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DOI: https://doi.org/10.3897/arphapreprints.e75960

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Fungal literature records database of the sub-Antarctic region of Aysén, Chile

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Abstract

Background

To this day, merely 15% of all estimated fungi species are documented, and in certain regions, its biodiversity is practically unknown. Inside the Fungi Kingdom, macrofungi and lichens assume a critical part in the ecosystem functionality and have a historical connection to mankind's social, clinical and nutritious uses. Despite their importance, the diversity of these groups has been widely overlooked in the sub-Antarctic region of Chile, a crucial area in the study of climate change due to its extraordinary biodiversity and its proximity to Antarctica. Few studies regarding both groups have been conducted in this sub-Antarctic region but data are still scarce and inaccessible, as there are only published in specialized journals, unreachable to local communities.

New information

This publication presents the records available in published scientific and technical reports on macrofungi and lichen diversity. In total, 987 occurrence records of 435 species (106 records of 95 macrofungi species 881 records of 340 lichen species) were digitized and integrated into the regional platform Biodiversity Information System for Aysén (SIB-Aysén) and into GBIF.

Keywords

database, Chilean Patagonia, macrofungi, lichens, Mycobiota, SiB-Aysén.

Introduction

The biodiversity of the Fungi Kingdom is immense, including organisms with varied forms, colors and life habits, from macroscopic to microscopic sizes, being present in all ecosystems on Earth, both terrestrial and marine (Tedersoo et al. 2014). They are essential for ecosystem functionality (Öpik et al. 2006), due to their participation in the organic matter decomposition processes and the symbiotic relationships with other living beings (Dighton and White 2017). They also provide unique uses as food, medicinal or cultural, being, in addition, an element with great potential for industrial development (Furci 2013, Hyde et al. 2019). Macrofungi and lichens are classified within this kingdom, in addition to yeasts and molds. Macrofungi are non-photosynthetic heterotrophic free-living organisms with macroscopic fructifications which may grow on various substrates (Vargas-Castillo and Morano 2014). Attending to their nutrition, they can be classified as: saprophytes, which obtain nutrients and energy from decaying plant material; parasites, which derive nutrients from their host from other co-inhabitants; and symbiotics, which associate with other organisms with a mutual benefit to each other (Lazo 2001, Furci 2008). Lichens, on the other hand, are symbiotic organisms in which a fungi, known as mycobiont, is in a close symbiosis with a microalgae or cyanobacterium, known as photobiont. As photosynthetic organisms and pioneers of ecosystems (Vargas-Castillo and Morano 2014, Bjerke et al. 2003), macrofungi and lichens have essential ecological functions as they participate in the carbon and nitrogen fixation cycle, act as primary colonizers in succession and serve as bioindicators (Furci 2013). They are found in all types of habitats and substrates, colonizing rocks, logs, the ground and other organisms (Quilhot et al. 2012). Taxonomically, most macrofungi and lichens are classified in the Divisions Basidiomycota and Ascomycota, which differ in the way they produce and discharge spores (Lazo 2001).

It is estimated that there are up to 5 million fungi species in the world, but currently, less than 15% are known (Blackwell 2011). In Chile, one of the barely known biodiversity groups is the Fungi Kingdom, with only 1500 known species (Furci 2008), and specifically in the Aysén region the lack of knowledge is even greater. This region, belonging to the sub-Antarctic zone of Chile together with the Magallanes region, is one of the most pristine places on the planet being crucial in the study of climate change due to its extraordinary biodiversity and its proximity to Antarctica (Osorio et al. 2002, Rozzi et al. 2020). This region represents the biogeographic limits of the extreme Antarctic conditions (Macaya and Zuccarello 2010), making it an extremely fragile area but with an extraordinary natural heritage since it houses a great variety of terrestrial and aquatic ecosystems (Álvarez et al. 2010). Due to the harsh conditions that occur in this territory composed by mountain ranges, deserts and glaciers, the fungi biodiversity is detrimentally affected, with only a few species being able to settle (Furci 2008). These hostile intrinsic conditions have even limited the fungi biodiversity research in this area in the past, but fortunately there are increasing initiatives that contribute to the local fungi biodiversity knowledge directly from the government (Corporación Nacional Forestal 2009, Corporación Nacional Forestal 2010 , Corporación Nacional Forestal 2012) as well as a regional platform that has been

