and functions that allows an application to communicate and exchange data with other applications

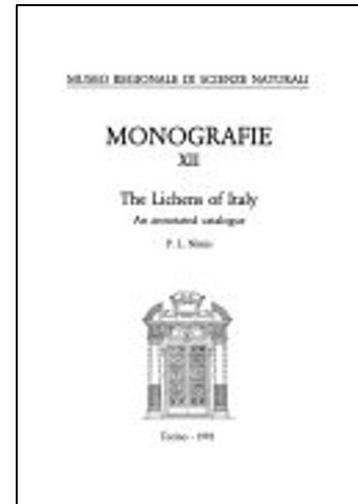


Thank you for your attention



Connecting ITALIC with international resources

❖ Nomenclature



❖ Occurrences



Occurrence data in IALIC

From:

- ❖ Literature
- ❖ Surveys



Review

Could Hair-Lichens of High-Elevation Forests Help Detect the Impact of Global Change in the Alps?

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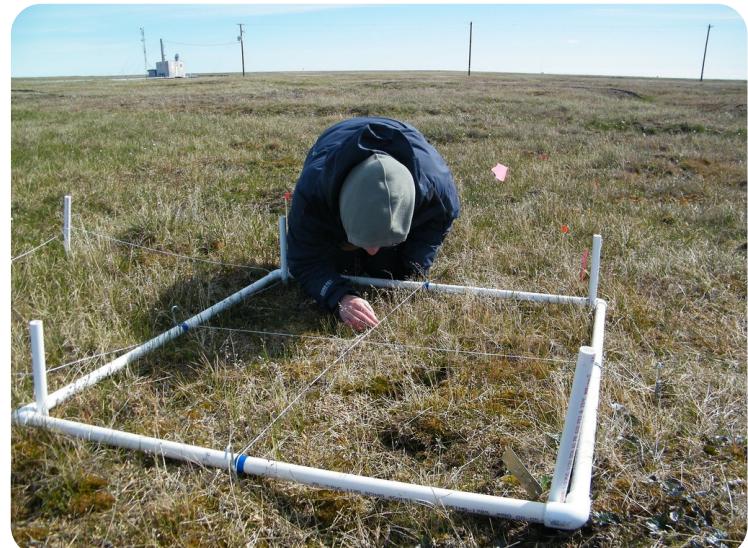
Abstract: Climate change and the anthropic emission of pollutants are likely to have an accelerated impact in high-elevation mountain areas. This phenomenon could have negative consequences on alpine habitats and for species of conservation in relative proximity to dense human populations. This premise implies that the crucial task is in the early detection of warning signals of ecological changes. In alpine landscapes, high-elevation forests provide a unique environment for taking full advantage of epiphytic lichens as sensitive indicators of climate change and air pollution. This literature review is intended to provide a starting point for developing practical biomonitoring tools that elucidate the potential of hair-lichens, associated with high-elevation forests, as ecological indicators of global change in the European Alps. We found support for the practical use of hair-lichens to detect the impact of climate change and nitrogen pollution in high-elevation forest habitats. The use of these organisms as ecological indicators presents an opportunity to expand monitoring activities and develop predictive tools that support decisions on how to mitigate the effects of global change in the Alps.

Keywords: biodiversity conservation; climate change; ecosystem functioning; fruticose-filamentous lichens; global warming; nitrogen pollution

1. Introduction

It is widely recognized that global change will impact ecosystems and society considerably [1,2]. The impact of global processes, including climate change and the anthropic emission of pollutants, is likely to accelerate for high-elevation mountain areas [3]. This phenomenon could cause negative consequences in the European Alps, which host high-priority habitats and species for conservation while also sustaining a relatively dense human population whose activities include summer and winter tourism, traditional agriculture, forest exploitation, and water extraction for energy production [4].

