Taxonomy, classification, and specimens

3/28/11

Taxonomy vs. classification

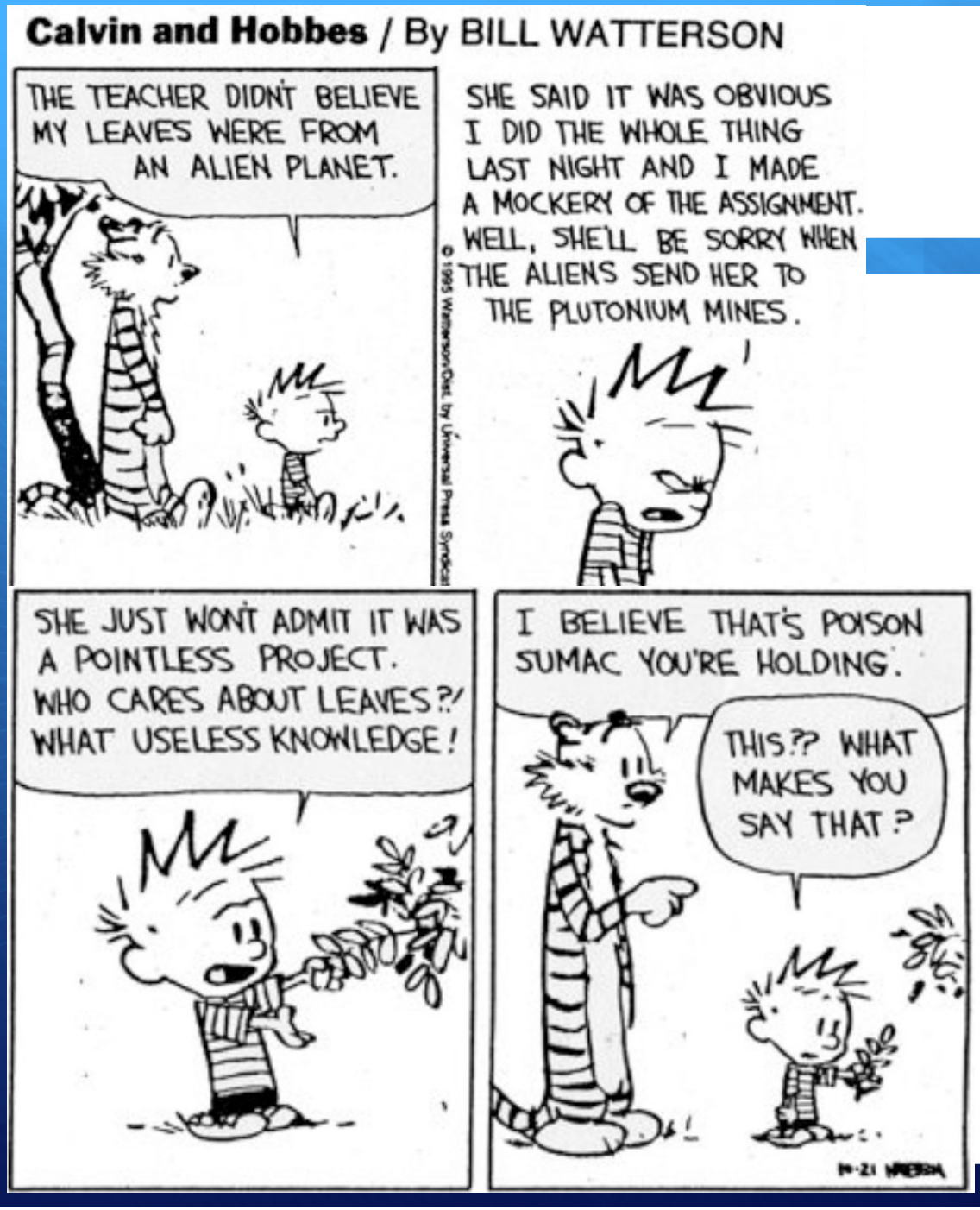
- **Taxonomy** is the practice and science of classification
- It is usually organized by **supertype-subtype** relationships (generalization-specialization relationships or parent-child relationships)
- A hierarchical taxonomy is a **tree structure** of classifications for a given set of objects. At the top of this structure is a single classification, the root node, that applies to all objects. Nodes below this root are more specific classifications that apply to subsets of the total set of classified objects

Biological taxonomy

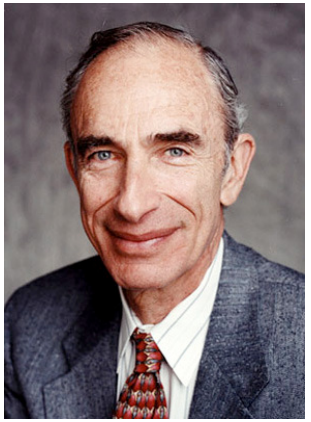
- **Alpha taxonomy** – the science of defining and naming organisms; it is the alphabet of biology
- **Beta taxonomy** (≈systematics) – the science of understanding the relationships among taxa; it is the grammar of biology
- Taxonomy provides a relational link between and amongst biological phenomena

Why alpha taxonomy matters

- Taxonomic name is the unique ID of a taxon
- Facilitates communication about taxa e.g.,
  - Identification and describing species
  - Biodiversity mapping and cataloging life
  - Standardization of model organisms
  - Classification of organisms according to a variety of criteria (evolutionary, utilitarian, geographic etc.)
- Was the prerequisite of the evolutionary thought