developed under the same standards as Darwin Core (DwC), the Biodiversity Information System for Aysén or SiB-Aysén (https://kataix.umag.cl/sib-aysen/). SiB-Aysén fosters citizen participation as it is an interactive platform that allows users to enter their records according to a validation protocol (Sánchez-Jardón et al. 2021).

One of the missions of this initiative attends the gathering of previous studies data, incorporating them into biodiversity information systems and making them accessible for consultation (Chavan and Penev 2011). This data integration effort is especially relevant in the remote areas of the planet, such as the sub-Antarctic region of Chile, where sampling tasks are extraordinarily expensive and therefore more scarce. As long as the information remains disseminated in multiple sources, it is easier for the disparity to occur in subsequent sampling efforts (Kühl et al. 2020), causing overrepresentation of records in some areas, generally those closer to human populations (Barbosa et al. 2013). It is important to note that behind the data collected in GBIF there is a considerable work of digitization, compilation and validation. Systematizing the sampling or collection data is common, but adapting the databases to certain standards, such as Darwin Core, so that they are available to the public represents an additional effort (Heberling et al. 2021).

The purpose of this work is to collect the macrofungi and lichen data available in other published scientific and technical reports to incorporate it in the Biodiversity Information System for Aysén (SIB-Aysén) and the GBIF. This way the biodiversity information can be consulted and used in management and conservation programs, as well as complemented by other scientific and citizen observations in future investigation and citizens science projects (Penev et al. 2017, Rozzi et al. 2020).

Project description

Title: Fungal literature records database of the sub-Antarctic region of Aysén, Chile (https://kataix.umag.cl/sib-aysen/)

Personnel: Laura Sánchez-Jardón

Sampling methods

Study extent: The geographic extent (48° 42' 55"S to 44° 8' 3"S; 74° 25' 32"W to 71° 32' 18"W) of the digitised dataset corresponds to the region of Aysén del General Carlos Ibáñez del Campo (XI Region) with an area 109.052 km^2, representing about 14% of the Chilean territory. This region is situated in the sub-Antarctic zone of Chile, which comprises both the Magallanes and Aysén administrative regions; both having an extraordinary biodiversity, representing one of the most pristine areas on the planet, unique for its proximity to Antarctica and with significant implications in the study of climate change (Osorio et al. 2002, Rozzi et al. 2020).

Sampling description: The digitization aims to summarise the fungi species occurrences accumulated in previous mycological studies and published in reviewed scientific literature

(Filippova et al. 2020). To fulfill the aim of this work, an exhaustive review of the scientific literature related to the diversity of macrofungi and lichens in the Aysén region, Chile, was carried out using scientific content search engines such as Web of Science and Google Scholar. A total of 15 references were found (9 specialized journals, 3 books and 3 technical documents) that contained records or suggested the presence of macrofungi and lichen species within the territory of the Aysén region (Bjerke et al. 2003, Corporación Nacional Forestal 2009, Corporación Nacional Forestal 2010, Corporación Nacional Forestal 2012, Furci 2008, Furci 2018, Furci 2013, Lazo 2001,Osorio et al. 2002, Quilhot et al. 2002a,Quilhot et al. 2002b, Quilhot et al. 2002c, Quilhot et al. 2012,Ramírez et al. 2014, Sandoval-Leiva 2014,Vargas-Castillo and Morano 2014). This data collection started with a project FIC from the Aysén Regional Government known as “Biodiversity Information System for Aysén, SIB-Aysén (BIP 40000522-0) and continued with the project “Hongusto: social innovation regarding wild and cultivated edible mushrooms from the Aysén region (CORFO 15IS-46635)”. Eventually, it will be complemented by the citizens’ observations associated with the SIB-Aysén. Eventually, the citizens’ observations associated with the SIB-Aysén will complement