This scenario invokes the crucial task of detecting early warning signals of changes that can affect ecosystem stability and, in turn, human well-being in the alpine zone. In most cases this would facilitate the prompt adoption of local management solutions that could mitigate the negative effects of global change; however, there is still a lack of monitoring in high-elevation regions, mainly due to practical constraints in managing instrumental devices under challenging logistical and climatic conditions [3]. This information gap could be partially filled by detecting and monitoring functionally



Occurrence data in ITALIC

- ❖ Occurrence maps in the taxon pages
- ❖ Data downloadable in Darwin Core format

Example of *Lecidella elaeochroma*

occurrenceID	basisOfRecord	institutionCode	eventDate	year	occurrenceRemarks	scientificName	kingdom
https://italic.units.it/object/ITL10014352	PreservedSpecimen	TSB	1988-03-04/1988-03-28	1988	On Bark of broad-leaved trees	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014353	PreservedSpecimen	TSB	1988-03-04/1988-03-28	1988		<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014354	PreservedSpecimen	TSB	1988-06-17	1988	On Bark of Robinia pseudacacia	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014356	PreservedSpecimen	TSB	1988-07-14	1988	On Bark of Juniperus	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014357	PreservedSpecimen	TSB	1988-06	1988	On Bark of Fagus	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014358	PreservedSpecimen	TSB	1988-06	1988	On Bark of Fagus	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014360	PreservedSpecimen	TSB			On Bark of Quercus ilex	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014361	PreservedSpecimen	TSB	1989-06-26	1989	On Bark of Fagus	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014362	PreservedSpecimen	TSB			On Bark of Quercus ilex	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014363	PreservedSpecimen	TSB	1989-04	1989	On Bark of Sambucus	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014364	PreservedSpecimen	TSB	1981-04-19	1981	On Bark of Acer	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014366	PreservedSpecimen	TSB	1990-04-09	1990	On Bark of broad-leaved trees	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014367	PreservedSpecimen	TSB	1981-05-10	1981	On Bark of Acer	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014368	PreservedSpecimen	TSB			On Bark of Fagus	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014369	PreservedSpecimen	TSB	1990-11-07	1990		<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014370	PreservedSpecimen	TSB	1981-06-10	1981	On Bark of broad-leaved trees	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014372	PreservedSpecimen	TSB	1991-03-24/1991-03-31	1991	On Bark of broad-leaved trees	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014373	PreservedSpecimen	TSB	1991-03-24/1991-03-31	1991	On Bark of broad-leaved trees	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014374	PreservedSpecimen	TSB	1991-03-24/1991-03-31	1991	On Bark of broad-leaved trees	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi
https://italic.units.it/object/ITL10014375	PreservedSpecimen	TSB	1981-06-21	1981		<i>Lecidella elaeochroma</i> (Ach.) M. Choisy var. <i>elaeochroma</i> f. <i>elaeochroma</i>	Fungi

Lecidella elaeochroma (Ach.) M. Choisy var. *elaeochroma* f. *elaeochroma*

Bull. Mens. Soc. linn. Lyon, 19: 19, 1950. Basionym: *Leidea parasema* var. *elaeochroma* Ach. - Meth. Lich.: 36, 1803.

Synonyms: *Blatiora ambigua* A. Massal.; *Blatiora tabescens* Körb.; *Leidea achristota* (Sommerf.) Britzelm.; *Leidea achristotera* Nyl.; *Leidea elaeochroma* (Ach.) Ach.; *Leidea enteroleuca* var. *olivacea* (Hoffm.) Fr.; *Leidea limitata* auct.; *Leidea olivacea* (Hoffm.) A. Massal.; *Leidea parasema* auct. p.p. non (Ach.) Ach.; *Leidea parasema* var. *rugulosa* A. Hertel; *Lecidella achristotera* (Nyl.) Hertel & Leuckert; *Lecidella enteroleuca* (Ach.) Körb.; *Lecidella olivacea* (Hoffm.) Hazsl. **Description:** Thallus crustose, episubstratic, continuous to verrucose, usually up to 0.5 mm thick, whitish to yellowish grey, often delimited by a dark prothallus. Apothecia common, lecideine, black (brown in old or damaged specimens, whitish in rare unpigmented forms), sessile, 0.8-1.8 mm across, with a flat to finally convex disc and a smooth to flexuous, often shiny, >0.1 mm thick, finally excluded proper margin. Proper exciple blue-green in outer part, colourless within, sometimes with crystals dissolving in K; epithecium blackish green, bluish green to dull grey-blue, rarely olive, without crystals; hymenium colourless, not inspersed or inspersed with small oil droplets (*L. achristotera*), 40-70 µm high; paraphyses easily made free in K, simple, rarely anastomosing or branched in upper part, not capitate; hypothecium brownish orange (K+ bright red-brown) to reddish brown. Ascii 8-spored, clavate, with an intensely I+ blue tholus penetrated by a weakly amyloid, broadly cylindrical axial mass, and a poorly developed ocular chamber. *Lecidella*-type. Ascospores 1-celled, hyaline, thick-walled, broadly ellipsoid to ellipsoid, 9-19 x 4.5-10 µm, often biguttulate. Pycnidia dark, immersed. Conidia thread-like, more or less curved. Photobiont chlorococcoid. Spot tests: thallus K- or K+ pale yellow, KC+ yellow, C+ orange, P- or P+ pale yellow (reactions often weak and patchy). Chemistry: arachelin, granulosin, different xanthones.