Taxonomy provides a stable and universal vocabulary of organisms



Paul Ehrlich – a cautionary tale

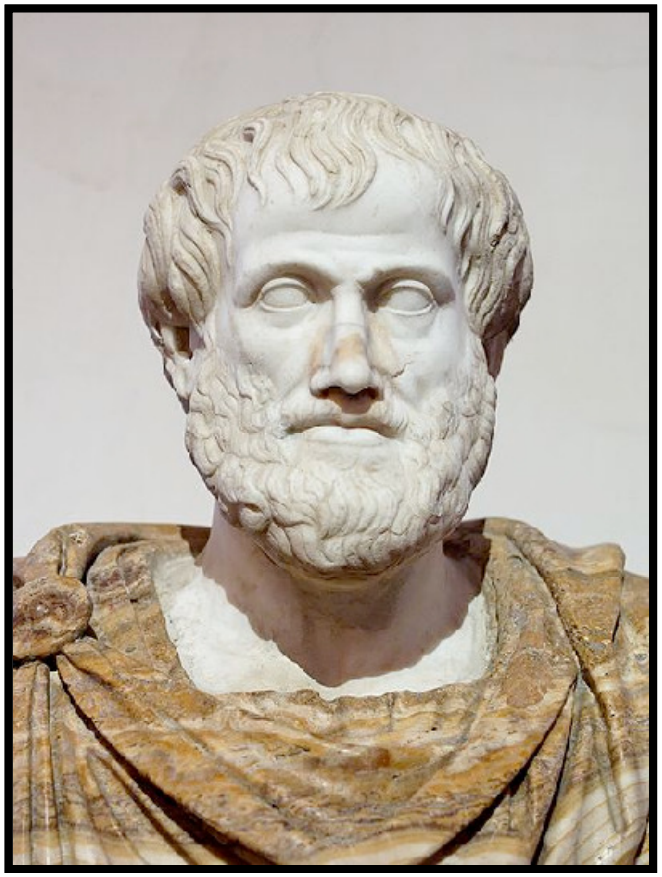
Criteria of a good taxonomy

- Stability (ICZN, ICBN etc.)
- Uniformity (using a "dead language")
- Traceability (taxonomic changes leave a documented "trail")
- Logical hierarchy (a difficult transition from *scala naturae* to phylogenies)

Pre-Linnean taxonomy

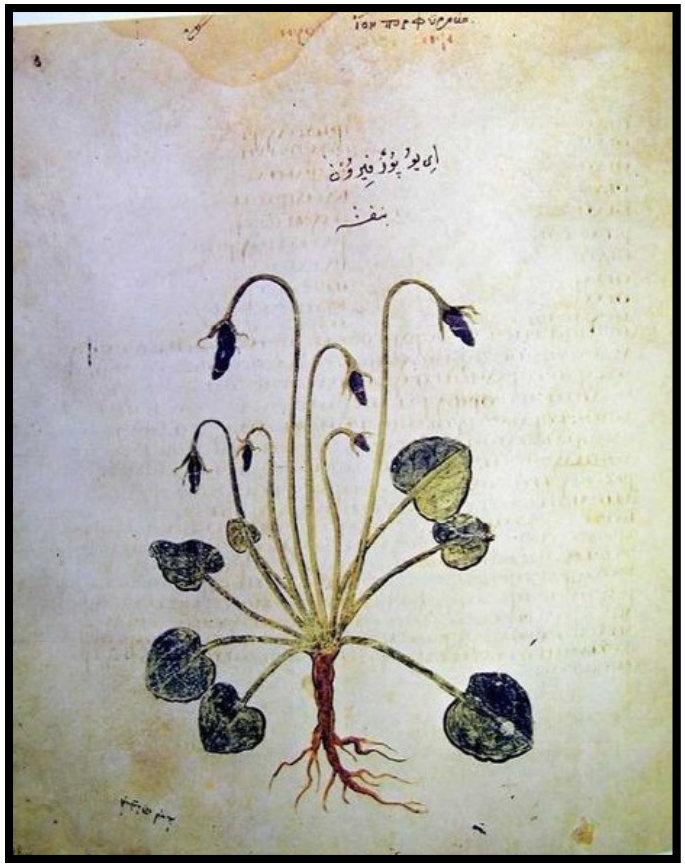
- Shen Nung, Emperor of China around 3000 BC.
- known as the Father of Chinese medicine and is believed to have introduced acupuncture
- pharmacopoeia *Divine Husbandman's Materia Medica* included 365 medicines derived from minerals, plants, and animals
- Around 1500 BC medicinal plants were illustrated on wall paintings in Egypt
- In one of the oldest and largest papyrus rolls, Ebers Papyrus, plants are included as medicines for different diseases. They have local names such as "celery of the hill country" and "celery of the delta" (species of Apiaceae)

Pre-Linnean taxonomy



- Biological taxonomy as a branch of Western science emerged with the Aristotle (384-322 BC)
- In *Historia Animālium* he introduced the concept of *scala naturae* (Ladder of Life) according to which organisms were classified
- Aristotle recognized 520 species of animals, which he divided into those "with blood" (vertebrates) and "without blood" (invertebrates)
- Animals were arranged according to their vitality and ability to move

Pre-Linnean taxonomy



Picture of a Violet in *De Materia Medica by* Dioscorides

- **Theophrastus** (370–285 BC) – wrote a classification of all known plants, *De Historia Plantarum*, which contained 480 species. His classification was based on growth form, and we still recognize many of his plant genera e.g., *Narcissus, Crocus* and *Cornus.*
- **Dioscorides** (40–90 AD) – a Greek physician, who wrote *De Materia Medica*, which contained around 600 species
- The classification in his work is based on the medicinal properties of the species.
- **Plinius** (23–79 AD) – in *Naturalis Historia*, a work of 160 volumes, he described plants and gave them Latin names
- Many of these names are still in use e.g., *Populus alba* and *Populus nigra*
- The Father of Botanical Latin

Pre-Linnean taxonomy

- **Gaspard Bauhin** (1560-1624), was a Swiss botanist who wrote *Pinax theatri botanici* (1596),
- He introduced many names of genera that were later adopted by Linnaeus, and remain in use.
- For species he carefully pruned the descriptions down to as few words as possible e.g., *Plantago media = Plantago foliis ovato-lanceolatis pubescentibus, spica cylindrica, scapo tereti*
- The single-word description was still a description intended to be diagnostic, not an arbitrarily-chosen name to serve as a unique identifier
- **Joseph Pitton de Tournefort** (1656 –1708) – a French botanist, introduced the concept of a **genus**, which can have multiple species

