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iNaturalist as a platform for documenting Chilean funga

iNaturalist como plataforma para documentar la funga chilena

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Abstract

This study analyzes the impact of iNaturalist on the recording and documentation of fungi in Chile from 2008 to 2024, highlighting its role in integrating citizen science into biodiversity monitoring. This community effort—which currently totals more than 63,000 observations representing 1,245 species—is concentrated in the central and southern regions of the country, mainly in urban areas, where a small group of hyperprolific users generates 44.40% of the records. Since 2020, an increase in the number of observations has been observed, which may be linked to a growing interest in mycology. The use of iNaturalist allows overcoming traditional logistical limitations, expanding the taxonomic, spatial, and temporal coverage of fungal observations, but these advantages are not without biases. In addition, mycology in Chile faces structural challenges, such as funding and training of new specialists. Collaboration between amateurs and professional mycologists is essential to validate the data and extract the potential of this type of tools. This approach complements conventional methods of biodiversity studies and strengthens conservation policies. Although iNaturalist has proven to be an effective tool, more effort and resources are required to address the knowledge gaps of fungal biodiversity. This study reinforces the potential of citizen science as a source of valuable and potentially useful data to address the planetary biodiversity crisis.

Palabras clave: Chile; citizen science; Fungi; iNaturalist.

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Resumen

Este estudio analiza el impacto de iNaturalist en el registro y documentación de hongos en Chile desde 2008 hasta 2024, destacando su rol en la integración de la ciencia ciudadana al monitoreo de biodiversidad. Este esfuerzo comunitario —que actualmente suma más de 63000 observaciones que representan 1245 especies— se concentra en la zona centro y sur del país, principalmente en áreas urbanas, donde un reducido grupo de usuarios hiperprolíficos genera el 44,40 % de los registros. Desde 2020, se ha observado un aumento en el número de observaciones, que puede estar ligado a un creciente interés en la micología. El uso de iNaturalist permite superar las limitaciones logísticas tradicionales, ampliando la cobertura taxonómica, espacial y temporal de las observaciones de hongos, pero estas ventajas no están exentas de sesgos. Además, la micología en Chile enfrenta desafíos estructurales, como el financiamiento y la formación de nuevos especialistas. La colaboración entre aficionados y micólogos profesionales es fundamental para validar los datos y extraer el potencial de este tipo de herramientas. Este enfoque complementa los métodos convencionales de los estudios de biodiversidad y fortalece las políticas de conservación. Aunque iNaturalist ha demostrado ser una herramienta efectiva, se requieren más esfuerzos y recursos para abordar los vacíos de conocimiento de la biodiversidad fúngica. Este estudio refuerza el potencial de la ciencia ciudadana como fuente de datos valiosos y potencialmente útiles para hacer frente a la crisis planetaria por pérdida de biodiversidad.

Keywords: Chile; ciencia ciudadana; Fungi; iNaturalist.

INTRODUCTION

Citizen or community science

Before the —relatively recent— professionalization of science, many of the observations about the natural world depended on people without formal scientific training (Miller-Rushing *et al*., 2012; Vetter, 2011). The recent phenomenon of citizen science stands out as a valuable source of data and has a scientific and social impact worthy of being considered (Bonney *et al*., 2014). Multiple attempts have been made to provide a definition of citizen science —also referred to as community science (Lin Hunter *et al*., 2023)— without yet reaching an interdisciplinary consensus (Auerbach *et al*., 2019). To address this, Heigl *et al*. (2019) propose a catalog of criteria —based on the ten principles of the European Citizen Science Association (2015)— to assess the quality of a citizen science project, covering seven areas of evaluation: (1) what is not citizen science, (2) scientific standards (3) collaboration, (4) open access to scientific research, (5) communication, (6) ethics, and (7) data management.

The scientific endeavor benefits from the propensity of people to record and document the natural world (Bonney, 2021). The inclusion of the community in the scientific research process can greatly contribute to monitoring biodiversity and environmental conditions, reinforcing their connection with nature (Peter *et al*., 2021). On the other hand, gathering new data while managing existing data efficiently is pivotal to fully understand emerging patterns and driving agents involved in biological and environmental phenomena. Primary data such as taxonomic identification, timestamps, and geographic coordinates are indispensable, and secondary data, often recorded unintentionally, are crucial to understanding biodiversity dynamics (Pernat *et al*., 2024).

