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CAMBRIDGE



CAMBRIDGE UNIVERSITY

Herbarium

DEPARTMENT OF PLANT SCIENCES



@CUHerb



Lauren M. Gardiner

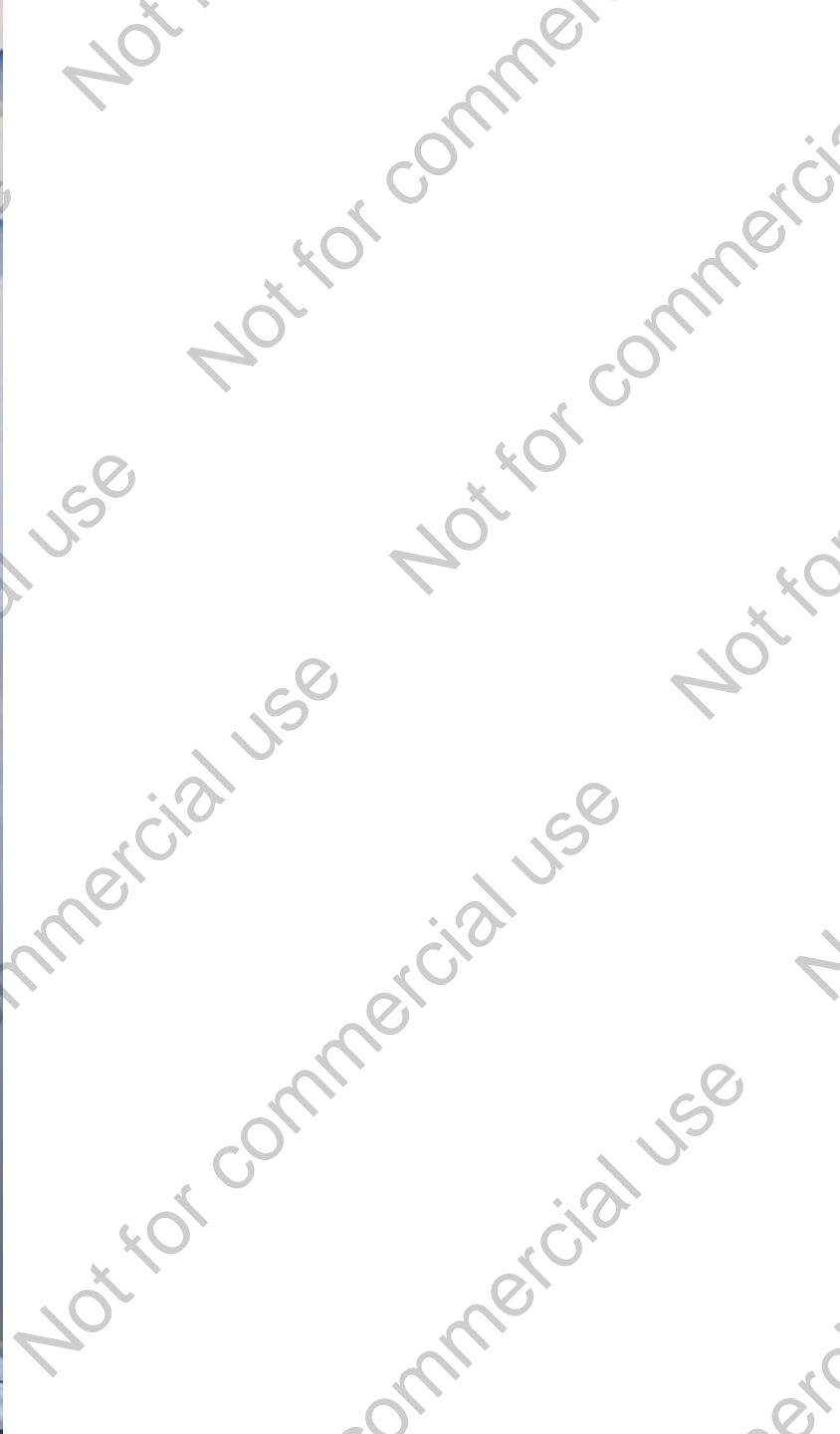
Care and use of herbarium specimens

Natural Science Collections: The Basics









1751

(a)

ERRA-

I	XIV
II	XV
III	XVI
IV	XVII
V	XVIII
VI	XIX
VII	XX
VIII	XXI
IX	XXII
X	XXIII
XI	XXIV
XII	
XIII	

1938

(b)





UNIVERSITY HERBARIUM
DEPT. OF PLANT SCIENCES
ROBINSON STREET
CAMBRIDGE CB2 3RA
ENGLAND

What is a herbarium specimen?

Specimen + associated information = data

Identification

Documentation

Verifiable

Vouchers

Herb. Univ. Cantab.

BRITISH ISLES

Viburnum trilobum (Mill.)

T.G. 24

Locality and Habitat

Thorn Road, Ganton Moor, Cambs

G.R. 52/252440

30 August 2003

Latex dull medium green. Flowers - green, orange to red.

Coll. P.D. Sell

No. 05/325

Specimen label data



Identification(s)

Herb. Univ. Cantab.

BRITISH ISLES

Viburnum trilobum Marsh.

v.t. 29

Locality and Habitat

Trap Road, Guilden Morden, Cambs.
G.R. 52/282440

30 August 2003

Leaves dull medium green. Fruit 8 – 9 mm, orange to red.

Coll. P.D. Sell

No. 03/325

Date collected

Location information

Collector(s) & collection number

Barcode/unique identifier

What is a herbarium?

A collection of dried pressed plant specimens* with associated data

300+ years of fieldwork

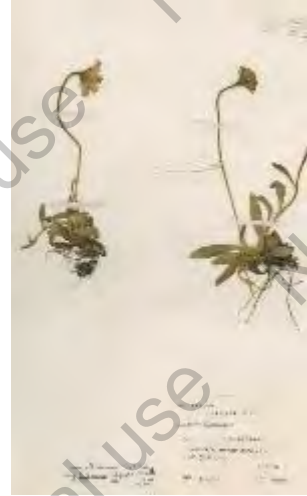
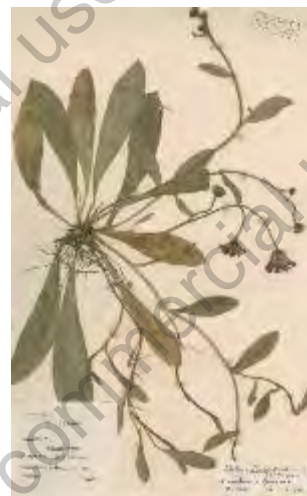
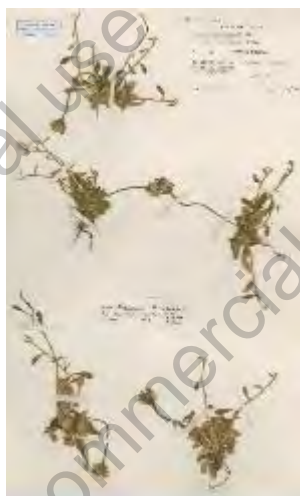
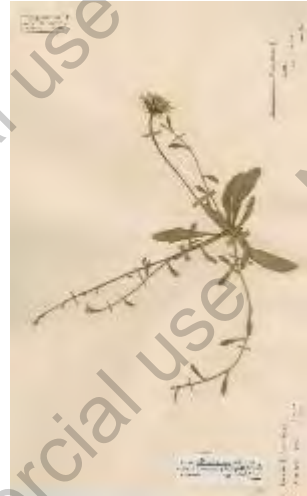
Archive of plant diversity – heritage and scientific

Comparative studies over time, space, taxa (incl morphology, distribution, phenology, phylogenetic relationships, environmental change..)