Carl Linnaeus (1707 –1778)

- Swedish botanist who introduced the now accepted hierarchical classification of living organisms and binomial nomenclature of species (for this Linnaeus was designated the lectotype of *Homo sapiens* [in Stearn 1959: 4])
- First presented in Leiden in 1735, *Systema Naturae* was based on Aristotle's system of progressive subdivision on groupings of organisms
- Introduced the concepts of kingdoms, classes, orders, genera, and species
- Published in 1753 , *Species Plantarum* is internationally accepted as the beginning of modern botanical nomenclature; it described over 7,300 species

International Code of Botanical Nomenclature (ICBN)

- The formal starting date of nomenclature at 1 May 1753, the publication of *Species Plantarum* by Linnaeus (or at later dates for specified groups and ranks)
- ICBN applies not only to plants, as they are now defined, but also to other organisms traditionally studied by botanists and mycologists. This includes Cyanobacteria; fungi, including chytrids, oomycetes, and slime moulds; photosynthetic protists and taxonomically related non-photosynthetic groups (bacteria were excluded in 1990)

International Code of Botanical Nomenclature

(VIENNA CODE)

Electronic version of the original English text.

adopted by the Seventeenth International Botanical Congress
Vienna, Austria, July 2005

prepared and edited by

J. MCNEILL, Chairman
F. R. BARRIE, H. M. BURDET, V. DEMOULIN,
D. L. HAWKSWORTH, K. MARHOLD, D. H. NICOLSON,
J. PRADO, P. C. SILVA, J. E. SKOG, J. H. WIERSEMA, Members
N. J. TURLAND, Secretary
of the Editorial Committee

2006

The printed and only official version of the Code has been published as
International Code of Botanical Nomenclature (Vienna Code). Regnum Vegetabile 146. A.R.G. Gantner Verlag KG.
ISBN 0080-0694

Taxonomic ranks recognized by ICBN

kingdom (*regnum*)
subregnum
division or **phylum** (*divisio*, *phylum*)
subdivisio or *subphylum*
class (*classis*)
subclassis
order (*ordo*)
subordo
family (*familia*)
subfamilia
tribe (*tribus*)
subtribus
genus (*genus*)
subgenus
section (*sectio*)
subsectio
series (*series*)
subseries
species (*species*)
subspecies
variety (*varietas*)
subvarietas
form (*forma*)
subforma

Naming rules of ICBN

- The name of a taxon above the rank of family is treated as a noun in the plural and is written with an initial capital letter
- A name of a **division** or **phylum** should end in *-phyta* unless the taxon is a division or phylum of fungi, in which case its name should end in *–mycota*
- A name of a **subdivision** or **subphylum** should end in *-phytina*, unless it is a subdivision or subphylum of fungi, in which case it should end in *–mycotina*
- A name of a **class** or of a **subclass** should end as follows:
  - In the algae: *-phyceae* (class) and *-phycidae* (subclass);
  - In the fungi: *-mycetes* (class) and *-mycetidae* (subclass);
  - In other groups of plants: *-opsida* (class) and *-idae*, but not *-viridae* (subclass)
- The name of a **family** is a plural adjective used as a noun with the termination *-aceae*

For the naming of cultivated plants there is a separate code, the **International Code of Nomenclature for Cultivated Plants (ICNCP)**

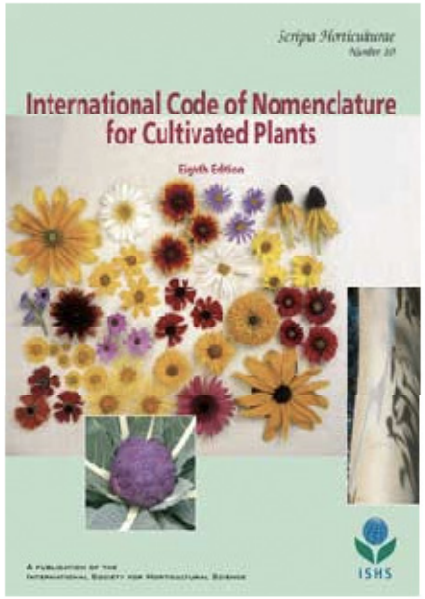
NEW EDITION OF THE INTERNATIONAL CODE OF NOMENCLATURE FOR CULTIVATED PLANTS

Published by the International Society for Horticultural Science (ISHS) in the series Scripta Horticulturae.
Scripta Horticulturae 10, 204 pages, October 2009 [ISSN 1813-9205 - ISBN 978-90-6605-662-6].
Price for non-members of ISHS: 20 euro

(ICNCP or Cultivated Plant Code), incorporating the Rules and Recommendations for naming plants in cultivation. **Eighth Edition**. Adopted by the International Union of Biological Sciences International Commission for the Nomenclature of Cultivated Plants. Prepared and edited by: C.D. Brickell (Commission Chairman), C. Alexander, J.C. David, W.L.A. Hetterscheid, A.C. Leslie, V. Malecot, Xiaobai Jin, members of the Editorial Committee and J.J. Cubey (Editorial Committee Secretary).

This eighth edition of the International Code of Nomenclature for Cultivated Plants (2009) replaces the seventh edition of the Code which was published in February 2004 as Acta Horticulturae Vol. 647 and as Regnum Vegetabile Vol. 144.