Community efforts aimed at gathering quality scientific data currently take place on a global scale (de Sherbinin *et al*., 2021; Chandler *et al*., 2017) and provide the opportunity to engage young volunteers (Aristeidou *et al*., 2021a, 2021b). Successful examples include the eBird platform (https://ebird.org/home), a global network of birders that advocates (a) reaching a balance between quantity and quality of data (b) facilitating access and use of data, and (c) encouraging diversity of collaborators in every aspect of the project (Sullivan *et al*., 2009, 2014). Other relevant initiatives include monitoring the advance of the invasive alien species *Harmonia axyridis* (Coleoptera, Coccinelidae) at national, continental, and global scales (de Groot *et al*., 2024; Grez *et al*., 2022; Hiller & Haelewaters, 2019), GLOBE Mosquito Habitat Mapper (https://observer.globe.gov/do-globe-observer/mosquito-habitats) that contributes to mosquito-borne disease risk modeling (Low *et al*., 2021), and *Científicos de la Basura* (https://cientificosdelabasura.ucn.cl/) that seeks to record data on anthropogenic waste on beaches and rivers (Thiel *et al*., 2023).

Citizen science in South America

Currently, studies whose data source comes from citizen science initiatives tend to increase in number and scope, even in developing countries (Follet & Strezov, 2015; Ortega-Alvarez & Casas, 2022; Requier *et al*., 2020). In South America specifically, there have been studies on bird ecology in Argentina (Schaaf *et al*., 2024), community-based environmental data gathering in Bolivia (Maillard *et al*., 2024), analysis of observations on terrestrial gastropods in Brazil (Rosa *et al*., 2022), taxonomic novelties on fungi in Colombia (Franco-Molano *et al*., 2024) and Ecuador (Vandegrift *et al*., 2023), the monitoring of the advance of invasive species in Paraguay and Uruguay (Goossen-Lebrón *et al*., 2023; Grattarola *et al*., 2024), bird mating patterns and nesting habits in Peru (Díaz *et al*., 2024), the use of local knowledge for decision-making on climate change adaptation measures in Suriname (Smith *et al*., 2024), and a surveillance program for insect vectors of Chagas disease in Venezuela (Delgado-Noguera *et al*., 2022). While in Chile citizen science have contributed, for instance, to amphibian conservation (Vidal *et al*., 2024), to documenting biotic interactions in gastropods (Barahona-Segovia *et al*., 2024a) and multi-taxa pollinators (Barahona-Segovia *et al*., 2023, 2024b; Fontúrbel *et al*., 2024), and to cetacean monitoring (Garcia-Cegarra *et al*., 2021).

Citizen science and fungi

Fungi play essential ecological roles in the conservation of the biosphere (Cao *et al*., 2021; Gonçalves *et al*., 2021). To date, 155,869 species of fungi have been described (Bánki *et al*., 2024), although the number of existing species is estimated to surpass 2,500,000 (Niskanen *et al*., 2023). In Chile, although there is no consensus regarding the number of species occurring in the territory, the most up-to-date data indicate that there are 1,600 species of macrofungi —of which 240 correspond to aphyllophoroid fungi— and 1,416 species of lichenized and lichenicolous fungi (Riquelme & Rajchenberg, 2021; Riquelme *et al*., 2022; Sandoval-Leiva *et al*., 2023; Vargas-Castillo & Sandoval-Leiva, 2020). While these numbers are substantial, it is possible to get even closer to the actual number of existing species by actively involving the community in the data gathering process (Haelewaters *et al*., 2024b). Studies using citizen science data, meanwhile, rely on open and efficient access to information, where the online databases Index Fungorum (Index Fungorum Partnership, 2024), MycoBank (Robert *et al*., 2013), and MyCoPortal (Miller & Bates, 2017; MyCoPortal, 2024), stand out along with the iNaturalist (https://www.inaturalist.org/home; iNaturalist Network, 2024), Mushroom Observer (https://mushroomobserver.org; Mushroom Observer, Inc., 2024), CitSci (https://citsci.org; CitSci.org, 2024), Guardians of Earth (https://www.guardiansofearth.io; Guardians of Earth, 2024), Observation.org (https://observation.org; Observation International and local partners, 2024), and SPOTTERON (https://www.spotteron.net; SPOTTERON GmbH, 2024) platforms. Some relevant citizen science projects focused on the study of fungi include Mind.Funga (https://mindfunga.ufsc.br; Chaves *et al*., 2024), Danish Fungal Atlas (https://svampe.databasen.org; Heilmann-Clausen *et al*., 2021), Fungimap (https://fungimap.org.au; Fungimap Inc, 2024), FunDiS (https://www.fundis.org; Fungal Diversity Survey, Inc., 2024; Sheehan *et al*., 2021), Lost and Found Fungi Project (https://fungi.myspecies.info/content/lost-and-found-fungi-project; Fungi of Great Britain and Ireland, 2014), Meetnet Paddenstoelen (https://www.mycologen.nl/onderzoek/meetnet; Nationale Databank Flora en Fauna [NDFF], 2024) y HongosAR (https://hongos.ar/; Fundación Hongos de Argentina para la Sustentabilidad [FHAS], 2024). Examples of the contributions on fungi from citizen science data can be found in countries such as Australia (Irga *et al*., 2018, 2020), Canada (Bazzicalupo *et al*., 2022), Chile (Riquelme *et al*., 2022), Denmark (Heilmann-Clausen *et al*., 2016, 2019, 2021), Ecuador (Vandegrift *et al*., 2023), Estonia (Copoț *et al*., 2024), United States (Shumskaya *et al*., 2023), Finland (Ruotsalainen *et al*., 2023), Greece (Polemis *et al*., 2023), Czech Republic (Koukol *et al*., 2020), and South Africa (Gryzenhout, 2015). Much of the data used in these studies converge in the Global Biodiversity Information Facility or GBIF (GBIF.org, 2024) under the Darwin Core standard (Biodiversity Information Standards [TDWG], 2024).