*usually



© CU Herbarium



What is a herbarium?



Cambridge University Herbarium
international code: **CGE**

CGE c. 1.1M specimens = a huge research dataset

Worldwide over 3,000 herbaria c. 380M specimens
= an enormous, powerful collaborative research dataset
and network

Largest herbaria

1. Muséum National d'Histoire Naturelle, Paris, France
2. The NY Botanical Garden, Bronx, USA
3. Royal Botanic Gardens, Kew, UK
4. Missouri Botanical Garden, St. Louis MA, USA
5. Conservatoire et Jardin botaniques, Geneva, Switzerland
6. Komarov Botanical Institute of RAS, St. Petersburg, Russia
7. Naturhistorisches Museum Wien, Vienna, Austria
8. The Natural History Museum, London, UK
9. Smithsonian Institution, Washington D.C., USA
10. Harvard University, Cambridge MA, USA

Continent	Herbaria	Specimens
Africa	203	c. 9022 000
Asia	794	c. 53 970 000
Australia	78	c. 10 478 000
Europe	1479	c. 201 149 000
N America	939	c. 88 314 000
S America	490	c. 26 167 000

Lang et al. (2019) *Using herbaria to study global environmental change. New Phytologist* 221: 110-122.

Index Herbariorum

<http://sweetgum.nybg.org/science/ih/>

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Royal Horticultural Society Garden Wisley

[EDIT](#) [CREATE NEW](#)

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[Collections Summary](#)

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[Map](#)

Name

Royal Horticultural Society Garden Wisley

Herbarium Code

WSY

Current Status

Active

Correspondents

Yvette Harvey, Yvetteharvey@rhs.org.uk

Contact

[44] 01483 224234

Fax: [44] 01483 211750

Email: yvetteharvey@rhs.org.uk

Address

Herbarium

Royal Horticultural Society Garden Wisley

Woking

Surrey GU23 6QB

U.K.

<https://www.rhs.org.uk/science/conservation-biodiversity/conserving-garden-plants>

[/rhs-herbarium](#)

CITES

GB 007

Specialty

Taxonomic Coverage: All groups of cultivated ornamental plants; standard specimens of cultivars

Geography: Mainly from U.K. and Europe

STEERE HERBARIUM

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Cambridge University

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[Overview](#)

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[Staff](#)

[Map](#)

Name

Cambridge University

Herbarium Code

CGE

Current Status

Active

Correspondents

Lauren Gardiner, Curator, lmg32@cam.ac.uk

Contact

Email: [lmg32\[at\]cam.ac.uk](mailto:lmg32[at]cam.ac.uk)

Address

Cambridge University Herbarium

Plant Sciences Department, Sainsbury Laboratory

Cambridge University

c/o Sainsbury Laboratory, Bateman Street

Cambridge, England CB2 1LR

U.K.

<https://data.plantsci.cam.ac.uk/herbarium/> [New website in preparation]

Specialty

Taxonomic Coverage: Historical material, Worldwide, UK material especially Cambridgeshire

Geography: Worldwide

Care and use of herbarium specimens

Natural Science Collections: The Basics

Decontamination: freezing, chemical treatment



Accessioning: logging, databasing



Mounting: techniques, materials



Naming: resources online and in literature, experts



Incorporation: local filing sequence, materials



Storage: environment, pest control, handling



Research use: access, loans, digital, sampling

Decontamination



- freeze all incoming material (-30°C for 3 days, bag specimens during to control humidity)

Accessioning and databasing

Identification(s)

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BRITISH ISLES

Viburnum trilobum Marsh.

v.c. 29

Locality and Habitat

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30 August 2003

Leaves dull medium green. Fruit 8 – 9 mm, orange to red.

Coll. P.D. Sell

No. 03/325

Date collected

Location information

Collector(s) & collection number

Physical location in collection

'Stored under' name

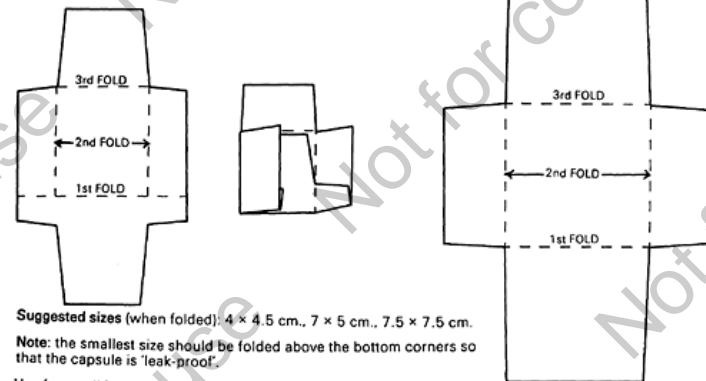
Barcode/unique
identifier

Mounting and preparing specimens

- strapping, gluing, sewing
- capsules/packets for loose and extra material
- associated collections eg. carpological and spirit collections

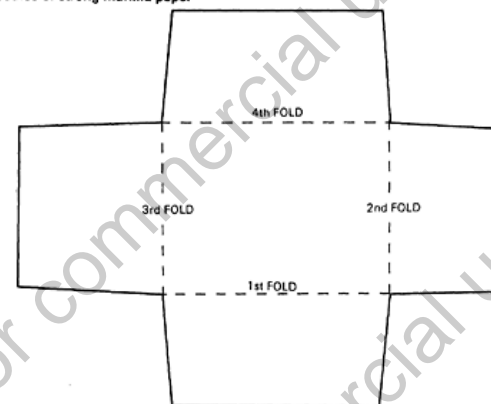


A Small capsules made of white bond paper



Use for small items such as delicate flowers and seeds.

B Large capsules of strong manilla paper



Suggested sizes (when folded): 20 × 11 cm., 17.5 × 12.5 cm., 12 × 9 cm.

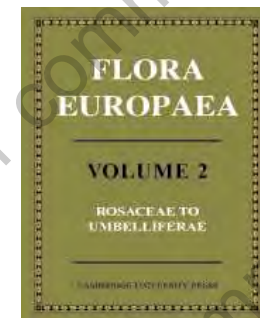
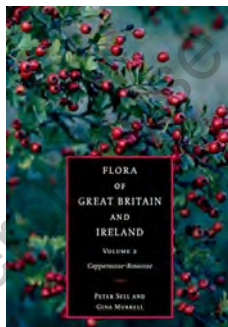
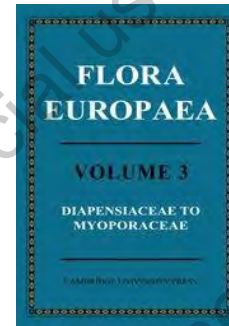
Note: the side flaps should allow a good overlap when folded. Preferably one side flap should be shorter than the other so that the overlap does not fall directly in the centre (corresponding to the thickest part of the filled capsule).