The organisation of the Fifth International Symposium on the Taxonomy of Cultivated Plants held at Wageningen, The Netherlands from October 15-19, 2007, provided a focus for the International Commission members charged with revisions of the ICNCP to meet to consider proposals to amend the Code and to prepare a further edition to take into account the changing needs



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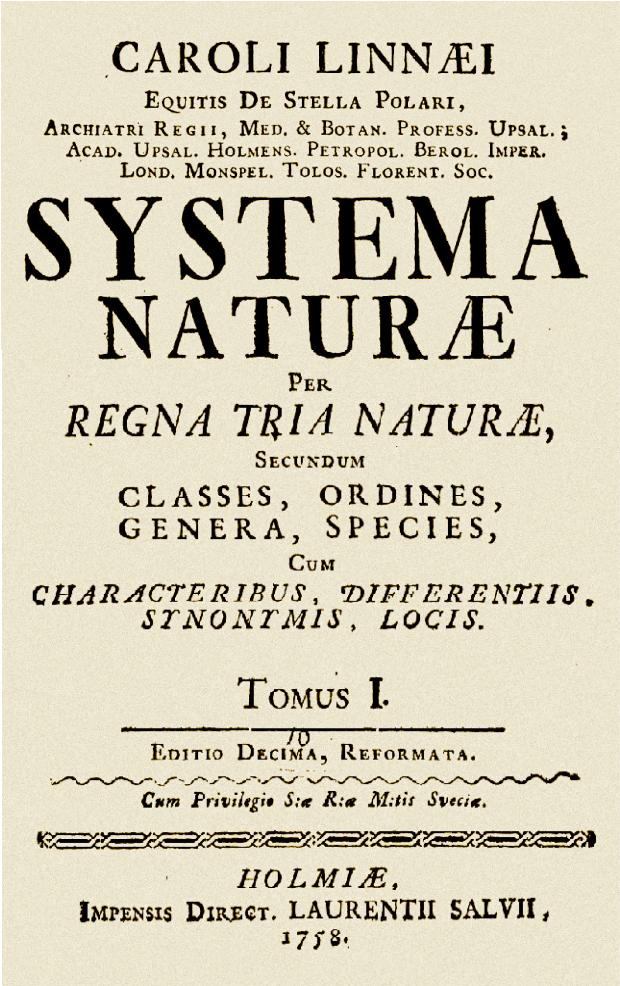
Carl Linnaeus (1707 –1778)



CAROLI LINNÆI

EQUITIS DE STELLA POLARI,
ARCHIATRI REGII, MED. & BOTAN. PROFESS. UPSAL.;
ACAD. UPSAL. HOLMENS. PETROPOL. BEROL. IMPER.
LOND. MONSPEL. TOLOS. FLORENT. SOC.

SYSTEMA NATURÆ

PER

REGNA TRIA NATURÆ,

SECUNDUM

CLASSES, ORDINES,
GENERA, SPECIES,

CUM

CHARACTERIBUS, DIFFERENTIIS,
SYNONYMIS, LOCIS.

TOMUS I.

10
EDITIO DECIMA, REFORMATA.

Cum Privilegio S:æ R:æ M:tis Sveciæ.

HOLMIÆ,
IMPENSIS DIRECT. LAURENTII SALVII,
1758.

- *Systema Naturae* - the 10th edition was released in 1758, it is the starting point for zoological nomenclature
- Names published before that date are unavailable, even if they would otherwise satisfy the rules. The only work which takes priority over the 10th edition is Carl Alexander Clerck's *Aranei Suecici*, which was published in 1757

International Code of Zoological Nomenclature (ICZN)

- Rules the naming and classification of the Metazoa and protistan taxa whenever they are or have been treated as animals for nomenclatural purposes
- Scope: independent of botanical nomenclature, no name is to be rejected because it is identical with the name of a plant (homonymy – a problem for databases)
- Basic principles
  - Law of Priority
  - Law of Proscription
  - Law of Type Fixation

Contents

International Commission on Zoological Nomenclature

INTERNATIONAL CODE OF ZOOLOGICAL NOMENCLATURE

Fourth Edition

adopted by the International Union of Biological Sciences

The provisions of this Code supersede those of the previous editions with effect from 1 January 2000

ISBN 0 85301 006 4

The author of this Code is the International Commission on Zoological Nomenclature

Editorial Committee
W.D.L. Ride, Chairman
H.G. Cogger
C. Dupuis
O. Kraus
A. Minelli
F. C. Thompson
P.K. Tubbs

Naming rules of ICZN

- **Nominate subtaxa**: if a taxon is divided into subtaxa, the name of one must be the same as, or derived from, that of the taxon (except for ending) e.g, Blaberinae (subfamily) in Blaberidae (family)
- **Endings:** Family Group names: **superfamily** – iodea, **family** – idea, **subfamily** – inae, **tribe** – ini, **subtribe** -ina; no rules for higher taxa
- Family- and Genus-group names are always capitalized,
- Genus – always a noun
- Species – usually an adjective that must agree in gender with the genus
- Species-group names are never capitalized
- No Species-group name alone constitutes the name of a species, it must be used in combination with a Genus-group name

Naming rules of ICZN

- Words: uninominal for supraspecific taxa, binominal for species, trinominal for subspecies (quatronomials – forms, variants are not covered by the ICZN)
- **Author**: author's name follows scientific name without punctuation, in parentheses if combined with a generic name different from the orig. combination e.g., *Redtenbacheriella maculata* Karny 1910 becomes *Pseudosaga maculata* (Karny 1910)
- Author of combination is not cited (in botany the author of the new combination is cited)

Problems with binomial (Species-group) nomenclature

- Is typological – inadequate to circumscribe genetic and morphological diversity of species
- Attempts to overcome the limitations by introducing subspecific taxa (subspecies variety, form)
- There is still no central, authoritative repository of ALL names for ALL organisms (but we are getting there)

Post-Linnean taxonomy

- **Jean-Baptiste de Lamarck** (1744–1829) launched an evolutionary theory including inheritance of acquired characters, named the "Lamarckism".
- First example of using data interpreted within an evolutionary framework to classify organisms, *Scala Naturae* no longer leading principle of classification.
- **Willi Hennig** (1913–1976) founded the era of cladistics
- Only similarities grouping species (synapomorphies) should be used in classification
- Taxa should include all descendants from one single ancestor (the rule of monophyly)

Rank-free classification: PhyloCode

- Kevin de Queiroz and Jacques Gauthier, started the discussions in the 1990's and laid the theoretical foundation to a new nomenclatural code for all organisms, the PhyloCode
- The first draft was published on the web in 2000
- PhyloCode reflects a philosophical shift from naming species and subsequently classifying them into higher taxa to naming both species and clades.
- Only species and clades should have names, and that **all ranks above species are excluded** from nomenclature.