Quality control: The taxonomic nomenclature used has been updated according to MycoBank (available at https://www.mycobank.org/). The geographic coordinates have been systemized from what was reported by the authors in the publications; when only the locality was mentioned, it has been approximated using Google Earth; in both cases the coordinates have been validated using the GBIF tool.

Step description: The records were systemized in a database with taxonomic, geographic and temporal information. The coordinates indicated by the authors were assumed; when not indicated in the publication, they were obtained from the locality names using GoogleEarth ®. The substrate information of the lichens when provided was classified as follows according to the reviewed literature: epiphytes when only growing on trees or shrubs; epiphytic-lignicolous when growing on rotten wood or decaying organic matter; folicolous when growing on living tree leaves; muscicolous when growing on mosses; saxicolous when growing on rocks and terricolous when growing on the ground. The taxonomic nomenclature used in each publication was updated according to MycoBank (available at https://www.mycobank.org/). Ultimately, this information was systemized in the form of records according to the DwC standard (Fig. 1) and uploaded to GBIF (Sánchez-Jardón et al. 2021). The complete dataset is available in Darwin Core Archive format via the Global Biodiversity Information Facility (GBIF).

Geographic coverage

Description: The records were distributed throughout the entire Aysén region, with a slightly greater presence in the southeastern half of the region (Fig. 2). Broadly, the density of records is low (from 1 to 4 records per locality) although there are areas with a higher density (up to 178 records in the same locality). The locations with the highest numbers of records are Puntilla de los Cisnes, in the National Park Laguna de San Rafael, with 178

records, Tamago National Reserve, with 123records and Interpretation Center of the National Forest Corporation (CONAF) in Laguna de San Rafael too, with 76 records.

Coordinates: 44° 8' 3"S and 48° 42' 55"S Latitude; 74° 25' 32"W and 71° 32' 18"W Longitude.

Taxonomic coverage

Description: In total, 1263 records have been collected from 618 taxa belonging to the Fungi Kingdom, namely macrofungi (341 records of 251 species) and lichens (922 records of 367 species). As shown in Table 1, the order of macrofungi with the most abundance of records is Agaricales (204 records of 158 species), which accumulates 60% of the macrofungi records, followed by Pezizales (27 records of 18 species); Boletales (19 records of 11 species), Polyporales (16 records of 10 species); Cytettariales (12 records of 6 species); Russulales (11 records of 8 species); Geastrales, Helotiales and Gomphales (7 records of 5, 7 and 5 species respectively); Dacrymycetales (6 records of 3 species); Hymenochaetales (5 records of 4 species); Geoglossales and Xylariales (4 records of 3 species each); Phallales and Tremellales (3 records of 2 and 3 species); Pucciniales and Hysterangiales (2 records of 1 and 2 speceies);and finally Auriculariales and Thelephorales (1 records of 1 species each). Regarding lichens, the orders with the most abundance of records are Lecanorales (438 records of 166 species) and Peltigerales 375 records of 142 species), both accumulating around 88% of the records, followed by Pertusariales (20 records of 9 species); Baeomycetales and Teloschistales (14 records of 10 and 8 species); Caliciales (12 records of 8 species); Umbilicariales (10 records 6 species); Rhizocarpales (9 records of 5 species); Agaricales and Verrucariales (6 records of 2 and 5 species respectively); Gyalectales (5 records of 1 specie); Arthoniales (4 records of 3 species); Graphidales and Incerti ordinis (3 records of 2 and 1 species); and finally, Candelariales, Ostropales and Superstratomycetales (1 record of 1 species each) . A complete list of species and number of records is available in Suppl. materials 1, 2.