iNaturalist network

iNaturalist is an online citizen science platform for recording and documenting biodiversity data (iNaturalist Network, 2024). It consists of a global network of users who voluntarily share their observations of biota through photographs and audio recordings, along with metadata such as timestamp and geolocation. It is also possible to introduce additional information—or secondary data—which may include ecological interactions, DNA sequence accession numbers, and voucher specimen codes. As of November 23, 2024, 8,350,896 iNaturalist users have contributed 243,346,228 observations, of which 13,880,320—equivalent to 23,770 species—are fungi. Observations that achieve a consensus of ⅔ of the species-level identification agreements or Community ID qualify to achieve Research Grade (https://help.inaturalist.org/en/support/solutions/articles/151000194901-how-do-identifications-work-) and are subsequently added into GBIF (GBIF.org, 2024). In addition, the global iNaturalist network converges in national-scale nodes associated with various governmental and non-governmental organizations. The iNaturalist node for Chile, called iNaturalistCL, brings together local naturalists, amateurs, and biodiversity professionals, in collaboration with the Ministerio de Medio Ambiente (https://inaturalist.mma.gob.cl/home).

Rationale

It is well known that citizen science—together with its assumptions, methods and products —can be considered a source of reliable biological data. However, its potential value is not easy to predict or quantify. So far, the impact of such initiatives at the local level is still not known. Involving the community in biodiversity studies can enhance biological data collection and processing, supporting improved conservation decisions and climate adaptation strategies. In this context, the records of iNaturalist fungal observations made in Chile since its implementation in 2008 until November 21, 2024, were analyzed. This paper provides an overview of the role of the iNaturalist platform in recording and documenting data on fungi in Chile, while addressing some aspects of the number of observations, user behavior, and the spatiotemporal distribution of observations.

MATERIALS AND METHODS

Data sources

The datasets were obtained from iNaturalist (https://www.inaturalist.org/observations/export) using the Export Observations option. The following parameters were entered in the Create a Query section: quality_grade=any&identifications=any&iconic_taxa[]=Fungi&place_id=7182&-verifiable=true&spam=false) while the following columns were selected in the Choose columns section: Columns id, uuid, observed_on_string, observed_on, time_observed_at, time_zone, user_id, user_login, user_name, created_at, updated_at, quality_grade, license, url, image_url, sound_url, tag_list, description, num_identification_agreements, num_identification_disagreements, captive_cultivated, oauth_application_id, place_guess, latitude, longitude, positional_accuracy, private_place_guess, private_latitude, private_longitude, public_positional_accuracy, geoprivacy, taxon_geoprivacy, coordinates_obscured, positioning_method, positioning_device, place_town_name, place_county_name, place_state_name, place_country_name, place_admin1_name, place_admin2_name, species_guess, scientific_name, common_name, iconic_taxon_name, taxon_id, taxon_kingdom_name, taxon_phylum_name, taxon_subphylum_name, taxon_superclass_name, taxon_class_name, taxon_subclass_name, taxon_superorder_name, taxon_order_name, taxon_suborder_name, taxon_superfamily_name, taxon_family_name, taxon_subfamily_name, taxon_supertribe_name, taxon_tribe_name, taxon_subtribe_name, taxon_genus_name, taxon_genushybrid_name, taxon_species_name, taxon_hybrid_name, taxon_subspecies_name, taxon_variety_name, taxon_form_name, field:animated+observation, field:count+of+individuals+observed, field:cultivated, field:genbank+accession+number, field:herbarium+catalog+number, field:host, field:original+collector%2F+observer, field:personal+herbarium+id, field:pollinates, field:predating, field:predator+species. Alternatively, in each of the subcategories Basic, Geo, Taxon, Taxon Extras, and Observation Fields it is possible to select the All option. Finally, it is necessary to click on Create Export, to obtain a .csv or Comma-Separated Values file for direct download or via e-mail.