Use: for detached leaves and large items. If there are also small delicate flowers or seeds, put them inside a smaller capsule and place inside the large one.



Naming specimens

- Nomenclature and accepted names
 - recent/well accepted floras, The World Flora Online, The Plant List, World Checklist of Selected Plant Families, Index Fungorum, etc



www.worldfloraonline.org



World Flora
Online

A Project of the World Flora Online Consortium

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[Sign in](#)

An Online Flora of All Known Plants

Supporting the Global Strategy for Plant Conservation

325,205 names, 350,510 accepted species, 55,272 images, 129,400 descriptions, 31,683 distributions and 1,154,750 references

Search by species, genus or family name, or any words describing the plant

[Search](#)



Isotria medeoloides (Pursh) Raf.

Vulnerable Species

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www.theplantlist.org

The Plant List

A working list of all plant species

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2011-2020
United Nations Decade on Biodiversity

Kew



MISSOURI
BOTANICAL
GARDEN



Global
Compositae
Checklist

The Plant List (TPL) was a working list of all known plant species produced by the botanical community in response to Target 1 of the 2002-2010 Global Strategy for Plant Conservation (GSPC). TPL has been static since 2013, but was used as the starting point for the Taxonomic Backbone of the **World Flora Online (WFO)**, and updated information can be found at www.worldfloraonline.org.

WFO is being developed by a consortium of leading botanical institutions worldwide in response to the 2011-2020 GSPC's updated Target 1: to achieve an online Flora of all known plants by 2020. WFO welcomes feedback from users for improvements to its Taxonomic Backbone which is curated by a growing community of WFO Taxonomic Expert Networks (TENs).

The Plant List is a working list of all known plant species. It aims to be comprehensive for species of Vascular plant (flowering plants, conifers, ferns and their allies) and of *Bryophytes* (mosses and liverworts).

Collaboration between the Royal Botanic Gardens, Kew and Missouri Botanical Garden enabled the creation of The Plant List by combining multiple checklist data sets held by these institutions and other [collaborators](#).

Version 1.1 (September 2013) replaces Version 1.0 which [remains accessible here](#).

Search

Enter a Genus (eg *Ocimum*) or genus and species (eg *Ocimum basilicum*).

SEARCH

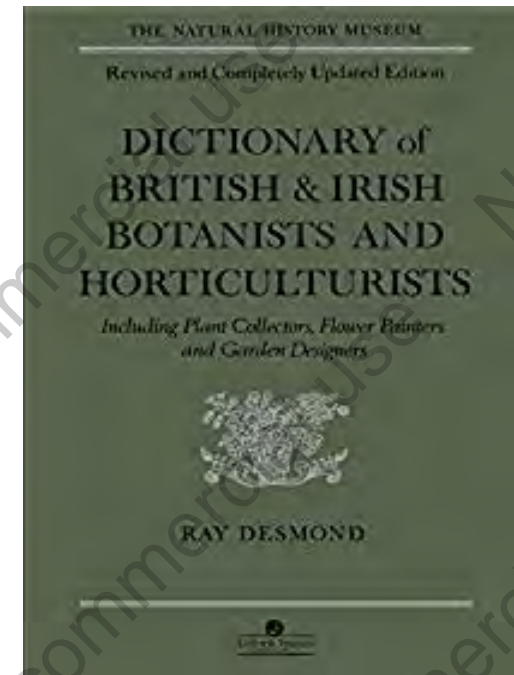
? will match a single character. * will match any number of characters.
Use at least three letters in the genus name if you include a ? or *.



Naming specimens



- **Nomenclature and accepted names**
 - recent/well accepted floras, The World Flora Online, The Plant List, World Checklist of Selected Plant Families, Index Fungorum
- **Authorities – International Plant Names Index (IPNI)**
- **Collectors – Desmond's Dictionary of British and Irish Botanists and Horticulturalists (1994), Harvard University Herbaria and Libraries Index of Botanists**





International Plant Names Index (IPNI)

[Advanced Search](#) ▼

Welcome to the International Plant Names Index (IPNI) produced by a collaboration between [The Royal Botanic Gardens, Kew](#), [The Harvard University Herbaria](#), and [The Australian National Herbarium](#), hosted by the Royal Botanic Gardens, Kew. IPNI provides nomenclatural information (spelling, author, types and first place and date of publication) for the scientific names of Vascular Plants from Family down to infraspecific ranks. You can search for plant names, authors or publications in the search box above. Click the down arrow for advanced search options. New records are added daily, and the IPNI team are continuously working to improve data [standardization](#).

IPNI provides links to protologues in online articles or page scans from the [Biodiversity Heritage Library](#) as well as links to taxonomic data (synonymy and native distribution) through the [Plants of the World Online](#).

If you have any questions, comments or feedback the team would be happy to hear from you by email at ipnifedback@kew.org

Royal Botanic Gardens
Kewscience

www.ipni.org

https://kiki.huh.harvard.edu/databases/botanist_index.html



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Index of Botanists

Index of Botanists

Authors of plant names, botanical and mycological collectors, and authors of publications of importance to systematic botany and mycology, are combined into a single resource. To search: enter the person's name either as *lastname, firstname*, e.g. *jones, david* or by the standard abbreviation, e.g. *d r jones*. The name of an author or collector sometimes consists of multiple names and can be entered as such. Team records can be located by searching for the name of any of its members. Check the **Team** box when searching for a team. Checking the botanist's role (Authors, Collectors, Individuals, Teams) will constrain the search further; otherwise all records in the database that satisfy the search criteria will be matched. Herbaria in which material is known to have been deposited by a botanist can be searched in **Remarks**. Place names and taxon names sporadically occur within **Remarks**.

Name	<input type="text"/>	ID	<input type="text"/>
Find similar sounding names	<input type="checkbox"/>		
Remarks	<input type="text"/>		
Areas of Publication or Collection		Restrict to:	
Specialty	<input type="text" value="any"/>	<input type="checkbox"/> Authors	
Country	<input type="text" value="any"/>	<input type="checkbox"/> Collectors	
		<input checked="" type="checkbox"/> Individuals	
		<input type="checkbox"/> Teams	

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Naming specimens



- JSTOR Plants – Global Plants Initiative
- Biodiversity Heritage Library (BHL)
- Wikipedia and Wikispecies
- Global Biodiversity Information Facility (GBIF)