The *PhyloCode* is a formal set of rules governing phylogenetic nomenclature. It is designed to name the parts of the tree of life by explicit reference to phylogeny. The *PhyloCode* will go into operation in a few years, but the exact date has not yet been determined. It is designed so that it may be used concurrently with the existing codes based on rank-based nomenclature (*ICBN*, *ICZN*, etc.). We anticipate that many people whose research concerns phylogeny will find phylogenetic nomenclature advantageous.

THE VERSION OF THE *PHYLOCODE* THAT IS POSTED HERE IS A DRAFT. Some parts of it may change before the code is implemented. Comments are welcome and may be sent to *phylocode@ohio.edu*.

The *PhyloCode* grew out of a workshop at Harvard University in August 1998, where decisions were made about its scope and content. Many of the workshop participants, together with several other people who subsequently joined the project, served as an advisory group (see the *PhyloCode* preface for a list of

Why specimens matter

- The specimens contained in museum collections represent the totality of our current understanding of the world's biodiversity
- Specimens in collections reveal polymorphisms, help reconstruct historical distributions, develop models of seasonal phenology, and identify potential hotspots of diversity and endemism which may be crucial to regional conservation efforts
- Collections-based research forms the foundation of all phylogenetic and systematic treatments, including molecular-based research

The process of managing a specimen collection

1. **Collecting and preparing the specimens** – focus on the preservation of maximum number of characters and specimen longevity
2. **Accessioning** – a process whereby a group of specimens entering the collection are recognized as a group united by their origin, and all associated information is recorded (permits, collectors etc.)
3. **Determination** – specimens are identified to lowest level of taxonomic hierarchy possible; identification and its accuracy can be refined with time

The process of managing a specimen collection

4. **Cataloging** – the assignment of a unique, institution and collection-specific identifier; only after a specimen has been cataloged it is considered fully "curated"

5. **Data capture and management** – data associated with each specimen are captured in a database; these data may be linked to other, related data (e.g., a database of host plants collected during the same expedition, but not curated with the insect collection). From this point on the history and use of the specimen will be tracked, and its associated data can be disseminated.

Data that should accompany each specimen record

- **Specimen unique ID**
- Lot ID/Accession ID/Catalog ID etc.
- Specimen location (institution, collection, drawer, vial etc)
- **Collecting/observation event data**
  - GPS coordinates
  - Locality names
  - Date/time
  - Collector
  - Collecting method
  - Habitat/behavior/association data

Information in **bold** must be on the physical specimen label

Data that should accompany each specimen record

- Specimen attributes
  - Sex/stage
  - Type status
  - Morphometrics
  - Media
  - Condition, notes etc.
- Identification data

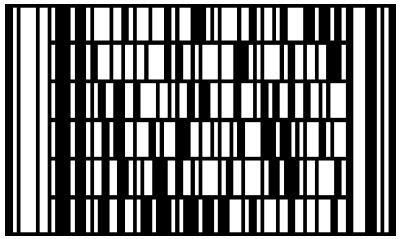
Tracking the specimen

- Each specimen in a collection/database should be tagged with a unique ID
- ID should be both machine- and human-readable
- ID must be unique within the collection/database
- ID may contain additional information (e.g., coden, species etc.)

Specimen barcodes

Code 93 (up to 43 characters)

Code 128



Stacked code (multiples of linear codes)

- **Linear barcodes**
  - Information encoded by a combination of widths of bars and spaces (e.g., 3 bars and 3 species per character in Code 128)
  - Readable by older generation readers
  - Numerical or alphanumerical
  - Large and limited in information content

Specimen barcodes

Data matrix code
(up to 2,335 characters)

QR code (up to 7,089 characters)

- **Matrix (2D) barcodes**
  - Information encoded by clustering and position of blocks
  - Require high resolution readers
  - Numerical or alphanumerical
  - Smaller and capable of large information content

ID data that should accompany each specimen record – Identification

- Species or morphospecies name e.g., *Gryllus campestris* L., *Gryllus* cf. *campestris*, *Gryllus* sp. 1
- Identifier's name
- Date of identification
- History of identification

What is specimen identification

Assigning an individual specimen to a species is a hypothesis that the unknown is conspecific with the ***type specimen*** of the species and NOT that it fits into a typological circumscription of that species (this concept is often misunderstood in real life)

How to confirm a name/identification

- Consult a specialist
- Use peer-reviewed printed publications (monographs, keys etc.)
- Compare with reference specimens (including types)
- Use online resources

How to confirm a name/identification

Online resources

- Taxonomic catalogs
- Type specimen databases
- Other specimen database (e.g., virtual herbaria)
- Other online identification resources

Type specimens

- Types are onomatophores – they provide a physical reference point for a specific, named, operational taxonomic unit
- Type specimens are not "typical" representatives of a species
- They provide a historical reference point for a species' diagnosis and are cornerstones of nomenclatorial stability

Type specimens

- **Holotype** - A single physical example (or illustration) of an organism used to formally describe a species. A **name-bearing** type (onomatophore, the primary type).
- **Syntype** – Any of two or more specimens listed in a species description where a holotype was not designated; term no longer in use.
- **Paratype** – Any additional specimen other than the holotype, listed in the type series, where the original description designated a holotype.
- **Neotype** – A specimen later selected to serve as the single type specimen when an original holotype has been lost or destroyed, or never designated.
- **Lectotype** – A specimen later selected to serve as the single type specimen for species originally described from a set of syntypes.
- **Paralectotype** – Any additional specimen from among a set of syntypes, after a lectotype has been designated from among them. These are not name-bearing types.