Data analysis

R v4.1.2 (R Core Team, 2021) and R v.4.4.2 (R Core Team, 2024) were used, including the following R packages: ggplot2 (Wickham, 2016), ggspatial (Dunnington, 2023), gridExtra (Auguié, 2017), iNEXT (Chao *et al*., 2014; Hsieh *et al*., 2016, 2024), rgeoboundaries (Runfola *et al*., 2020; Dicko, 2024), sf (Pebesma, 2018), terra (Hijmans, 2022), and tidyverse (Wickham *et al*., 2019).

Data availability

The original datasets and the R script to run the analyses are available in the Zenodo repository (European Organization for Nuclear Research & OpenAIRE, 2013; Riquelme, 2024c): https://doi.org/10.5281/zenodo.14223732

RESULTS

There are more than 63,000 observations of fungi in the iNaturalistCL. The iNaturalist node in Chile, also called iNaturalistCL, accumulates 63,174 observations of fungi —1,245 species— of which 14,376 (22.76%) are Research Grade. The interpolation rarefaction curve based on samples and projected with a 95% confidence interval, estimates a growth in the number of species observed as the number of observations increases (Fig. 1A). Seventy percent of the observations, equivalent to 44,558, are ranked in the class Agaricomycetes (Basidiomycota), followed by 7,146 in Lecanoromycetes (Ascomycota). An overview of the number of observations at the class level is presented in Fig. 2.

About 100 users have contributed 30,000 observations of fungi. Regarding user behavior, the data indicate that the weight of the identification proposal falls mainly on the observer and that the user community generally agrees with this proposal (Fig. 1B). Also, there are 103 users (2.10%) with 100 or more observations of fungi. These hyperprolific users —following the term proposed by Prylutskyi and Kapets (2024)— have contributed 28,077 records, accounting for 44.40% of the 63,174 observations recorded by November 21, 2024.

Observations of fungi are concentrated between Valparaíso and Los Lagos. Since its implementation, the iNaturalistCL platform shows an upward trend in the number of fungal observations, with a marked increase after 2020 (Fig. 1C). In addition, observations of fungi are concentrated in central and southern Chile, between the regions of Valparaíso and Los Lagos. Also, it can be observed that the density of observations is higher in more populated localities (Fig. 1D).