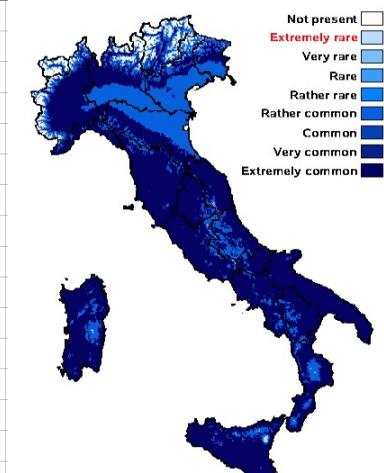
Note: this is the commonest epiphytic lichen of Italy, with an extraordinarily wide ecological and altitudinal range, occurring both in natural forests and in urban environments. In NW Europe the species is also saxicolous, especially on brick walls (Aptroot, in litt.). According to Zhao & al. (2015) the species might prove to be heterogeneous. Some records could refer to *L. euporea*.

Growth form: Crustose
Substrata: bark
Photobiont: green algae other than *Trentepohlia*
Reproductive strategy: mainly sexual
Pioneer species

CLASSIFICATION REFERENCES

Commonness-rarity: (info)
Alpine belt: absent
Subalpine belt: very rare
Oromediterranean belt: extremely rare
Montane belt: rather common
Submediterranean belt: extremely common
Padanian area: rather common
Humid submediterranean belt: extremely common
Humid mediterranean belt: extremely common
Dry mediterranean belt: extremely common