Type specimens online

- Universal access to type information (**negative identification** as the primary function)
- Permanent type documentation
- Error correction/type designation
- Repatriation of information, other buzzwords

Online type data and image access

- First online type image collection in 1995 (Venezuelan butterflies)
- First taxonomists not necessarily first to be online (most of Linnean and Fabricius' types have never been photographed)

The Linnean Collections

The LINNEAN SOCIETY of London

Home | About | Herbarium | Insects | Fish | Shell | Correspondence | Search | Help

Login | Create Account Search Savage Number

LINN 0047 Papilio agamemnon (Ins Linn)

LINN 0047 Papilio agamemnon (Ins Linn)


Zoomable image (requires Flash)


Zoomable image (requires Flash)


Zoomable image (requires Flash)

Genus:	*Papilio*
Species:	*agamemnon*
Genus number:	231
Species number:	22
Specimen number:	0047
Label data:	21 Agamemnon [Linnaeus]/ Agamemnon 748. [Smith]
Primary type status:	Lectotype
Collection history:	Linnaeus

Types imaged: 2,372

Derived Data

Annotations/Identifications:

	Name	Ref	Annotated by	Date
1	Graphium agamemnon	Honey &Scoble, 2001 (p. 292)	Linnaeus	UNSPECIFIED

Order:	Lepidoptera
Family:	Papilionidae

SysTax - a Database System for Systematics and Taxonomy

- HOME
- About
- Data Query
- Taxon Browser
- Systax Portal
- Garden Portal
- Contact
- Documentation
- Systax Manual
- Systax-light Manual
- Upload
- Download

name search
go
zool. coll.
go
herbaria
go
gardens
go
wildcard: % or *

SysTax is an integrated concept-based databa
system for storing biodiversity data.

A "hybrid" approach: DORSA & FoCol

The SysTax database system comprises:

- **concept-based botanical and zoological systema**
  SysTax stores an unlimited number of "concepts" of a taxon regarding its systematic position and its synonyms
- **literature**
- **Botanic Gardens, Herbaria, and Zoological Collections**
  SysTax holds the data of an unlimited number of gardens of other collections and provides all functions for e.g. seed exchange and loan.
- **addresses**
- **multimedia data (pictures, sound files and video sequences**
  Multimedia data can be linked with collection items, taxa, and / or literature citations.

Have a look at the complete task profile here or at the (German) manual.

Date can be entered in Systax through the SysTax client software [download] or imported from other databases. The offline application "SysTax-light" can be used for Data entry of data from gardens or collections [free download].

New: [...]

cultivates:	9833
zoological taxa:	
total	161262
families:	4869
genera:	28506
species:	125880
literature:	
citations, total:	52980
bot. assignments:	82800
zool. assignments:	121165
specimen:	
botany:	43719
thereof types:	2424
# taxa, botany:	13717
zoology:	217823
thereof types:	40264
# taxa, zoology:	54388
botanical gardens:	
accessions:	223290
# taxa:	56476
multimedia objects:	
images:	67388
sound objects:	8942
OLE-objects:	18
text objects:	1985

SysTax is GBIF-Provider for the German GBIF-nodes Evertebrata 1, Evertebrata 2, and Vertebrata. The botanical data stored in SysTax are part of the node Botany. [list of project partners ...]

© *Jürgen R. Hoppe, Evelin Boos, Thorsten Ludwig, Michael Wiedemann, Dept. of Systematic Botany and Ecology, University of Ulm, D- 89069 Ulm, Germany; Thomas Stützel, Systematic Botany, Ruhr-University of Bochum, Universitätsstrasse 150, D- 44780 Bochum, Germany*

Smithsonian Institution Department of Entomology

Search NMNH Collections

http://nhb-acsmith1.si.edu/search/ento/

uth Africa Nati... | MCZ Insect Type ... | Search NMNH Coll... | ScienceDirect

	Insecta	Diptera	Culicidae	A
	Insecta	Diptera	Culicidae	A
23928	Insecta	Diptera	Culicidae	A
58807	Insecta	Diptera	Culicidae	A
	Insecta	Diptera	Culicidae	A

Page 1 of 135 | Clear Selections

ntomology Collections | Keyword Search | **Search by Field**

arch by Field

talog Number - USNM:
rcode:
llection: Types
ass:
der: Diptera
mily:
ientific Name:
untry:
ovince/State/Territory:
strict/County:
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nly Records with Images: ☑

cords/Page to Display: ◉ 10 ○ 20 ○ 50 ○ 100

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(Melanoconion) falsificator Dyar & Knab, 1

Catalog Number: USNM 12108
Barcode:
Catalog: Entomology Types
Collection: Primary Types
Scientific Name: (Melanoconion) falsificator Dyar & Knab, 1909
Other Identifications: Culex (Melanoconion) atratus

Type Citations:

Taxon	Type Status	Citation
	Lectotype	

Sex/Stage:

Sex	Stage	Remarks
Male		

Preparation Details:

Preparation	Remarks
Pinned	Condition: Good

Country:
Province/State:
District/County:
Precise Locality:
Centroid Latitude:
Centroid Longitude:
Elevation (m):
Collector(s):
Date Collected:
Record Status:
Record Last Modified:

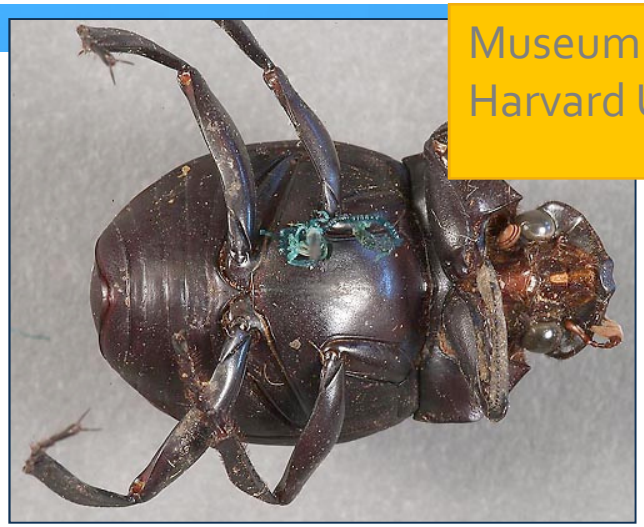
Title: Culex falsificator Lectotype specimen, Adult Dorsal abdomen
Description: Dorsal abdomen view, Culicidae type specimen, USNM 12108, Culex falsificator
Creator: Amanda Newton
Rights Holder: Smithsonian Institution Department of Entomology