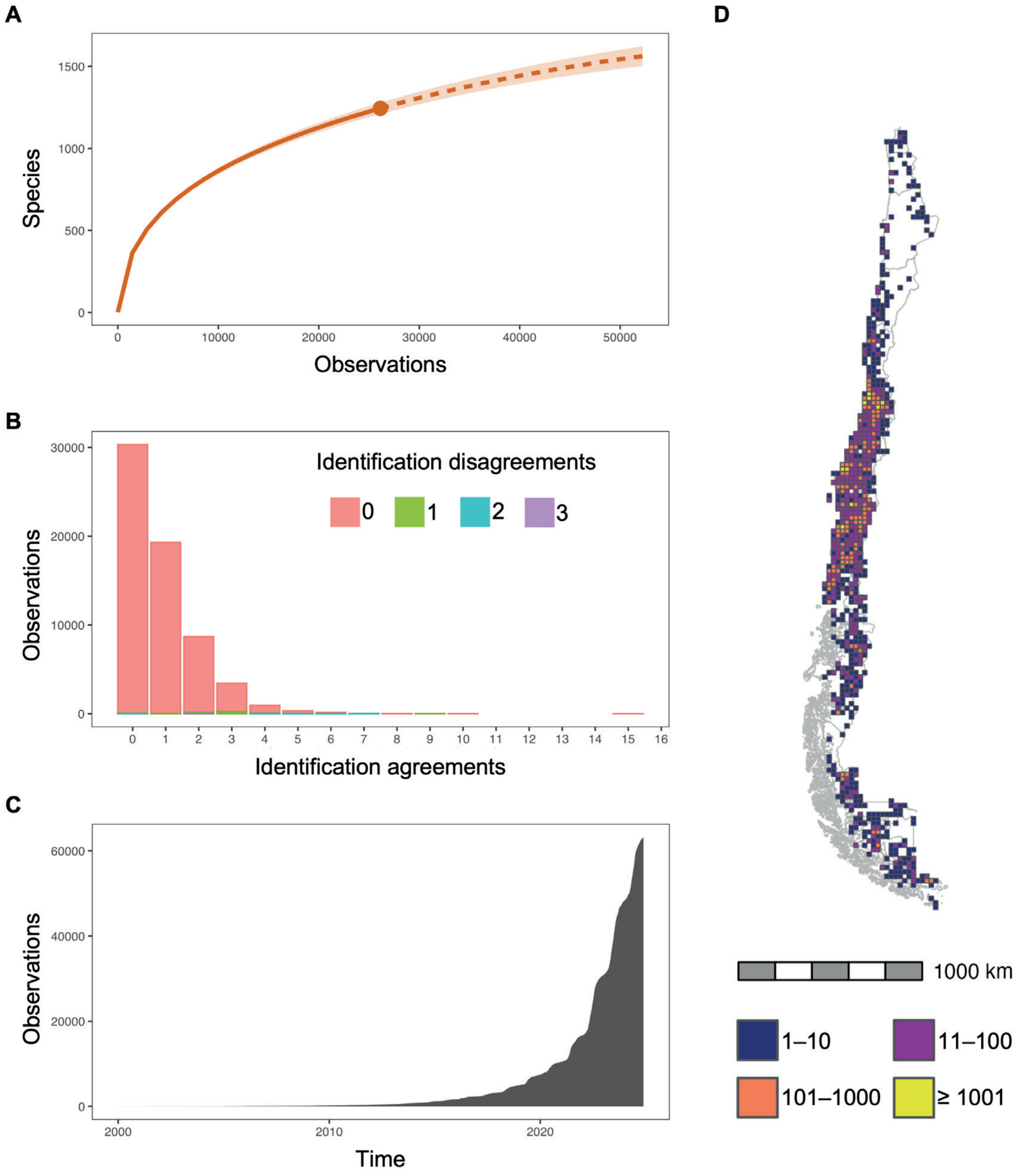

Fig. 1. Analysis of Chilean fungal data from iNaturalist. A) Rarefaction curve relating the cumulative number of observations to the number of species. The solid line indicates the rarefaction of the data, while the dotted line corresponds to a projection, with a 95% confidence interval. B) Graph of identification activity relating the number of observations to identification agreements and disagreements. C) Accumulation curve of fungal observations since the launch of the platform. D) Map of the density of fungal observations per cell as of November 21, 2024. Each cell represents an area of 1,000 km^2.

Fig. 1. Análisis de datos sobre la funga chilena en iNaturalist. A) Curva de rarefacción que relaciona la cantidad acumulada de observaciones con el número de especies. La línea sólida señala la rarefacción de los datos, mientras que la línea punteada corresponde a una proyección, con un intervalo de confianza del 95 %. B) Gráfico de actividad de identificación que relaciona el número de observaciones con acuerdos y desacuerdos de identificación. C) Curva de acumulación de observaciones de hongos desde el lanzamiento de la plataforma. D) Mapa de la densidad de observaciones de hongos por celda al 21 de noviembre de 2024. Cada celda representa una superficie de 1000 km^2.