<https://plants.jstor.org/>



Global Plants

Access provided by University of Cambridge

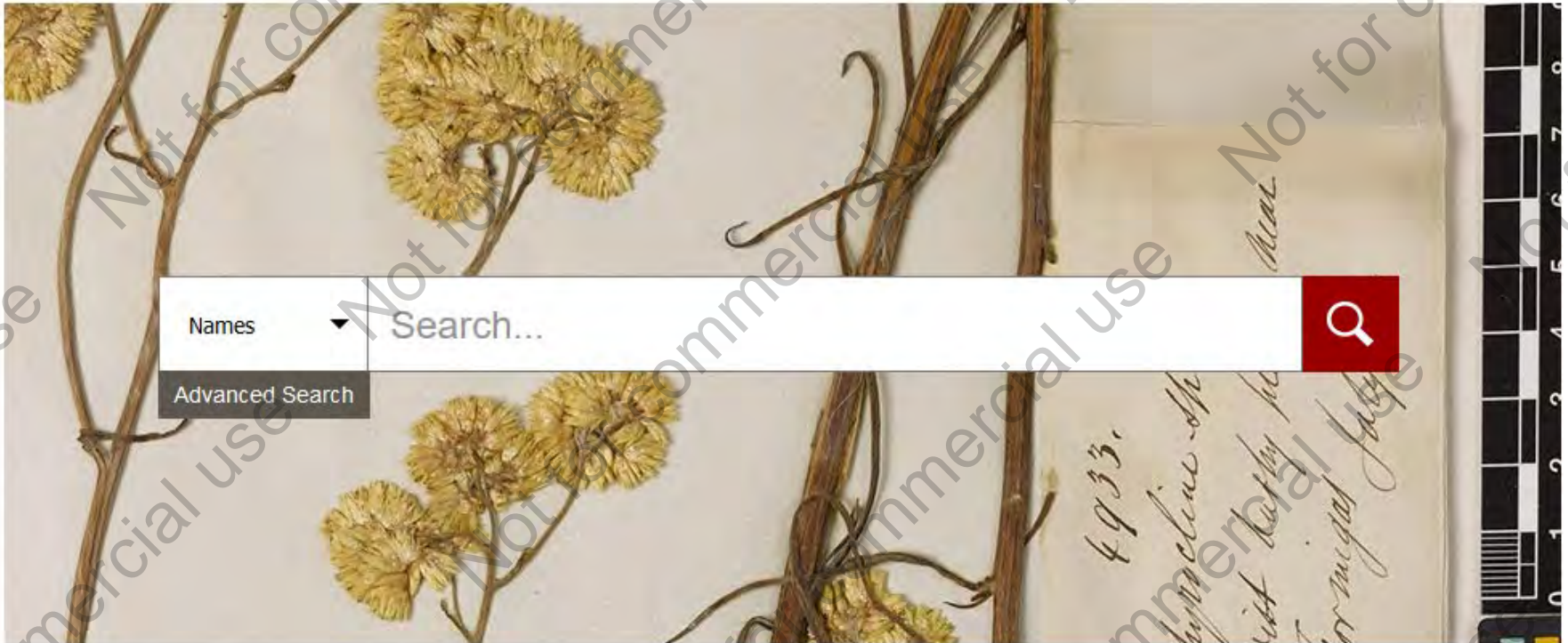
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**CHAMPION PLANT
PRESERVATION**



<https://www.biodiversitylibrary.org/>



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The Biodiversity Heritage Library improves research methodology by collaboratively making biodiversity literature openly available to the world as part of a global biodiversity community.

Search across books and journals, scientific names, authors and subjects

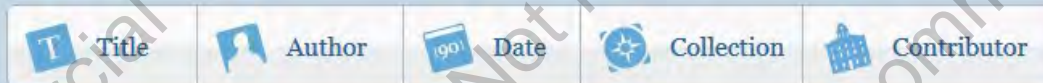
Search the catalog and full-text



☒ Full-text ☐ Catalog [?](#)

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New on the BHL Blog

An Annotated Copy of Butterflies of Australia by Waterhouse and Lyell (1914)

Published in 1914, *Butterflies of Australia* by Gustavus Athol Waterhouse and George Lyell

Today's Picks Flickr Stream



Featured Content

Unearthed! Smithsonian Libraries' Paleo Collection



<https://species.wikimedia.org/wiki/>

English Not logged in Talk Contributions Create account Log in

Main Page Discussion

Read View source View history

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Translation

Wikispecies needs translators to make it more accessible. More info on [this page](#).

[dismiss]

Welcome to Wikispecies

The free species directory that anyone can edit.

It covers [Animalia](#), [Plantae](#), [Fungi](#), [Bacteria](#), [Archaea](#), [Protista](#) and all other forms of life.

So far we have **711,846** articles

Wikispecies is free, because life is in the public domain!

You can also check us out on Twitter: [@Wikispecies](#)
or use the [Android app](#) sponsored by Wikimedia.

We also have an IRC Channel [#wikispeciesconnect](#)

Taxon Navigation

- Superregnum [Archaea](#)
- Superregnum [Bacteria](#)
- Superregnum [Eukaryota](#)
 - Regnum [Protista](#)
 - Regnum [Fungi](#)
 - Regnum [Plantae](#)
 - Regnum [Animalia](#)
- [Virus](#) (classification still unclear)



Michtotamia aurata



Heliconia angusta



Balistapus undulatus



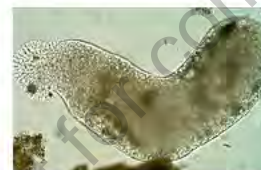
Chroicocephalus ridibundus



Aepyceros melampus



Phyllidia varicosa



Pelomyxa palustris

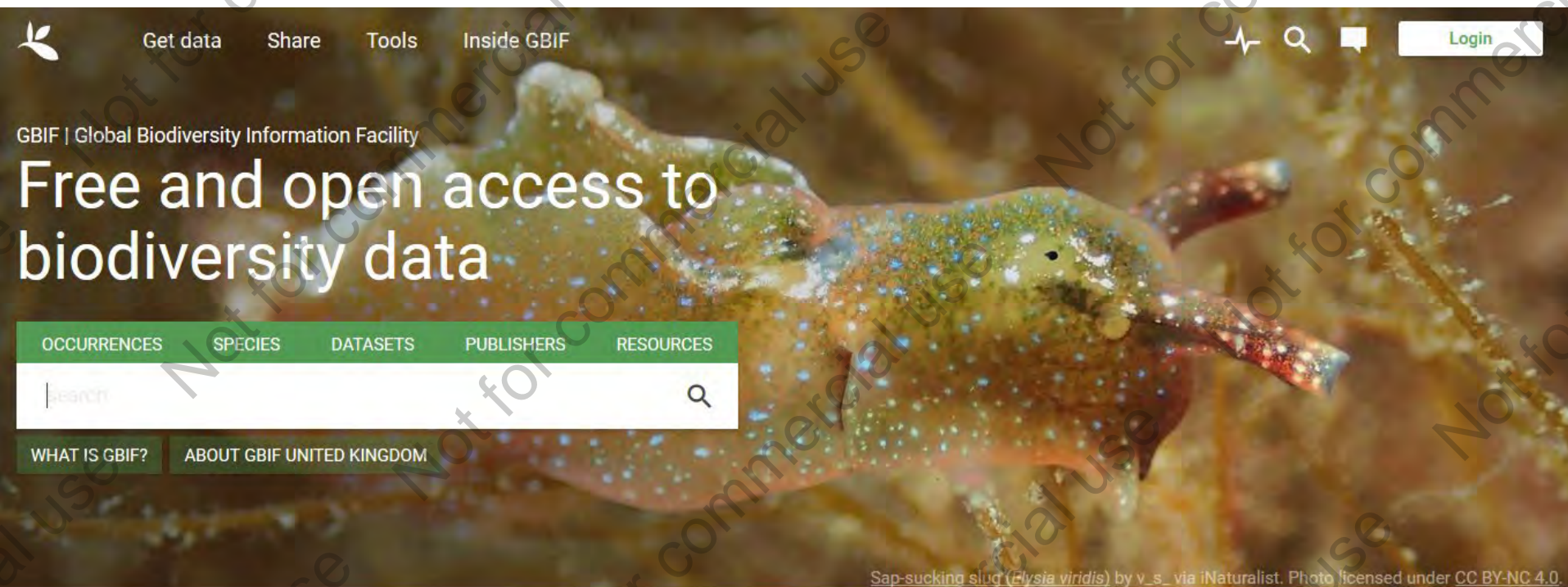


Agama sinaita

Explore Wikispecies

Species of the month

www.gbif.org/



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WHAT IS GBIF? ABOUT GBIF UNITED KINGDOM

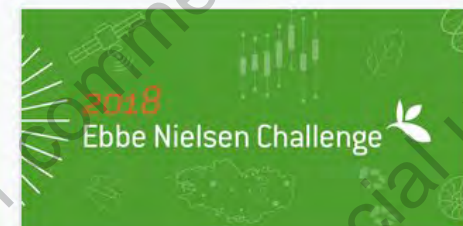
Sap-sucking slug (*Elysia viridis*) by v_s_ via iNaturalist. Photo licensed under CC BY-NC 4.0.

