The Herbonauts website: a citizen science project to acquire plant metadata over the four past centuries, from herbarium collections

Poster · October 2018

DOI: 10.13140/RG.2.2.18524.51848

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The Herbonauts website: a citizen science project to acquire plant metadata over the four past centuries, from herbarium collections

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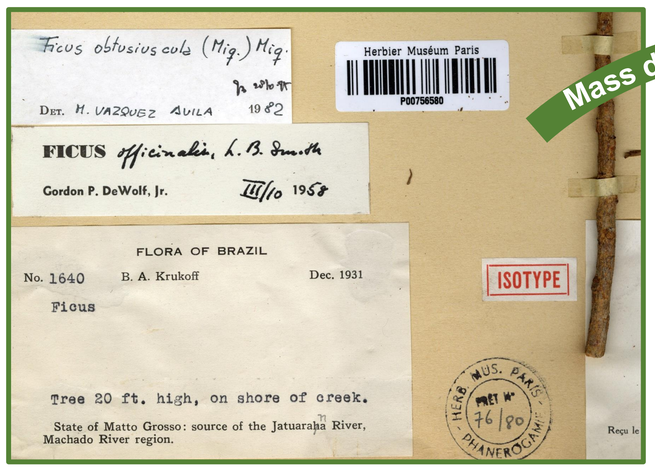
Natural History Collections allow tackling many questions in ecology and evolution : the data provided by both the specimens themselves and the labels linked to the specimens, with rare advantages: data are real, spanned over time, checkable for accurate identifications, and the preserved physical objects make them not questionable.

Herbaria represent millions of actual plants records collected in all continents since four centuries. However, such records linking a plant species to historical and ecological information (location, altitude, date, phenology…) are available for analyses only once all information has been read on herbarium labels, transcribed, and databased.

The Paris Herbarium (Muséum national d'Histoire naturelle -MNHN- France) completed in 2012 a first step toward the goal with the most ambitious digitization project ever conducted on the world's largest Herbarium. All 6,000,000 specimens of vascular plants have been digitized with all images freely available online.

But, only 1 million is fully databased; for all 5 other millions, only binomial name, family and Geographic area are available.

Paris Herbarium Database : http://science.mnhn.fr/institution/mnhn/search



Mass digitization

Few collection's data databased

SPECIMEN

Herbier	MNHN-P-P00756580
Sector	AME (America)

TAXONOMY

Family	Moraceae
Genus	Ficus
Species	Ficus obtusiuscula
Name	*Ficus obtusiuscula* (Miq.) Miq.

Herbonautes

All other collection's data acquired

ORIGIN

Country label	Brésil
Country ISO (code)	Brazil (br)
Verbatim locality	State of Matto Grosso: source of the Jatuarana River, Machado River Region
Collector's name	B.A. Krukoff
Collector's number	1640
Collection date	1931-12
Description	Tree 20 ft. high
Ecological note	on shore of creek

The Herbonauts website
http://lesherbonautes.mnhn.fr

The MNHN launched in 2012 a participatory science project to enrich the database with transcriptions of herbarium labels, done by general public who read images and answer questions online.

To encourage participation, small subsets of the herbarium (called 'missions') are presented to the participants (named 'herbonauts'), and are thought to provide a specific research project with data.

After 6 years, 72 'missions' and more than 250,000 specimens have been transcribed.

Herbonauts Mission:
Searching for new metal hyperaccumulator plant species

Research: the X-TrEM project aims at developing a large-scale X-ray fluorescence screen to identify new metal hyperaccumulator species and a cross-species comparative transcriptomic analysis method to identify the molecular mechanisms involved in this phenomenon.

Herbonauts help in databasing all data for the herbarium specimens positively screened, in order to study potential correlations between hyperaccumulators species and distribution, or ecology.

Project leaded by CNRS, Institut de Biologie Intégrative de la Cellule, Gif-sur-Yvette, France.

Herbonauts Mission :
Adaptation of foliar morphology to climate change: application in paleobotany

Research: Studying the tree genera *Cinnamomum* and *Quercus*, the project aims at acquiring morphometric data to assess the variability of leaf shapes in relation to the climate ; this relationships should help to improve paleoclimatic and paleoenvironmental interpretations from leaf fossils.

Herbonauts help in interpreting localities as geographical coordinates for all specimens, in order to ascribe the corresponding climatic features to each gathering.

Project leaded by MNHN, Paris, France.

Herbonauts Mission :
The genomics of local adaptation in parasitic weeds

The parasitic plant species *Striga hermonthica* (Orobanchaceae) is devastating major crops of the sub-Saharan regions in particular cereals (corn, rice, sorghum, cane, or millet).

Research: co-nesting ecology and genomic data to better understand how *Striga hermonthica* adapts in time and space to environmental fluctuations and different hosts.

Herbonauts help in defining the distribution of *S. hermonthica* and the species diversity of its hosts, both in the different localities and over time.

Project leaded by Pennsylvania State University, USA.

Herbonauts Mission :
Identification of Important Plant Areas (IPAs) for conservation in Lebanon

Research: Define IPAs for Lebanon, based on distributions of species using data from both historical herbarium collections, and recent inventories in the field.

Herbonauts help in providing data from the past (species/localities) that enriched ongoing programs on botanical diversity. Data of species occurrences over time should also help in building the IUCN Red List of threatened species.

Project leaded by St Joseph University, Beyrouth, Lebanon.
Bou Dagher-Kharrat et al. (2018), *Journal for Nature Conservation* 43: 45-94.

Herbonauts Mission :
Macroecology of rare and endemic species in New Caledonia

New Caledonia is characterized by a very rich and highly endemic flora despite its small area (ca. 3400 species of vascular plants and 75% endemism at the species level) in an area of just ca. 19,000 km^2.

Research: Studying the endemic and/or particularly rare Caledonian plant species, by looking for possible links with their distribution in the archipelago.

Herbonauts help in interpreting localities as geographical coordinates for all specimens, in order to study potential relationships between rare and/or endemic species and local biotic or abiotic factors such as types of soil (serpentinic or not, etc).

Project leaded by MNHN, Paris, France.

The Herbonauts is a program of the national French Research infrastructure e-ReColNat, supported by the National Research Agency (ANR-II-INBS-004).