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Data Paper

Herbarium collection of the Pontificia Universidad Católica de Valparaíso (PUCV), Chile

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Abstract

Background

This database gathers 10,721 specimens, belonging to 2,578 species from the Chilean vascular flora (angiosperms, gymnosperms and pteridophytes) deposited in the Herbarium of the Pontificia Universidad Católica de Valparaíso (PUCV) in Chile. The PUCV botanical collection was started by the renowned botanist Otto Zöllner and represents a major natural historical legacy for central Chile, with decades of information represented through preserved specimens. This collection is currently deposited in the Curauma campus of the PUCV. This digitisation effort is part of the PUCV's endeavour to mobilise its biological collections and make them freely available through GBIF, encouraging national and international researchers to generate new knowledge, based on this invaluable heritage, which is a silent witness of the vast plant diversity that once existed in Chile and that is now vanishing due to anthropogenic drivers.

New information

The database provides occurrence records from 10,721 specimens of vascular flora held in the PUCV Herbarium, representing 2,578 species, 914 genera and 177 families. Each

record includes data on taxonomy, geographic distribution, elevation and collection information (e.g. date of collection, *legitimavit* and *determinavit* of specimens, general observations). The database serves as a repository containing records from past decades on the diversity and distribution of plant species, mainly from the Chilean Mediterranean biodiversity hotspot.

Keywords

biological collections, Chile, herbarium specimens, long-term data collections, museum collections

Introduction

During the first half of the 20th Century, renowned naturalists were based in central Chile and promoted the creation of the largest and most important biological collections in this South American country. Those collections are the silent witness of the country biodiversity and allow us to reconstruct past species distribution, assess local extinctions and track the spread of invasive species (e.g. Castro et al. 2005, Fuentes et al. 2007, Fuentes et al. 2012). This is the case of the Herbarium of the Pontificia Universidad Católica de Valparaíso (PUCV), which was started by the German botanist Otto Zöllner. Dr. Zöllner began this collection from scratch and also made a great contribution to the training of local experts in plant taxonomy, which were particularly scarce in Chile at that time. During several decades, Dr. Zöllner and his collaborators, along with many students, studied the flora of central Chile, which is considered a biodiversity hotspot due to the high proportion of endemic species (Letelier et al. 2020, Mittermeier et al. 2011) and the specialised ecological interactions of its flora with pollinator species (Medel et al. 2018). Despite its importance, the flora of central Chile is highly threatened by urban encroachment and the expansion of agricultural lands (mainly avocado farms, Armesto et al. 2010). Thus, the PUCV Herbarium comprises a representative sample of central Chile flora prior to the rapid degradation that began in the decade of 1990. The specimens preserved in the PUCV Herbarium constitute a priceless baseline of the biodiversity that once existed in Chile and now cannot be found due to land-use changes (Miranda et al. 2016).

The digitisation of the Herbarium is part of an institutional endeavour to recover and modernise the biological collections held within the University, as they are an important natural heritage. Following the guidelines of the Chilean Ministry of Environment, the first step in this direction is to digitise and mobilise collection specimens to digital platforms, such as the Global Biodiversity Information Facility (GBIF). Thus, the database presented here was developed taking the FAIR (Findable, Accessible, Interoperable and Reusable) principles in mind (Wilkinson et al. 2016). The next step would be the modernisation of the collection, taking advantage of modern technologies that allow inclusion of additional related information besides the preserved species following the extended specimen concept (Lendemer et al. 2019), which expands the possibilities of research and education that can be achieved with biological collections by including extra information that is usually

lost after specimen preservation (e.g. tissue samples for DNA extraction, chemical profiles and ecological context information; Teixeira-Costa et al. 2022).

General description

Purpose: The main aim is to mobilise the PUCV biological collections, making them freely available while encouraging researchers to generate new knowledge, based on this invaluable heritage.

Project description

Title: Vascular flora from the PUCV Herbarium.

Study area description: Chile, South America.

Sampling methods

Study extent: This database contains the specimens of vascular flora recorded in the Herbarium collection held at the Pontificia Universidad Catolica de Valparaíso, indexed on Index Herbariorum as PUCV. The collection results from almost a century of work initiated by Prof. Otto Zöllner and continued by many professors and students.

Sampling description: Specimen processing follows standard procedures for fresh material collection and dried material mounting and conservation (Bridson and Forman 2000). Specimens are collected from the field and pressed and dried at the laboratory. Then, dried specimens are mounted on acid-free paper using cloth tape and labelled, providing information on taxonomy, geographic distribution, altitude, collection date, *legitimavit* and *determinavit* and observations. Finally, a unique identifier is provided for each specimen, which is then integrated into the herbarium collection.