Occurrence records
981,624,721

Datasets
38,979

Publishing institutions
1,182

Species
Learn more about the number of species covered by data in GBIF.org.



2018 GBIF Ebbe Nielsen Challenge seeks open-data



Port Stephens, Australia - a sea hare haven?



The world's newest country becomes GBIF's newest



Call for nominations opens for 2018 GBIF Young Researchers

Incorporation of specimens



- flimsies, species covers, genus covers, type folders
 - photographs, artwork, paperwork

Physical sequence (and pros & cons)

- alphabetical by family (WSY: all vascular plants)
 - alphabetical by genus (CGE: mosses)
- systematically according to a specific floristic or monographic treatment (eg. Sell and Murrell's Flora of Great Britain and Ireland, Flora Europaea, Bentham & Hooker, APGIII or IV..)
- geographically (eg. major subdivisions or within larger treatments)
- by collector or collection (eg. Darwin, Wallich, Lindley)

Storage: environmental conditions



In the collections storage area, aim for:

- temperature below 20° C (ideally below 18° C)
- relative humidity 40-60%, avoiding frequent or rapid fluctuations
- dark/low UV (cover specimens when not in use)
 - minimise handling and movement

Storage: pest control and monitoring



- freeze all incoming material (-30°C for 3 days, bag specimens during to control humidity)
 - maintain well sealed boxes/cupboards
 - keep collection clean (and easy to clean)
 - no food/drink in collections
 - blunder traps to monitor, ideally quarterly
- re-freeze or treat material if pests detected/suspected

Biscuit beetle
Stegobium paniceum



Cigarette beetle
Lasioderma serricorne



Varied carpet beetle
Anthrenus verbasci



Varied carpet beetle
Attagenus pello





Museum Pests

<https://museumpests.net>

Historyonics

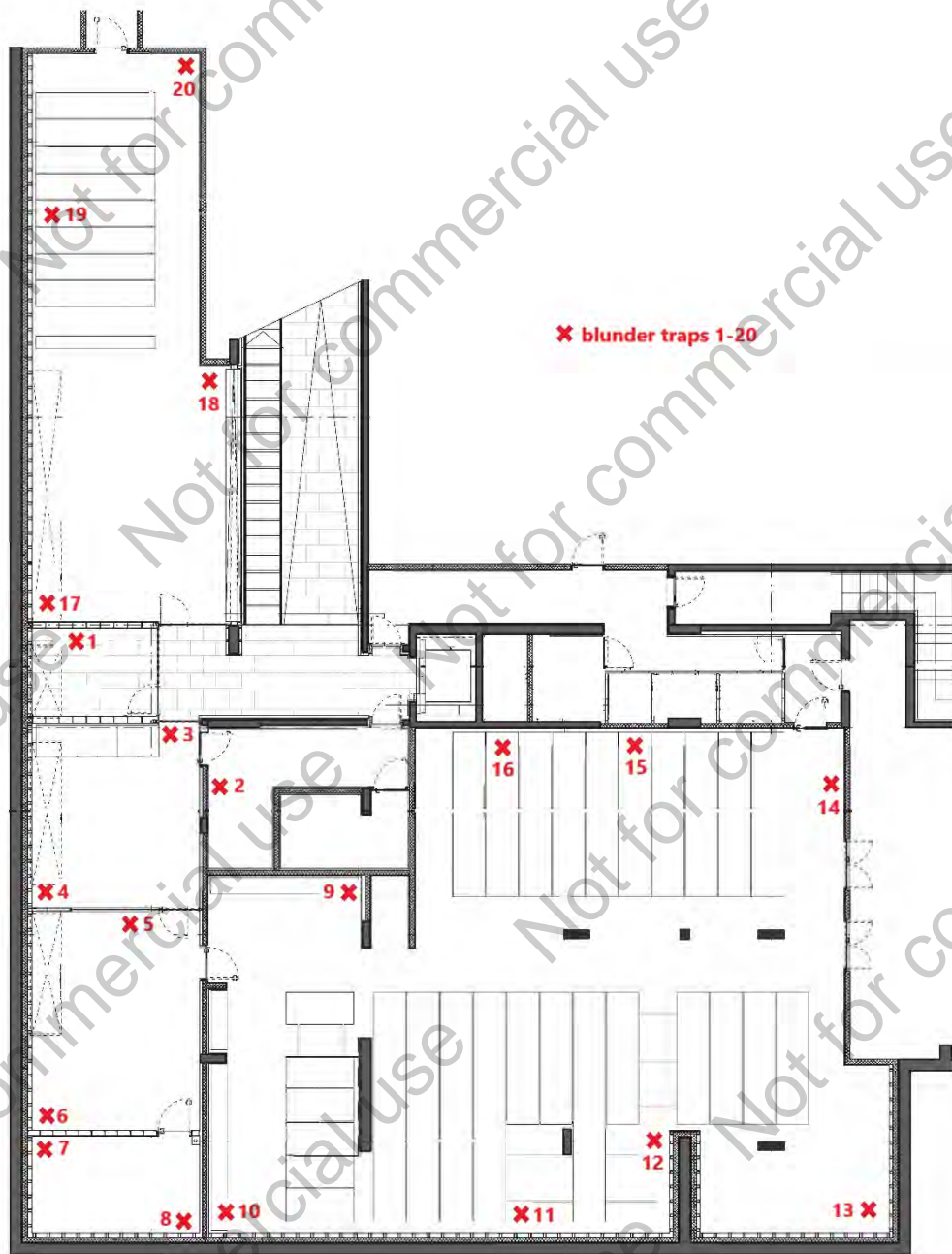
<http://www.historyonics.com>

Integrated Pest Management in Cultural Heritage



David Pinniger

Illustrated by Annette Townsend



Storage: pest control and monitoring



- freeze all incoming material (-30° C for 3 days, bag specimens during to control humidity)
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 - blunder traps to monitor, ideally quarterly
- re-freeze or treat material if pests detected/suspected

WARNING: beware *previous* pesticide use..