At family level, among the macrofungi, Agaricaceae is the most diverse with 31 records of 24 species (Table 2), followed by Cortinaceae and Strophariaceae with 28 records of 22 and 26 species respectively. The macrofungi species with the most records are *Cyttaria darwinii* and *Cortinarius magellanicus* (4 records each), followed by *Ganoderma australe, Gyromitra antarctica, Morchella conica, Ramaria flava* and *Trametes versicolor*among 20 other specieswith 2 records each. In the case of lichens, the most frequent family is Parmeliaceae with 277 records of 86 species (Table 2), followed by Peltigeraceae (239 records of 81 species) and Pannariaceae (82 records of 34 species). The species with the most records are *Menegazzia globulifera* (13 records) and *Leifidium tenerum* (12 records), *Pseudocyphellaria crocata* and *Chlorea malacea* (11 records each). The number of records per species is available in Suppl. materials 1, 2.

Traits coverage

Considering the type of substrate in which the lichen grow, most of the recorded lichen species are epiphytic (which includes epiphytic, lignicolous, folicolous and muscicolous of the database habitat categories) with 192of 367species with substrate information(Fig. 3), followed by 48 saxicolous species; 410 epiphytic-saxicolous species and 33 terricolous species. The remaining species were epiphytic-terricolous (28 species); saxicolous-terricolous (13 species) and epiphytic-saxicolous-terricolous (13 species). Regarding temporary coverage, the records cover a period of 51 years, from 1967 to 2018.

Temporal coverage

Data range: 1984-11-01 - 2014-1-01.

Usage licence

Usage licence: Creative Commons Public Domain Waiver (CC-Zero)

Data resources

Data package title: Fungal literature records database of the sub-Antarctic region of Aysén, Chile

Resource link: https://www.gbif.org/es/dataset/8fbf6bab-3c5f-4397-8eac-362a4d582b3c

Alternative identifiers: https://doi.org/10.15468/fuwe8e; http://gbif-chile.mma.gob.cl/ipt/resource?r=fungi_sib_aysen

Number of data sets: 1

Data set name: Diversidad potencial del Reino Fungi (macrohongos y líquenes) en el Sistema de Información en Biodiverisad para Aysén (SIB-Aysén), Chile

Data format: Darwin Core

Description: The dataset includes a table in Darwin Core format with 53 fields and 1263 records.

Column label	Column description
type	The nature or genre of the resource. The name of the class that defines the root of the record.
language	A language of the resource.

license	A legal document giving official permission to do something with the resource.
rightsHolder	A person or organization owning or managing rights over the resource.
accessRights	Information about who can access the resource or an indication of its security status.
InstitutionID	An identifier for the institution having custody of the object(s) or information referred to in the record.
collectionID	An identifier for the collection or dataset from which the record was derived.
institutionCode	The name (or acronym) in use by the institution having custody of the object(s) or information referred to in the record.
collectionCode	The name, acronym, coden, or initialism identifying the collection or data set from which the record was derived.
datasetName	The name identifying the data set from which the record was derived.
basisOfRecord	The specific nature of the data record.
occurrenceID	An identifier for the Occurrence.
catalogNumber	An identifier (preferably unique) for the record within the data set or collection.
recordedBy	A list of names of people, groups, or organizations responsible for recording the original Occurrence.
associatedMedia	A list of identifiers (publication, global unique identifier, URI) of media associated with the Occurrence.
associatedReferences	A list of identifiers of literature associated with the Occurrence.
eventDate	The date-time or interval during which an Event occurred.
year	The four-digit year in which the Event occurred
verbatimEventDate	The verbatim original representation of the date and time information for an Event.The four-digit year in which the Event occurred
habitat	A category or description of the habitat in which the Event occurred.
continent	The name of the continent in which the Location occurs.
country	The name of the country in which the Location occurs.
countryCode	The standard code for the country in which the Location occurs.
stateProvince	The name of the next smaller administrative region than country in which the Location occurs.
county	The full, unabbreviated name of the next smaller administrative region than stateProvince.
municipality	The full, unabbreviated name of the next smaller administrative region than county in which the Location occurs.