Museum of Comparative Zoology,
Harvard University



Canthon vigilans LeConte, 1858
(Coleoptera: Scarabaeidae)
MCZ Type Number: 3701
Type status: Type
Stage: Adult
Medium: Mounted

	AMNH		BMNH		CAS		FMNH		LACM		MCZ		MNHN		UMO		USNM	
Blattodea					5	0					67	10					166	0
Coleoptera	1666	most?			4607	268	10758	220	230		14256	13309	1402	1360			5,000	1,074
Dermaptera					23	0					46	0					90	0
Diptera	3068	few?			2635	313	582	0	228		3193	1327			2287	0	5,000	1,347
Embioptera					13	0					23	0					1	0
Ephemeroptera					101	0					119	0					29	0
Grylloblattodea																	5	0
Hemiptera	2978	most?			2176	0			33		200	33	3219	0			5,000	2,279
Hymenoptera					3525	300	84	0	781		5492	1469	721	0			5,000	2,252
Isoptera				119	5	0					117	0					495	0
Lepidoptera					264	0	5	2	484		1782	364					5,000	3,722
Mantodea																	31	0
Mecoptera					12	0					64	0					27	0
Megaloptera					10	0					29	0					28	0
Neuroptera					100	0			4		774	35					140	0
Odonata	18	0			21	0					557	80				52	167	64
Orthoptera	120	0			155	0			7		83	23	716	294			803	0
Phasmatodea					12	0					1	0					63	0
Phthiraptera					7	0	120	0			15	0					1,368	0
Plecoptera					80	0			8		211	1					264	0
Psocoptera					8	0			2		265	1					85	0
Raphidioptera					7	0					14	0					3	0
Siphonaptera					1	0			16		1	0					481	0
Strepsiptera					17	0			23		1	0					126	0
Thysanoptera					437	0											1,378	0
Trichoptera					322	0			5		982	1					1,675	0
Zoraptera																	9	0
unspecified			275225												25000			
types/photos	7850	?5000	275225	119	14543	881	11549	222	1821	0	28292	16653	6058	1654	27287	52	32434	10738
% photos		**~?65**		**0.04**		**6.06**		**1.92**		**0***		**58.9**		**27**		**0.2**		**33.1**

Insect types in major collections

- Types specimens of 434,367 species in 13 major online collections
- Images available for 35,320 species
- Images available for 8.13% species in these collections
- Images available for ~**4%** of described species of insect (at the most)

Taxonomic authority files

- Taxon-specific authority files (bottom-up approach)
- Aggregate authority file portals and federated biological databases (top-down)

Orthoptera Species File (Version 2.0/4.0)

Home Search Taxa Glossary Key

Orthoptera Species File Online

TETTIGONIOIDEA
Species: 8,310
Types imaged: 5,269 (63%)

David C. Eades, Principal Database Developer,
Illinois Natural History Survey
Daniel Otte, Founder and Principal Author,
Academy of Natural Sciences of Philadelphia
María Marta Cigliano, Author,
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Major Contributors:
Sam Heads, Illinois Natural History Survey
Piotr Naskrecki, Museum of Comparative Zoology, Harvard University

With the cooperation of
The Orthopterists' Society

Tropicophyllum maculosum (Bowen-Jones, 2000)

The Orthoptera Species File is a taxonomic database of the world's Orthoptera (grasshoppers, locusts, katydids and crickets), both living and fossil. It has full synonymic and taxonomic information for more than 25,350 valid species, 42,460 scientific names, 165,300 citations to 12,500 references, 70,000 images, 180 sound recordings, 78,400 specimen records, and keys to 2,800 taxa.

Videos

Plague of *Dichroplus maculipennis* in Argentina

To see information contained in the database, use the links across the top of the page. Click on **Search** to find a specific taxon or other kinds of information. Clicking on **Taxa** will make the order Orthoptera your current taxon unless you have previously moved to a different taxon in this session.

This website and database use Species File Software. Information about the design and use of SFS may be found on a separate website.

Other Places to Start

- Table of contents

http://orthoptera.speciesfile.org/

Myrmica subopaca Smith 1858:127.
Monomorium subopacum (Smith) : Mayr 1862:7
(BMNH) [examined].
Monomorium (Xeromyrmex) subopacum (Smith)
[Xeromyrmex a junior synonym of Monomorium
Myrmica glyciphila Smith 1858: 125. Syntype [[w
[examined]. Syn. under M. subopacum (Smith) :
Monomorium mediterraneum Mayr 1861:72 (dia

FORMICIDAE
Species: 14,097
Types imaged: 801 (5.7%)

CASENT0010820

CASENT0010821

CASENT0010823

AntWeb

Curator Login

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Browse... Search for Go » Advanced Search

Global: Bolton World Catalog

Specimen: CASENT0005576
Species: Strumigenys lexex
Photographer:
Date Uploaded:
Copyright: Copyright AntWeb.org, 2000-2009. Licensing: Attribution-ShareAlike 3.0 (cc-by-sa-3.0) Creative Commons License
View Original TIFF

http://antweb.org

PHASMIDA
Species: 2,960
Types imaged: 1,935 (65%)

Phasmida Species File (Version 2.1/4.0)

Home Search Taxa Glossary Key

Phasmida Species File Online

Diapherodes gigantea

Paul D. Brock, Author,
The Natural History Museum, London
David C. Eades, Database Developer,
Illinois Natural History Survey
Daniel Otte, Major Contributor,
Academy of Natural Sciences of Philadelphia
Ed Baker, Assistant Editor