Research use



Policies and procedures needed for:

- Physical access to collections and loans – resourcing, security, specimen handling
- Digital access: ‘digital on demand’ and online specimen portals – resourcing, resolution required
- Destructive sampling – ethics, purpose of collection, ‘value added’



© Sara Barrios



Harris & Marisco (2017)
Applications in Plant Sciences 5(4)



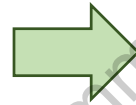


(Specimen request received)

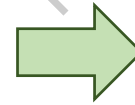


Specimen in collection

CGE specimen imaging workflow



Specimen imaged



(Image sent to enquirer)



Label data transcribed



Herbarium database populated

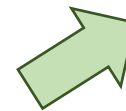


Image and data hosted on specimen portal



Image served to GBIF, JSTOR Plants, etc

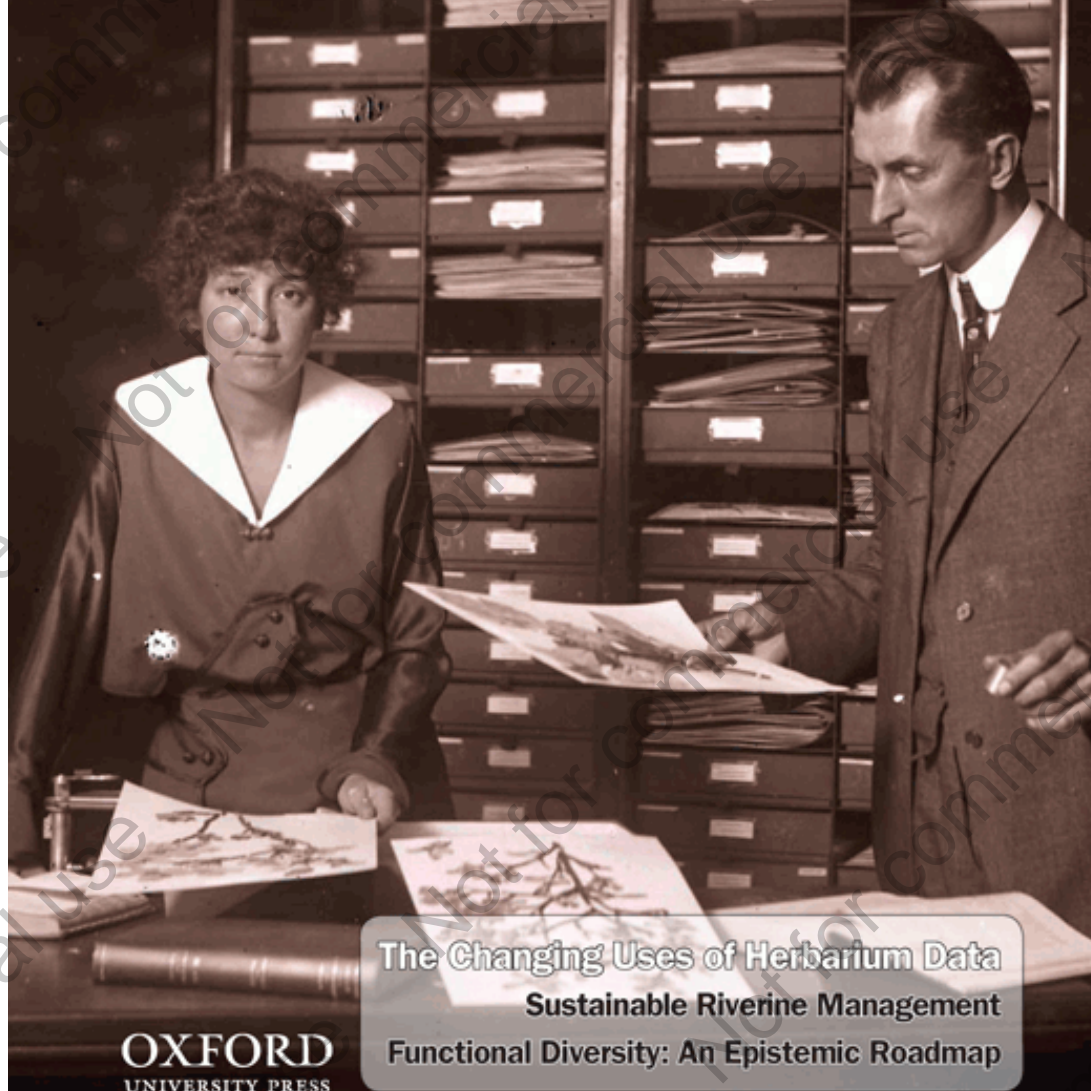
BioScience®

A Forum for Integrating the Life Sciences

October 2019

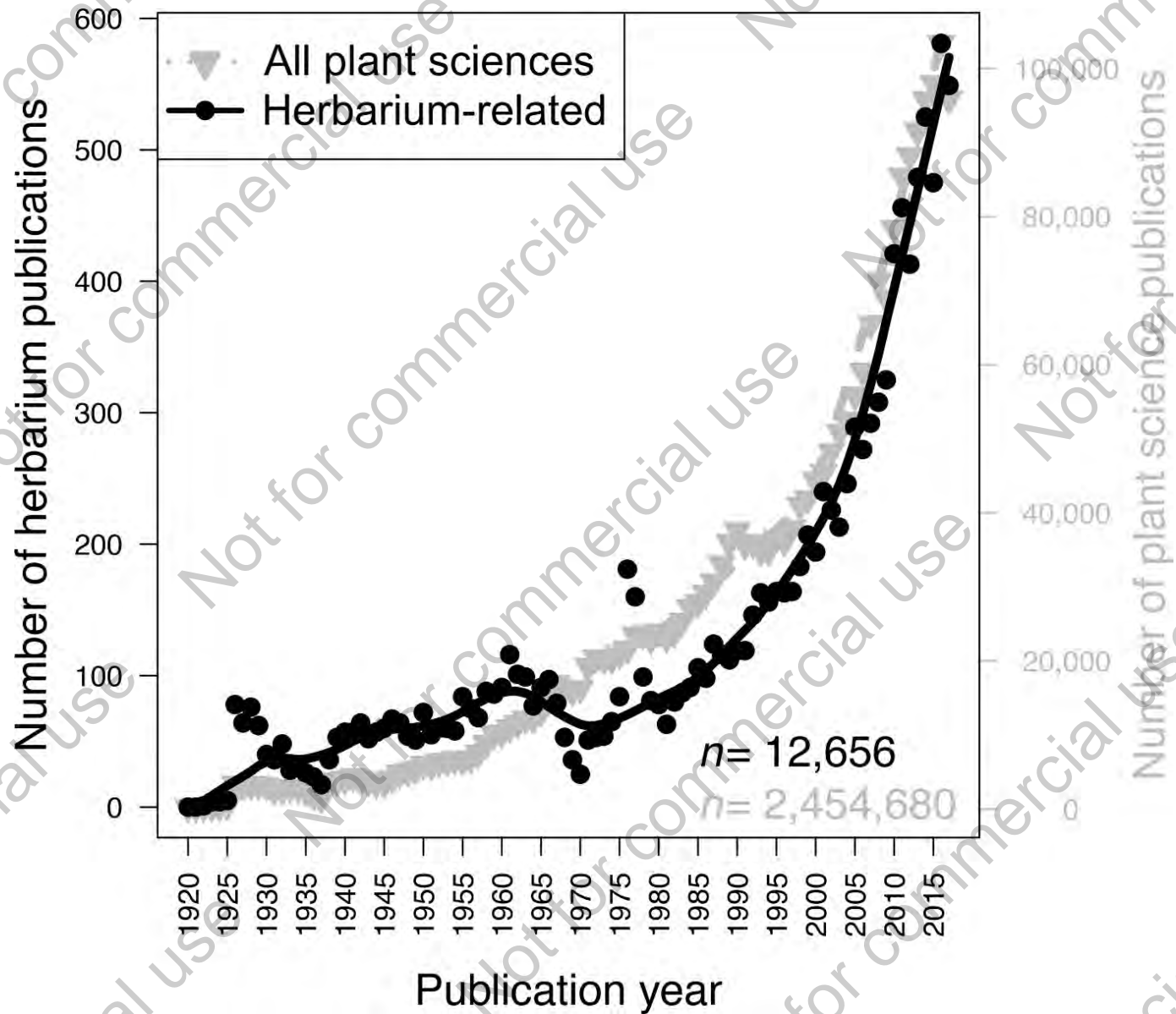
American Institute of Biological Sciences