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

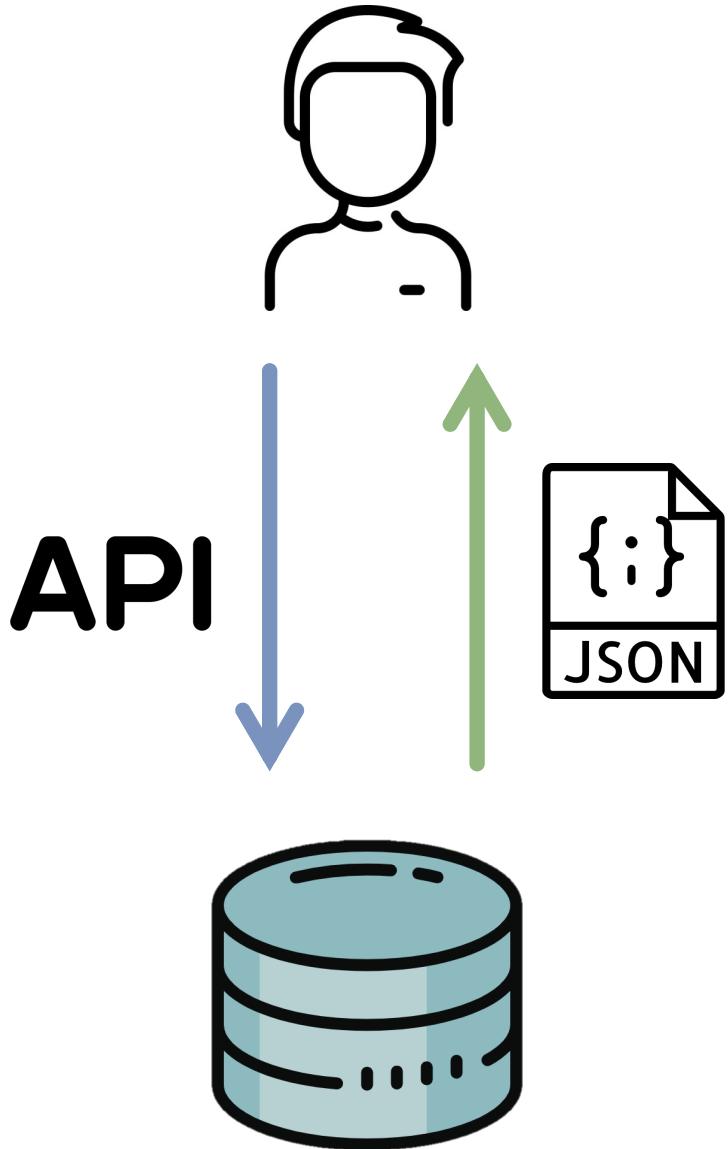


Predictive model



Herbarium samples

DOWNLOAD DATA



REQUEST:

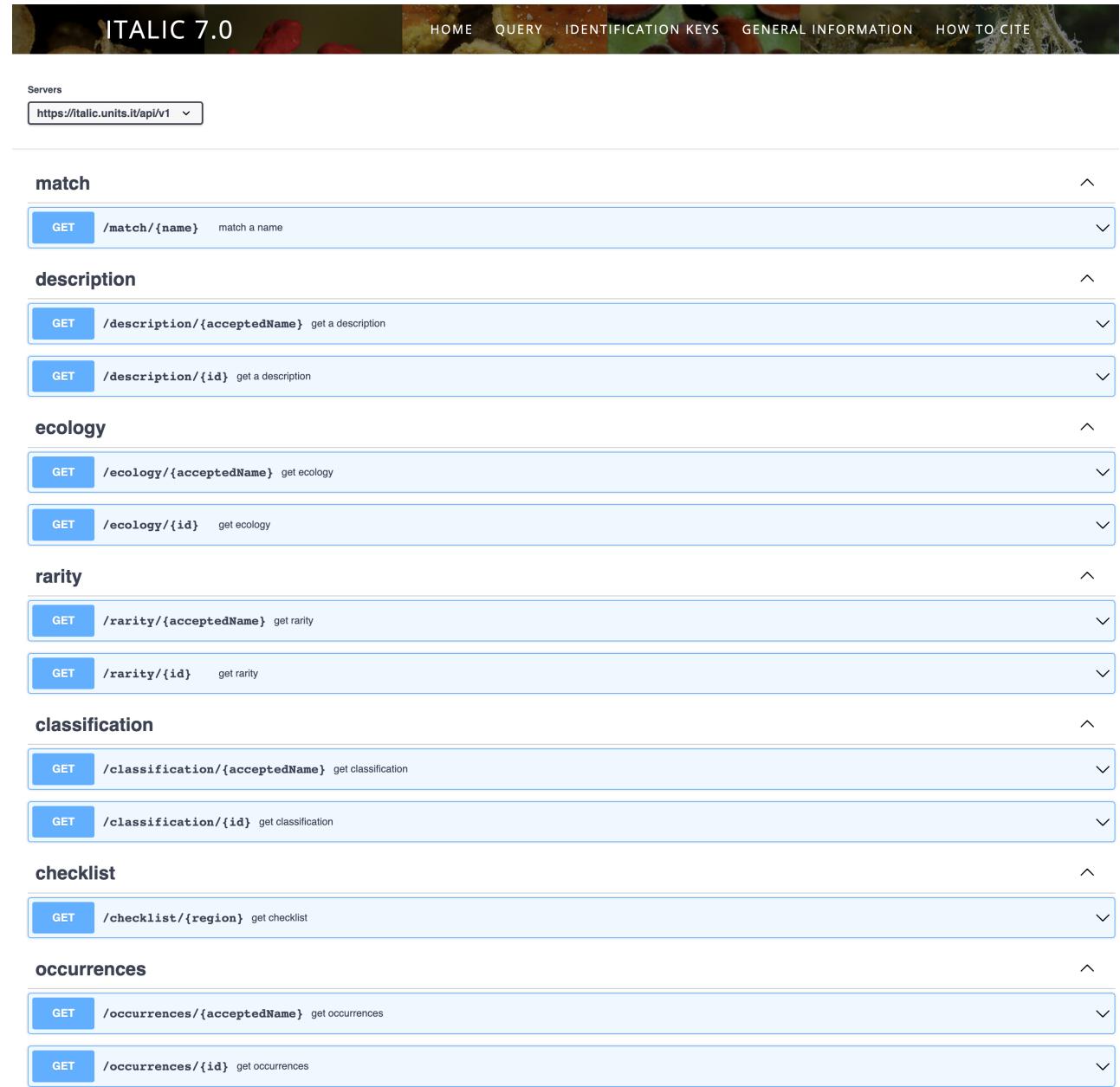
<https://italic.units.it/api/v1/match/Xantoria fallax>