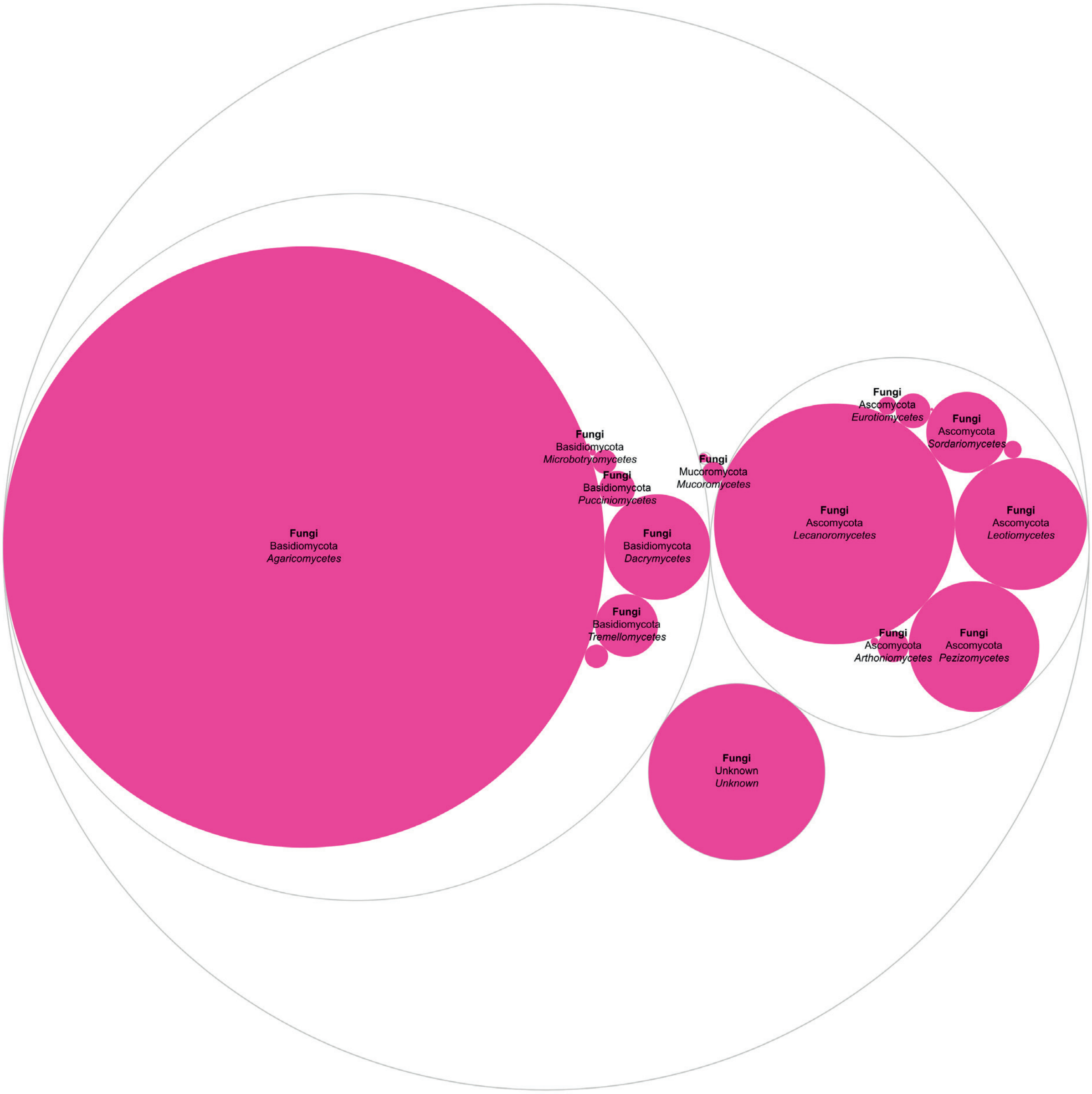

Fig. 2. Circle packing plot representing a total of 63,174 fungal observations from iNaturalist in Chile as of November 21, 2024, up to the taxonomic category of class. Plot made in RAWGraphs 2.0 (Mauri *et al*., 2017).

Fig. 2. Gráfico de empaquetamiento de círculos que representa un total de 63.174 observaciones de hongos de iNaturalist en Chile al 21 de noviembre de 2024, hasta la categoría taxonómica de clase. Gráfico hecho en RAWGraphs 2.0 (Mauri *et al*., 2017).

DISCUSSION AND CONCLUSIONS

Overview

In Chile, the iNaturalist platform accumulated 63,174 observations of fungi as of November 21, 2024, of which 44.40% were recorded by 103 users who can be considered hyperprolific. An important pattern that emerged from the data was that a large part of the observations of fungi were made in central and southern Chile, concentrating in the most densely populated areas. The results also indicate that if sampling efforts are maintained it would be possible to find a greater number of species (Fig. 1A). On the other hand, the interest shown by the community in contributing data on fungi, particularly since 2020, as opposed to the low number of identification disagreements —and even more so the high number of identification agreements— may indicate a limited understanding of the community about the species of fungi inhabiting the territory. Considering this information, it is important to address some aspects related to the possible implications of citizen science in mycological studies at the local level.