Vol. 69 No. 10

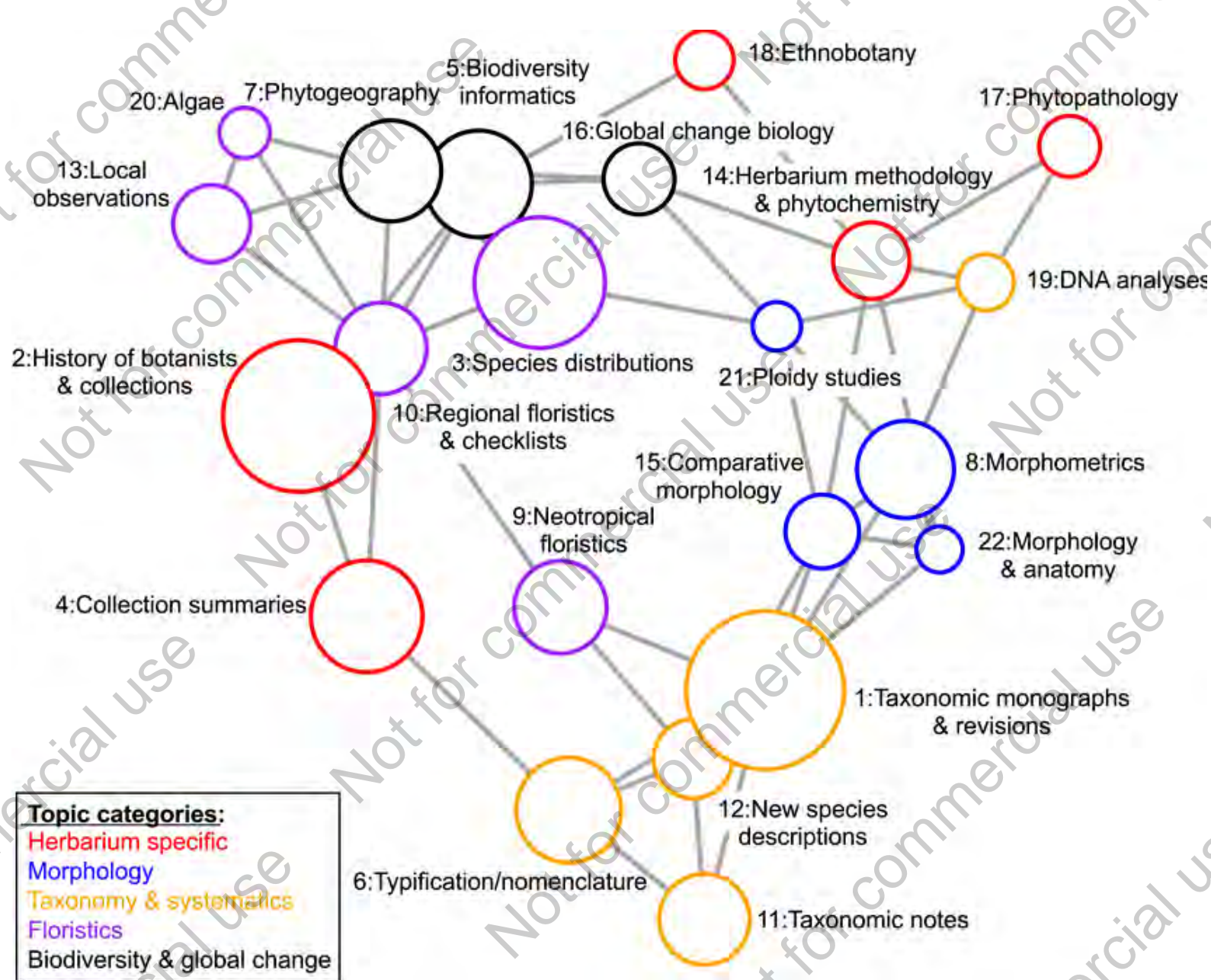


The Changing Uses of Herbarium Data
Sustainable Riverine Management
Functional Diversity: An Epistemic Roadmap

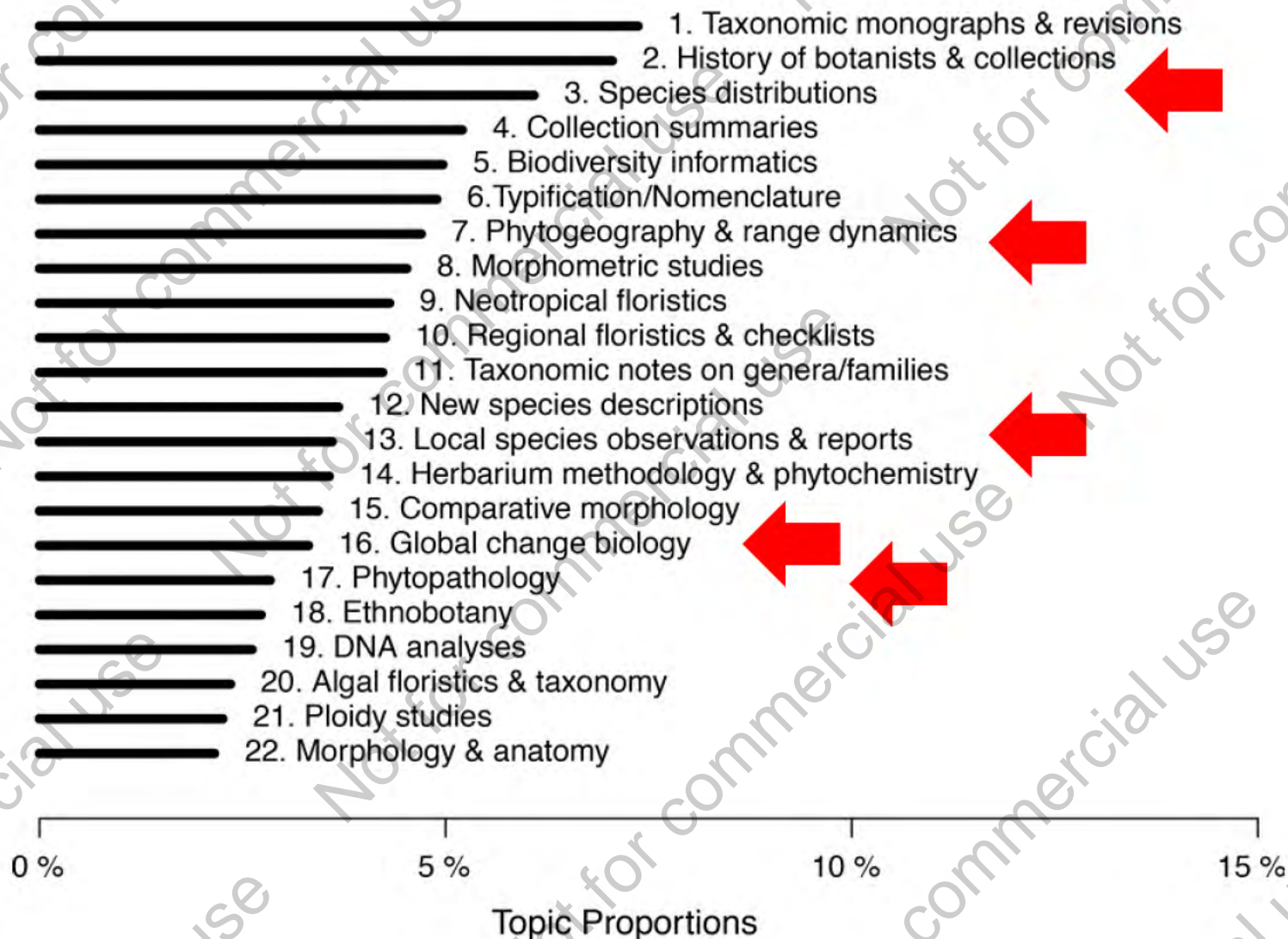
OXFORD
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Heberling, Prather & Tonsor (2019) *The changing uses of herbarium data in an era of global change: an overview using automated content analysis.* **BioScience** 69: 812-822.