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locality	The specific description of the place.
verbatimLocality	The original textual description of the place.
verbatimElevation	The original description of the elevation (altitude) of the Location.
locationRemarks	Comments or notes about the Location.
geodeticDatum	The coordinate system and set of reference points upon which the geographic coordinates are based.
verbatimCoordinates	The verbatim original spatial coordinates of the Location.
verbatimLatitude	The verbatim original latitude of the Location.
verbatimLongitude	The verbatim original longitude of the Location.
verbatimCoordinateSystem	The spatial coordinate system for the verbatimLatitude and verbatimLongitude or the verbatimCoordinates of the Location.
decimalLatitude	The geographic latitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of the geographic center of a Location.
decimalLongitude	The geographic latitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of the geographic center of a Locati
GeoreferenceSources	A map, gazetteer, or other resource used to georeference the Location.
GeoreferenceRemarks	Notes or comments about the spatial description determination, explaining assumptions made in addition or opposition to the those formalized in the method referred to in georeferenceProtocol.
CoordinateUncertaintyInMeters	The horizontal distance (in meters) from the given decimalLatitude and decimalLongitude describing the smallest circle containing the whole of the Location.
scientificName	The full scientific name, with authorship and date information if known.
acceptedNameUsage	The scientificName of the taxon considered to be the valid (zoological) or accepted (botanical) name for this nameUsage.
Kingdom	The full scientific name of the kingdom in which the taxon is classified.
phylum	The full scientific name of the phylum or division in which the taxon is classified.
class	The full scientific name of the class in which the taxon is classified.
order	The full scientific name of the order in which the taxon is classified.
family	The full scientific name of the family in which the taxon is classified.
genus	The full scientific name of the genus in which the taxon is classified.
specificEpithet	The name of the first or species epithet of the scientificName.
infraspecificEpithet	The name of the lowest or terminal infraspecific epithet of the scientificName, excluding any rank designation.

taxonRank	The taxonomic rank of the most specific name in the scientificName.
scientificNameAuthorship	The authorship information for the scientificName formatted according to the conventions of the applicable nomenclaturalCode.
vernacularName	A common or vernacular name.

Acknowledgements

We especially acknowledge all participants among the local communities and team members who contributed to systemize data to SIB-Aysén. Chile's Innovation for Competitiveness Fund (FIC) provided funding for both SIB-Aysén (BIP 30346481-0) and the Open Laboratory for Sub-Antarctic Sciences (BIP 40000521-0) initiatives.

Author contributions

All authors have contributed equally to the work.

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Figure 1.

Flowchart depicting major steps in dataset development and publishing.

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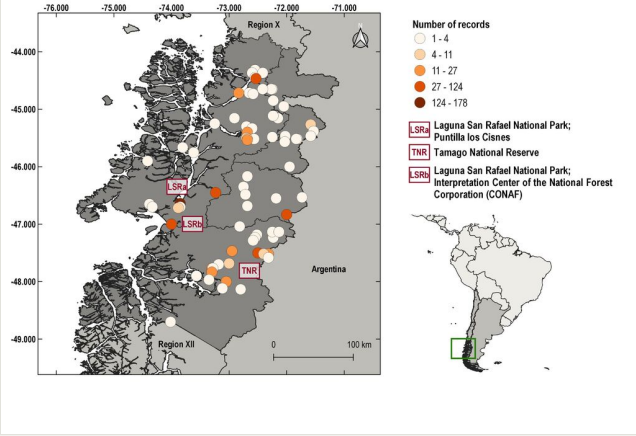

Figure 2.

Number of Fungi records in Aysén, Chile. Localities with the highest numbers are indicated.