iNaturalist as a platform for documenting Chilean funga

In comparison with other South American countries (Riquelme, 2024b; https://doi.org/10.5281/zenodo.14269923), Chile ranks seventh out of 12 in terms of population; however, in terms of number of observations and number of users it ranks fourth, after Brazil, Colombia, and Ecuador, respectively. In terms of observations of fungi per user, Chile is in second place, only behind Guyana. Similarly, in the “observers per capita” parameter, Chile is in second place after Ecuador. Another parameter, the percentage of iNaturalist users with respect to the total population of each country, places Ecuador in the lead, followed by Bolivia, Chile, Uruguay, and Colombia. This preliminary balance —without pretending to be exhaustive and leaving aside multiple factors that could well explain this situation— reveals a growing interest in this platform within the community. It also indicates a tendency among users to document fungi in Chile.

The relevance of taxonomy and biological collections

Recently, there has been renewed interest in recording and documenting fungi at the local level in Chile (Fig. 1C), but this interest has not turned into peer-reviewed scientific publications. In the last five years, only 10 articles reported new species of fungi for Chile (Riquelme, 2024a; https://doi.org/10.5281/zenodo.14275186; https://www.webofscience.com/wos/woscc/summary/b8566cee-40df-42e8-b02e-db843ebc7599-0131a50439/

date-ascending/1). This can be explained by factors such as the scarcity of research and development funding, which in Chile reached 0.36% of gross domestic product (GDP) in 2021, roughly one-seventh of the average figure for countries belonging to the Organisation for Economic Co-operation and Development (OECD) which was 2.72% in the same year (https://data-viewer.oecd.org/?chartId=74051c6c-7933-4bf5-b3b7-c63ce901d061), and the lack of specialists in fungal taxonomy. Moreover, mycology can be considered as a discipline that does not enjoy the same status as zoology, botany or microbiology (Cerrejón *et al*., 2025; Rambold *et al*., 2013) but emulates the same weaknesses of the other disciplines in terms of promoting—and thus allocating resources to—the training of new taxonomists (Löbl *et al*., 2023; Pearson *et al*., 2011).

Natural history collections —and in particular biological collections— are fundamental resources, not only for taxonomy, but for multiple areas of basic and applied research, but their continuity is far from assured (Antonelli *et al*., 2024; Funk, 2018). Meanwhile, biological collections of fungi, called fungaria (plural of fungarium) undergo low taxonomic and geographic coverage —restricted mostly to the northern hemisphere— or limited access to specimen data (Andrew *et al*., 2018; Paton *et al*., 2020; Pearce *et al*., 2020). One way to increase access to specimen data is proposed by Heberling and Isaac (2018) where they use the iNaturalist platform for the purpose of enhancing the value of specimens in biological collections and facilitating access to associated information.

Recently, D'Elía (2024) exposed the current state of biological collections in Chile, emphasizing three aspects that require more attention, such as (a) the scarce funding that affects infrastructure and personnel, (b) the lack of guarantee of the perpetuity of the collections, and (c) the low growth of their holdings. Another worrying aspect is the almost null representation of fungi in biological collections in Chile (Ortiz *et al*., 2023). A particular example of a local biological collection of fungi whose data are open access is VALD-F (Riquelme, 2024d). Addressing this Linnean, Wallacean, and Scottian deficit is an urgent and challenging task (Antonelli *et al*., 2024).

Fungal conservation policies

As of November 27, 2024, the number of species of fungi globally assessed according to their conservation status is 763 —an increase of 27.80% over the number reported by Mueller *et al*. (2022)— with 183 species in the Vulnerable (VU), 106 Endangered (EN) and 37 Critically Endangered (CR) categories, that is, 42.72% of the fungal species assessed are considered to be threatened with extinction (The Global Fungal Red List Initiative, 2024).

During the last decade, the recommendation of the International Union for Conservation of Nature (IUCN) to include the assessment of fungi and lichens in Chilean environmental policy was included in Ley

N.° 20417 (Ley N.° 20417/2010), which amends Ley N.° 19300 (Ley N.° 19300/1994). In line with Decreto Supremo N.° 40/2012, fungi must be considered in environmental impact assessment. In addition, Decreto Supremo N.° 29/2012 or rules for the classification of species according to conservation status establishes the procedure for assessing the risk of extinction of native species of fungi in Chile using the IUCN criteria. To date, 19 species classification processes have been conducted. In the eleventh classification process, during 2014, 21 species of fungi were included for the first time (Ministerio del Medio Ambiente [MMA], 2024). Currently, 137 species of fungi have been evaluated and around 28% are threatened with extinction.