Step description: We reviewed the specimens from the collection and verified the coincidence with the assigned taxonomic information. Then, the information contained in the labels was extracted and digitised. To check taxonomy and accuracy, we compared scientific names with The Plant List (www.theplantlist.org) and the Taxon Match Tool (https://www.gbif.org/tools/species-lookup). Since the taxonomy of many groups has changed during the last decades, sometimes tricky to track, we also revised the Catalog of Chilean vascular plants (Rodriguez et al. 2018) to avoid any uncertainty about the identity of the species. Finally, the curated data were uploaded to the GBIF platform to make it publicly available (https://www.gbif.org/dataset/0f99f0f9-e32a-4deb-ad51-4e729dc9f274; Fonturbel et al. 2022).

Geographic coverage

Description: The majority of specimens were collected in Chile (95.6%; 10,244 specimens; Fig. 1), with the most represented administrative region being Valparaíso, where the Herbarium is based (53.1% of the total; 5,440 specimens), followed by the regions of Los Lagos (9.2%; 939) and Coquimbo (7.4%; 753). The Herbarium also contains some specimens from other South American countries, such as Argentina (359 specimens), Brazil (20), Paraguay (20), Bolivia (10) and Perú (4). North America and Europe are also represented by specimens from the USA (14), Germany (14), Austria (5) and Switzerland (1).

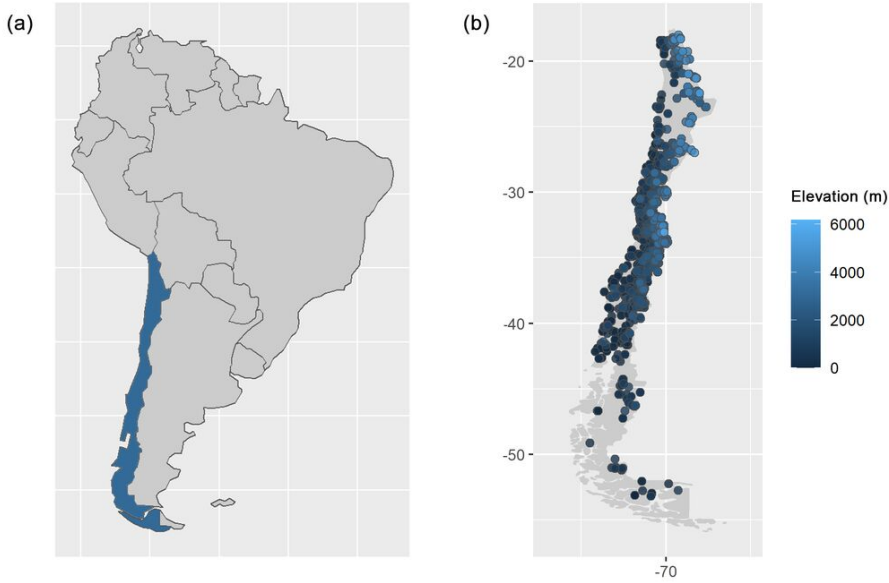

Figure 1. doi

Location of **a** Chile within South America and **b** localities of collection of the specimens deposited in the PUCV Herbarium.

Taxonomic coverage

Description: Acanthaceae (1 specimen/1 name); Adiantaceae (30/3); Aextoxicaceae (9/1); Aizoaceae (22/9); Alstroemeriaceae (2/2); Altingiaceae (1/1); Amaranthaceae (125/48); Amaryllidaceae (27/11); Anacardiaceae (88/12); Annonaceae (4/2); Apiaceae (340/85); Apocynaceae (88/14); Aquifoliaceae (4/1); Araliaceae (6/3); Araucariaceae (10/3); Asparagaceae (8/3); Asphodelaceae (1/1); Aspleniaceae (141/8); Asteraceae (1889/540); Atherospermataceae (4/2); Begoniaceae (1/1); Berberidaceae (61/11); Betulaceae (7/3); Bignoniaceae (26/9); Blechnaceae (142/13); Boraginaceae (53/19); Brassicaceae (216/69); Cactaceae (10/9); Calceolariaceae (176/41); Campanulaceae (2/2); Cannabaceae (7/5); Caprifoliaceae (74/26); Cardiopteridaceae (20/1); Caryophyllaceae (120/30);