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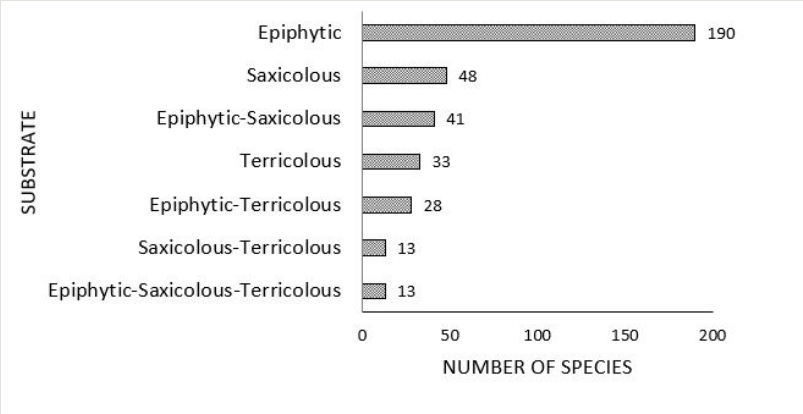

Figure 3.

Number of lichen species according to their substrate.

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Table 1.

Number of records (Nº R.) for each Order.

Order of Macrofungi	**NºR**		**Order of Lichen**	**NºR**
Agaricales	203		Lecanorales	437
Pezizales	27		Peltigerales	375
Boletales	19		Pertusariales	20
Polyporales	16		Baeomycetales	14
Cyttariales	12		Teloschistales	14
Russulales	12		Rhizocarpales	13
Geastrales	7		Caliciales	12
Helotiales	7		Umbilicariales	10
Gomphales	7		Verrucariales	7
Dacrymycetales	6		Agaricales	6
Hymenochaetales	5		Gyalectales	5
Geoglossales	4		Arthoniales	4
Xylariales	4		Graphidales	3
Phallales	3		Candelariales	1
Tremellales	3		Ostropales	1
Hysterangiales	2			
Pucciniales	2			
Auriculariales	1			
Thelephorales	1			

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Table 2.

Number of records (Nº R.) identified by Family. Other Families include those with less than 5 records.

Macrofungi families	**N°R**		**Lichens families**	**N°R**
Strophariaceae	30		Parmeliaceae	277
Agaricaceae	28		Peltigeraceae	251
Cortinariaceae	28		Pannariaceae	83
Mycenaceae	18		Cladoniaceae	75
Tricholomataceae	15		Sphaerophoraceae	45
Cyttariaceae	12		Collemataceae	34
Lycoperdaceae	10		Stereocaulaceae	18
Marasmiaceae	10		Teloschistaceae	14
Polyporaceae	10		Trapeliaceae	14
Pyronemataceae	9		Coccotremataceae	13
Amanitaceae	7		Rhizocarpaceae	13
Geastraceae	7		Lecanoraceae	12
Gomphaceae	7		Physciaceae	11
Stereaceae	7		Umbilicariaceae	10
Bolbitiaceae	6		Verrucariaceae	7
Crepidotaceae	6		Hygrophoraceae	6
Dacrymycetaceae	6		Coccocarpiaceae	5
Pezizaceae	6		Phlyctidaceae	5
Schizophyllaceae	6		Other families	29
Suillaceae	6			
Entolomataceae	5			
Hygrophoraceae	5			
Morchellaceae	5			
Pluteaceae	5			
Other Families	87			

Supplementary materials

Suppl. material 1: Number of records (Nº R.) of each lichen species.

Authors: Sánchez-Jardón, L.
Data type: Occurences
Brief description: The table shows the compilation of lichens species with the number of records in the Aysén region.
Download file (16.34 kb)

Suppl. material 2: Number of records (Nº R) of each macrofungi species.

Authors: Sánchez-Jardón, L.
Data type: Occurences
Brief description: The table shows the compilation of macrofungi species with the number of records in the Aysén region.
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