Other ways to conserve fungal species have emerged over time. Citizen science and the incorporation of new DNA sequencing technologies emerge as advantageous options compared to traditional conservation measures (Cazabonne *et al*., 2022; Haelewaters *et al*., 2024b; Lofgren & Stajich, 2021; May *et al*., 2019; Niskanen *et al*., 2023; Srivathsan *et al*., 2021). Contributions from the amateur mycology community have increased the volume and flow of biological data on fungi (Bazzicalupo *et al*., 2022; de Lange *et al*., 2022; Haelewaters *et al*., 2024a; Heilmann-Clausen *et al*., 2019; Irga *et al*., 2018, 2020). Furthermore, the use of environmental DNA has the potential to improve mushroom conservation measures (Copoț *et al*., 2024; Geml *et al*., 2014; Frøslev *et al*., 2019).

Possible limitations of citizen science for the study of funga

Photographs can be considered a valuable source of data in the study of biodiversity (Miralles *et al*., 2020; Phang *et al*., 2022). Also, some observations on citizen science platforms have turned out to be the very first photographs of living specimens ever recorded (Mesaglio *et al*., 2021). Even, data from observations as photographs or geolocation have enabled, respectively, to implement machine learning systems and modelling species distributions (Geurts *et al*., 2023b; Hao *et al*., 2020). However, one of the limitations of using this type of data is that they often have errors and biases that need to be addressed. Although the usefulness of machine learning models for identification from images is self-evident (Chaves *et al*., 2024; Koch *et al*., 2022, 2023; Picek *et al*., 2022; Rahman *et al*., 2022; van Horn *et al*., 2018), in some cases they have been shown to be not reliable enough to accurately distinguish between species (Hodgson *et al*., 2023; Munzi *et al*., 2023).

Open repositories of geo-referenced biological data, developed from citizen science records and digitized specimen information from biological collections, often have quality issues, potentially incompatible with large-scale fungal diversity and biogeography studies (Hao *et al*., 2021; McMullin & Allen, 2022). As for diversity data, these data sources exhibit a taxonomic bias towards charismatic or more well-known species (Cazabonne *et al*., 2024; Di Cecco *et al.*, 2021; Haelewaters *et al.*, 2024b; Martínez-Sagarra *et al.*, 2022; Pernat *et al.*, 2024) that is even reproduced in machine learning models (Koch *et al.*, 2023) along with a spatial and temporal bias (Geldmann *et al.*, 2016; Stallman *et al.*, 2024), often associated with access and proximity to trails, or the date of occurrence of some massive biodiversity recording event, also known as BioBlitz (Dimson & Gillespie, 2023; Geurts *et al.*, 2023a, 2023b).

While data retrieved from iNaturalist can be considered complementary to those obtained by conventional means —in aspects such as taxonomic diversity and expanded geographic coverage— identifications that reach Research Grade within the platform should be treated as only tentative (Hochmair *et al.*, 2020) and still require analysis of specimens to confirm their taxonomic identity (Nachman *et al.*, 2023).

Moreover, the data generated in citizen science studies offer the opportunity to obtain information that is often neglected (Mesaglio & Callaghan, 2021). Studies with sampling in the same region over time allow capturing relevant information on the fungal diversity of the territory, such as recording in detail the phenology of sporocarp production (Boddy *et al.*, 2014; Stallman *et al.*, 2024; Stallman & Robinson, 2022), determining the type of associated vegetation (Heilmann-Clausen *et al.*, 2016) or documenting episodes of trophic interactions such as mycophagy (Barahona-Segovia *et al.*, 2024a). To facilitate the analysis of this type of data it is recommended to adopt the guidelines of the Darwin Core standard (Marques *et al.*, 2024).

CONCLUSIONS

In summary, this study aligns with the challenges set by Callaghan *et al.* (2020): (a) sampling historically overlooked organisms, (b) estimating species abundance in space and time, and (c) exploiting the potential of secondary data in ecology and conservation. Particularly, for the case of fungi, Halme *et al.* (2012) propose strategies for recording and documenting fungi, from fungal forays and specimen collection to the extensive use of environmental DNA to monitor fungi in an area, even in the absence of sporocarps, aiming at efficient data management. Fungal blindness—paraphrasing Wandersee and Schussler (1999)—must be avoided at all costs.

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CONFLICT OF INTEREST

The author declares to be user since 2016 and curator since 2018 of the iNaturalist network (https://www.inaturalist.org/people/cristianriquelme).

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