Casuarinaceae (15/2); Celastraceae (32/5); Cephalotaxaceae (3/2); Ceratophyllaceae (1/1); Cervantesiaceae (1/1); Columelliaceae (4/1); Combretaceae (3/2); Convolvulaceae (77/22); Coriariaceae (5/1); Cornaceae (1/1); Crassulaceae (6/3); Cucurbitaceae (13/7); Cunoniaceae (32/4); Cupressaceae (94/24); Cyatheaceae (3/1); Cyperaceae (2/2); Cystopteridaceae (42/1); Dennstaedtiaceae (42/3); Dicksoniaceae (35/2); Dioscoreaceae (3/3); Dryopteridaceae (113/13); Ehretiaceae (9/5); Elaeagnaceae (3/2); Elaeocarpaceae (38/3); Ephedraceae (39/6); Equisetaceae (37/2); Ericaceae (54/17); Erythroxylaceae (2/2); Escalloniaceae (92/16); Euphorbiaceae (162/36); Fabaceae (812/241); Fagaceae (29/7); Francoaceae (12/2); Frankeniaceae (23/4); Gentianaceae (22/7); Geraniaceae (79/19); Gesneriaceae (13/3); Ginkgoaceae (3/1); Gleicheniaceae (128/4); Gomortegaceae (1/1); Goodeniaceae (10/1); Griseliniaceae (5/2); Grossulariaceae (37/10); Gunneraceae (8/2); Haloragaceae (36/1); Hydrangeaceae (9/3); Hydroleaceae (2/1); Hydrophyllaceae (47/7); Hymenophyllaceae (259/15); Hypericaceae (4/2); Iridaceae (3/3); Isoetaceae (2/1); Juglandaceae (2/1); Juncaceae (3/3); Krameriaceae (11/2); Lamiaceae (172/39); Lardizabalaceae (6/2); Lauraceae (59/9); Lentibulariaceae (4/1); Linaceae (30/4); Lindsaeaceae (12/1); Loasaceae (86/24); Loranthaceae (49/7); Lycopodiaceae (22/1); Lythraceae (35/11); Magnoliaceae (5/3); Malesherbiaceae (48/14); Malpighiaceae (18/5); Malvaceae (141/67); Marantaceae (1/1); Meliaceae (9/5); Misodendraceae (31/3); Molluginaceae (2/1); Monimiaceae (15/1); Montiaceae (74/24); Moraceae (13/7); Muntingiaceae (1/1); Myrtaceae (192/45); Nanodeaceae (1/1); Nephrolepidaceae (2/1); Nothofagaceae (111/9); Nyctaginaceae (30/9); Oleaceae (17/13); Onagraceae (91/21); Ophioglossaceae (3/1); Orchidaceae (27/7); Orobanchaceae (41/16); Oxalidaceae (120/29); Papaveraceae (77/12); Passifloraceae (11/7); Phrymaceae (42/8); Phytolaccaceae (30/6); Pinaceae (33/19); Piperaceae (7/4); Pittosporaceae (1/1); Plantaginaceae (132/37); Platanaceae (7/2); Plumbaginaceae (34/5); Poaceae (26/26); Podocarpaceae (43/7); Polemoniaceae (44/14); Polygalaceae (48/12); Polygonaceae (156/38); Polypodiaceae (87/7); Primulaceae (30/10); Proteaceae (69/7); Pteridaceae (371/23); Quillajaceae (15/1); Ranunculaceae (73/27); Rhamnaceae (109/21); Rosaceae (166/47); Rubiaceae (108/38); Rutaceae (23/11); Salicaceae (88/18); Salviniaceae (14/2); Santalaceae (7/1); Sapindaceae (50/10); Sapotaceae (14/4); Saxifragaceae (5/5); Schizaeaceae (3/1); Schoepfiaceae (58/6); Scrophulariaceae (37/9); Selaginellaceae (12/1); Simaroubaceae (2/1); Smilacaceae (1/1); Solanaceae (445/109); Strelitziaceae (1/1); Stylidiaceae (1/1); Tamaricaceae (2/1); Tectariaceae (4/1); Thelypteridaceae (21/2); Thymelaeaceae (7/1); Tropaeolaceae (67/8); Ulmaceae (4/3); Urticaceae (38/16); Verbenaceae (182/43); Violaceae (54/26); Viscaceae (1/1); Vitaceae (9/1); Vivianiaceae (71/8); Winteraceae (13/1); Woodsiaceae (2/1); Zygophyllaceae (60/7). The general taxonomic distribution of occurrences, including higher taxonomic categories, is presented in Fig. 2

Temporal coverage

Notes: Although the founding year of the PUCV Herbarium is unknown, it is presumed to have been in 1931 since the institution was founded in 1924 and the first specimen was deposited seven years later by the botanist Gualterio Looser. However, the Herbarium

contains a few earlier records from 1900, probably integrated from the personal collection of the professors Otto Zöllner and Beatriz Palma. During the following years, few specimens were deposited until 1955, when the additions increased and were regularised (Fig. 3), mainly by the botanists Otto Zöllner, Bernardo Parra, Hugo Gunckel and Otto Magen.