RESPONSE:

```
{  
    "input_name": "Xantoria fallax",  
    "match": {  
        "matched_name": "Xanthoria fallax Hepp ex Arnold",  
        "status": "synonym",  
        "accepted_name": "Xanthomendoza fallax (Hepp)  
                        Søchting, Kärnefelt & S.Y. Kondr.",  
        "score": 87,  
        "name_score": 96,  
        "auth_score": 0  
    },  
    "other_matches": []  
}
```

APIs

- ❖ Can be called from anywhere
- ❖ Can be integrated in any application/project
- ❖ Full documentation available at
<https://italic.units.it/index.php?procedure=api>



The screenshot shows the ITALIC 7.0 API documentation interface. At the top, there's a banner with the text "ITALIC 7.0" and navigation links for "HOME", "QUERY", "IDENTIFICATION KEYS", "GENERAL INFORMATION", and "HOW TO CITE". Below the banner, there's a "Servers" dropdown set to "https://italic.units.it/api/v1". The main content area is organized into sections: "match", "description", "ecology", "rarity", "classification", "checklist", and "occurrences". Each section contains one or more API endpoints listed as "GET /resource/resource_id". The "match" section has one endpoint: "GET /match/{name} match a name". The "description" section has two endpoints: "GET /description/{acceptedName} get a description" and "GET /description/{id} get a description". The "ecology" section has two endpoints: "GET /ecology/{acceptedName} get ecology" and "GET /ecology/{id} get ecology". The "rarity" section has two endpoints: "GET /rarity/{acceptedName} get rarity" and "GET /rarity/{id} get rarity". The "classification" section has two endpoints: "GET /classification/{acceptedName} get classification" and "GET /classification/{id} get classification". The "checklist" section has one endpoint: "GET /checklist/{region} get checklist". The "occurrences" section has two endpoints: "GET /occurrences/{acceptedName} get occurrences" and "GET /occurrences/{id} get occurrences". Each endpoint is accompanied by a brief description.

Libraries for R and python





italic: use cases

- ❖ Align a list of scientific names to the Checklist of Lichens of Italy

```
italic::lich_match(dataset$names)
```

input_name	matched_name	status	accepted_name	score	name_score	auth_score
Evernia prunastri	Evernia prunastri (L.) Ach.	accepted	Evernia prunastri (L.) Ach.	90	100	0
Fulglesia australis	Fulglesia australis (Arnold) Poelt	synonym	Variospora australis (Arnold) Arup, Søchting & Frödén	90	100	0
Peltigera collina	Peltigera collina (Ach.) Schrad.	accepted	Peltigera collina (Ach.) Schrad.	90	100	0
Ramalina fraxinea	Ramalina fraxinea (L.) Ach.	accepted	Ramalina fraxinea (L.) Ach.	90	100	0
Placidium squamulosus	Placidium squamulosum (Ach.) Breuss	accepted	Placidium squamulosum (Ach.) Breuss	85	95	0
Ramonia interjecta				0	0	0

italic: use cases

- ❖ Get occurrence data for species distribution models

```
italic::lich_occurrences(  
  'Cetraria islandica (L.) Ach. subsp. islandica')
```