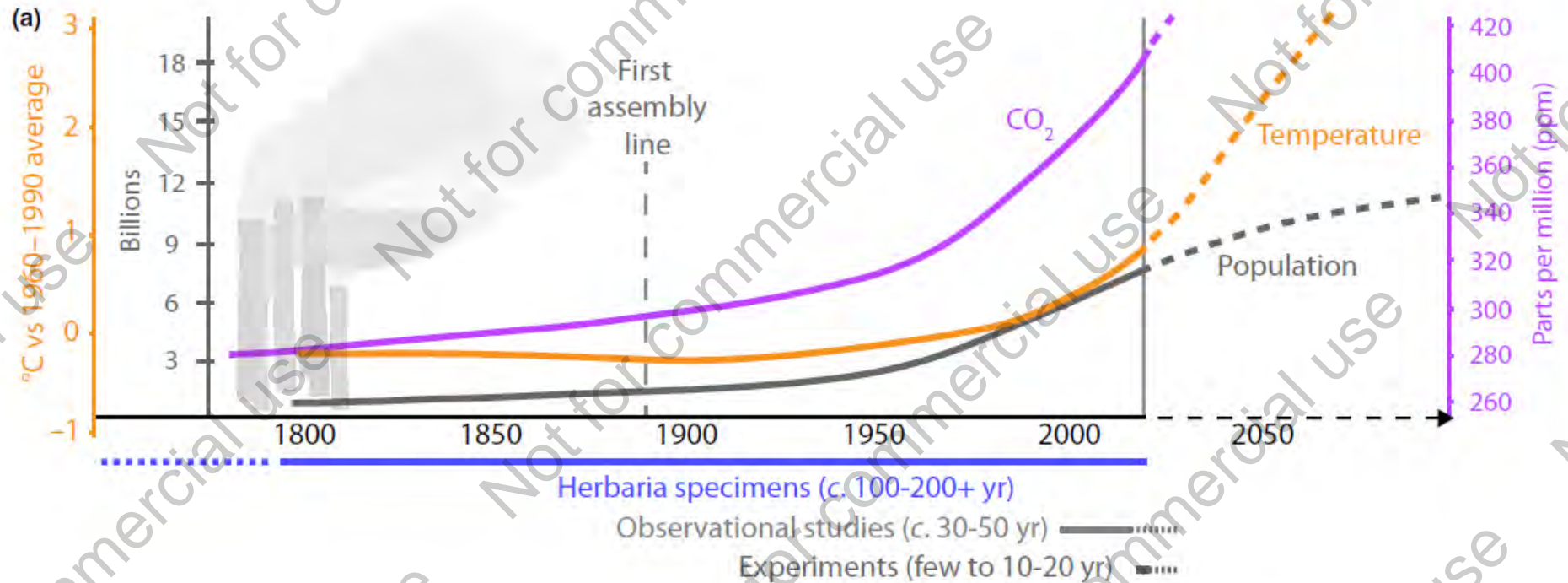


Heberling, Prather & Tonsor (2019) *The changing uses of herbarium data in an era of global change: an overview using automated content analysis.* **BioScience** 69: 812-822.



Heberling, Prather & Tonsor (2019) *The changing uses of herbarium data in an era of global change: an overview using automated content analysis.* **BioScience** 69: 812-822.

Hundreds of years of fieldwork...



Lang et al. (2019) Using herbaria to study global environmental change. *New Phytologist* 221: 110-122.

Pollution

Date of a contamination?

Contamination levels?

Eutrophication?

Photorespiration vs photosynthesis?

Contamination adaptation / plasticity?

Past CO₂ concentrations?
(stomatal densities)

Molecules

element ratios
isotope ratios
DNA

Phenotype
macroscopic
microscopic

Climate change

Spatial escape upwards / polewards?

Temporal escape?
(leaf-out, flowering, fruiting)

Mismatched interactions?
(pollinator / herbivore traces)

Habitat change

Relative abundances?
Distributions?
Species diversity?
Extinction events + causes?

Pollinator loss?

Within-species genetic
diversity?
Adaptive potential?

Phenology
flowering
leaf-out
fruiting

Biotic interactions
pathogens
herbivores
pollinators

Meta-information
date
location

Invasions

Genetic paradox of invasions?
Genetic setups through time?

Causes and dynamics of invasions?
Anthropogenic / historic factors?

Co-evolutionary host-pathogen dynamics?
Spread dynamics?
Causal strains?

Lang et al. (2019) Using herbaria to
study global environmental change.
New Phytologist 221: 110-122.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B

BIOLOGICAL SCIENCES

Biological collections for understanding biodiversity in the Anthropocene

Theme issue compiled and edited by Emily K. Meinke, Barnabas H. Daru, T. Jonathan Davies and Charles C. Davis

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ROYAL
SOCIETY
PUBLISHING

15 review papers... ...10 specifically about herbaria

- Using museum specimens to track **morphological shifts** through **climate change**
- Fossil **Atmospheres**: a case study of **citizen science** in question-driven palaeontological research
- **Fungarium** specimens: a largely untapped source in **global change biology** and beyond
- Facets of phylodiversity: **evolutionary diversification, divergence and survival** as **conservation** targets
- The use and misuse of herbarium specimens in evaluating **plant extinction risks**
- Museum specimens provide novel insights into **changing plant–herbivore interactions**
- Bookkeeping of **insect herbivory trends** in herbarium specimens of purple loosestrife (*Lythrum salicaria*)
- A novel proof of concept for capturing the diversity of **endophytic fungi preserved in herbarium specimens**
- Specimen-based analysis of morphology and the environment in ecologically dominant grasses: **the power of the herbarium**
- The history and impact of digitization and digital **data mobilization on biodiversity research**

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