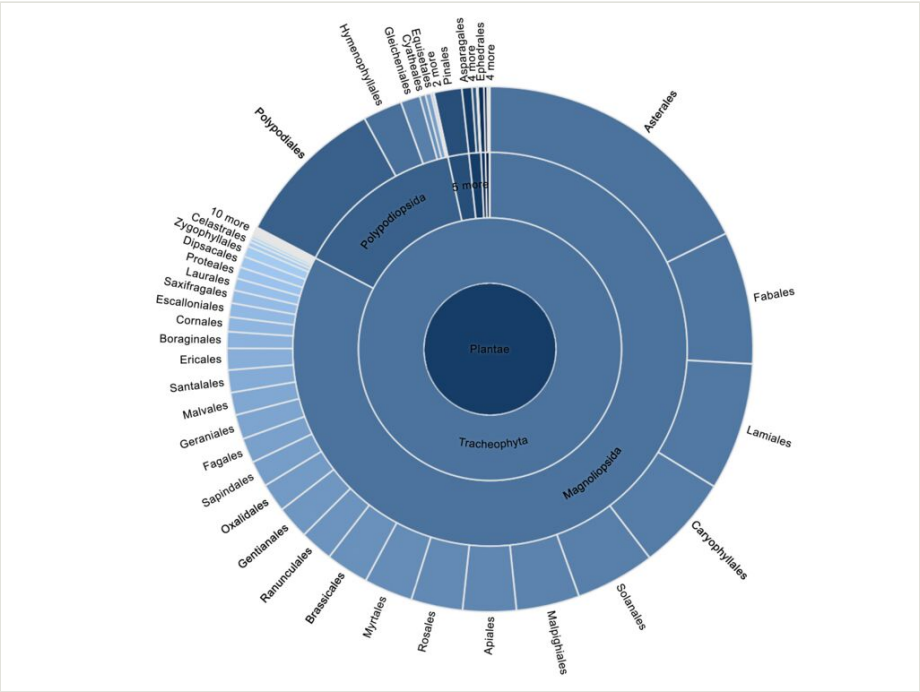

Figure 2. doi

The general taxonomic distribution of occurrences.

Collection data

Collection name: PUCV Herbarium

Collection identifier: PUCV

Specimen preservation method: Dried and pressed

Usage licence

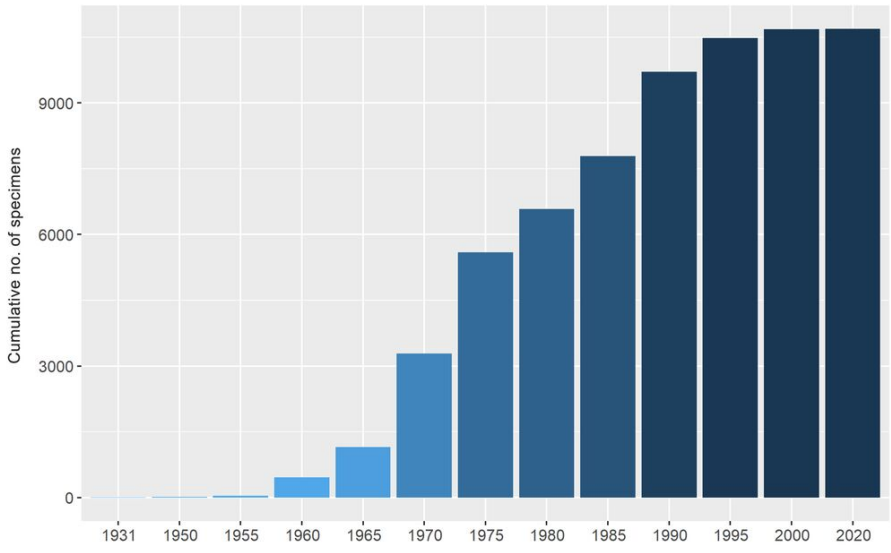

Figure 3. doi

Temporal coverage of the specimens deposited in the PUCV Herbarium since the presumed Herbarium foundation in 1931.

Data resources

Data package title: Vascular flora from the PUCV Herbarium

Resource link: https://www.gbif.org/dataset/0f99f0f9-e32a-4deb-ad51-4e729dc9f274

Number of data sets: 1

Data set name: Vascular flora from the PUCV Herbarium

Download URL: https://www.gbif.org/dataset/0f99f0f9-e32a-4deb-ad51-4e729dc9f274

Description: This database includes 10,721 specimens from vascular flora (angiosperms, gymnosperms and pteridophytes) deposited in the Herbarium of the Pontificia Universidad Católica de Valparaíso (PUCV) in Chile. This botanical collection was started by the renowned botanist Otto Zöllner and represents a major natural historical legacy for central Chile, with decades of information represented through preserved specimens. This collection is currently deposited in the Curauma campus of the PUCV. This digitisation process is part of the PUCV effort to mobilise its biological collections and make them freely available through GBIF, encouraging national and international researchers to generate new knowledge, based on this invaluable heritage, which is a silent witness of the vast plant diversity that once existed in Chile and that is now vanishing due to anthropogenic drivers.

Column label	Column description
occurrenceID	The unique identifier of the occurrence.
basisOfRecord	The specific nature of the data record.
type	The nature of the resource.
eventDate	The date of collection.
year	Year of collection.
month	Month of collection.
day	Day of collection.
eventRemarks	Comments or notes about the Event.
scientificName	The full scientific name of the species.
scientificNameAuthorship	The authorship information for the scientific name.
verbatimScientificName	The scientific name of the species.
kingdom	The scientific name of the kingdom in which the taxon is classified.
phyllum	The scientific name of the phyllum in which the taxon is classified.
class	The scientific name of the class in which the taxon is classified.
order	The scientific name of the order in which the taxon is classified.
family	The scientific name of the family in which the taxon is classified.
genus	The scientific name of the genus in which the taxon is classified.
specificEpithet	The specific epithet of the scientific name.
infraspecificEpithet	The infrageneric part of a binomial name at ranks above species, but below genus.
taxonRank	The taxonomic rank of the most specific name provided in the scientificName.
identifiedBy	A list of names of people, groups or organisations who assigned the Taxon to the subject.
decimalLatitude	The geographic latitude of the geographic centre of a location, expressed in decimal degrees. Positive and negative values indicate north and south of the Equator, respectively.
decimalLongitude	The geographic longitud of the geographic centre of a location, expressed in decimal degrees. Positive and negative values indicate north and south of the Equator, respectively.
geodeticDatum	The ellipsoid, geodetic datum or spatial reference system (SRS) upon which the geographic coordinates given in decimalLatitude and decimalLongitude are based.
continent	The name of the continent in which the location occurs.
country	The name of the country in which the location occurs.

countryCode	The code for the country in which the location occurs according to ISO 3166-1-alpha-2 country codes.
stateProvince	The name of the next smaller administrative region than country in which the Location occurs.
locality	The specific description of the location.
maximumElevationInMetres	Maximum elevation to above sea level, expressed in metres.
language	Language in which the data and metadata are presented.
institutionID	The name of the institution having custody of the object(s) or information referred to in the record.
institutionCode	The acronym of the institution having custody of the object(s) or information referred to in the record.
catalogNumber	The unique code that identifies the record within the collection.
collectionCode	The name identifying the collection from which the record was derived.
recordedBy	A list of the person, people, groups or organisations responsible for recording the original Occurrence.

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We are deeply grateful to the founders and former curators of the PUCV Herbarium, especially Prof. Otto Zöllner, for his remarkable dedication to collecting and identifying more than half of the specimens deposited in the Herbarium. We also thank Professor Lorena Flores for continuing Professor Zöllner's legacy, as well as the students who contributed to its digitisation. Additionally, to Leisy Amaya from the Chilean Ministry of Environment. S.C was supported by a Ph.D. scholarship granted by the Chilean Agency of Research and Development (ANID, 21211752). F.G was supported by a Ph.D. scholarship granted by the Chilean Agency of Research and Development (ANID, 21221244). We also thank three community reviewers for their valuable suggestions that helped improve the original version.

Author contributions

S.C. collected and curated the data and wrote the first draft of the manuscript; M.L.A. collected and processed the data; F.G. collected the data; F.E.F. coordinated the project, processed the data and wrote the manuscript.

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