With the cooperation of
The Orthopterists' Society

Phyllium giganteum

Agathemera maculafulgens

Dryococelus australis

The Phasmida Species File (PSF) is a taxonomic database of the world's Phasmida (stick and leaf insects, known as walking sticks and walking leaves in the U.S.). It contains full synonymic and taxonomic information for over 2,950 valid species and over 4,500 taxonomic names (all ranks, valid and not valid). There are c. 26,000 citations to c. 2300 references. There are also c. 6000 specimen records and more than 10000 images of two thirds of valid species, with more being added to on a regular basis. Keys to taxa will be added at a later stage.

http://phasmida.speciesfile.org

Tropicos®

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TROPICOS® was originally created for internal research but has since been made available to the world's scientific community. All of the nomenclatural, bibliographic, and specimen data accumulated in MBG's electronic databases during the past 25 years are publicly available here. This system has over 1.2 million scientific names and 3.9 million specimen records.

Quick Name Search [ ] Search Search Exact

Common Name [ ]

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Helpful Links

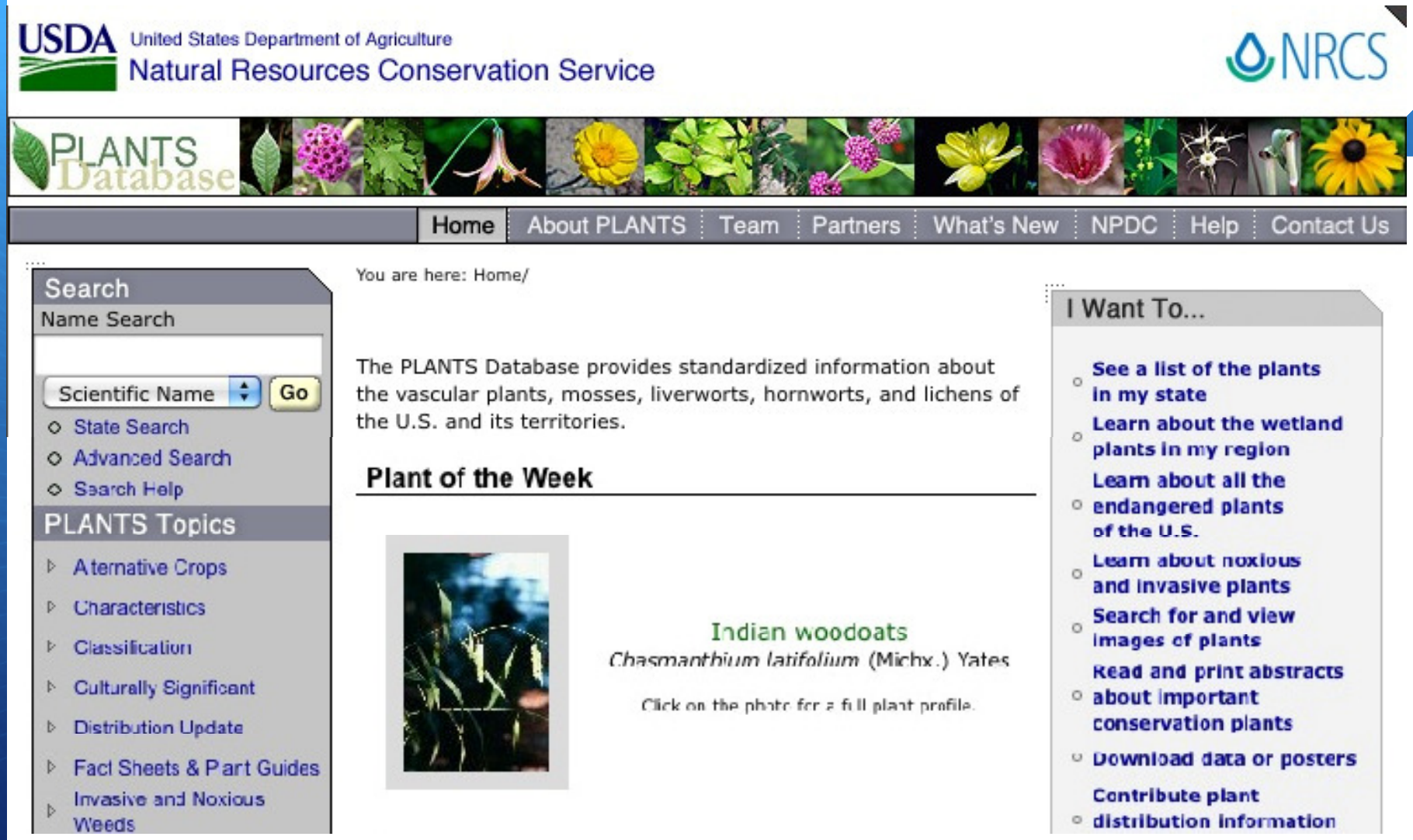
Research
Bryological Research
Botanicus digital library
Biodiversity Heritage Library
eFloras
Angiosperm Phylogeny Website

Explore Data

Family Word Cloud
MBG Specimen Country Occurrence Map
MBG Specimen Global Heat Map
Browse Tropicos® Specimens in Google Earth
Add Tropicos as a browser search provider

Name : Anthurium centimillesimum Croat
Specimen : Croat, Thomas Bernard – 100000

http://www.tropicos.org/



http://plants.usda.gov

http://www.fishbase.org/

MCZBASE:The Database of the Zoological Collections

Museum of Comparative Zoology - Harvard University

Search | My Stuff

Access to 1569733 records. Holdings Details

Search | Clear Form | **See results as:** Specimen Records | Show Observations? ☐ | Tissues Only? ☐

Identifiers — Customize | Show More Options

Institutional Catalog: All | Number:

Identification and Taxonomy — Show More Options

Any Taxonomic Element:

Locality — Show More Options

Any Geographic Element:

Date/Collector — Show More Options

Year Collected: --> Copy -->

Biological Individual — Show Fewer Options

Part: Define

Preservation Method: Define

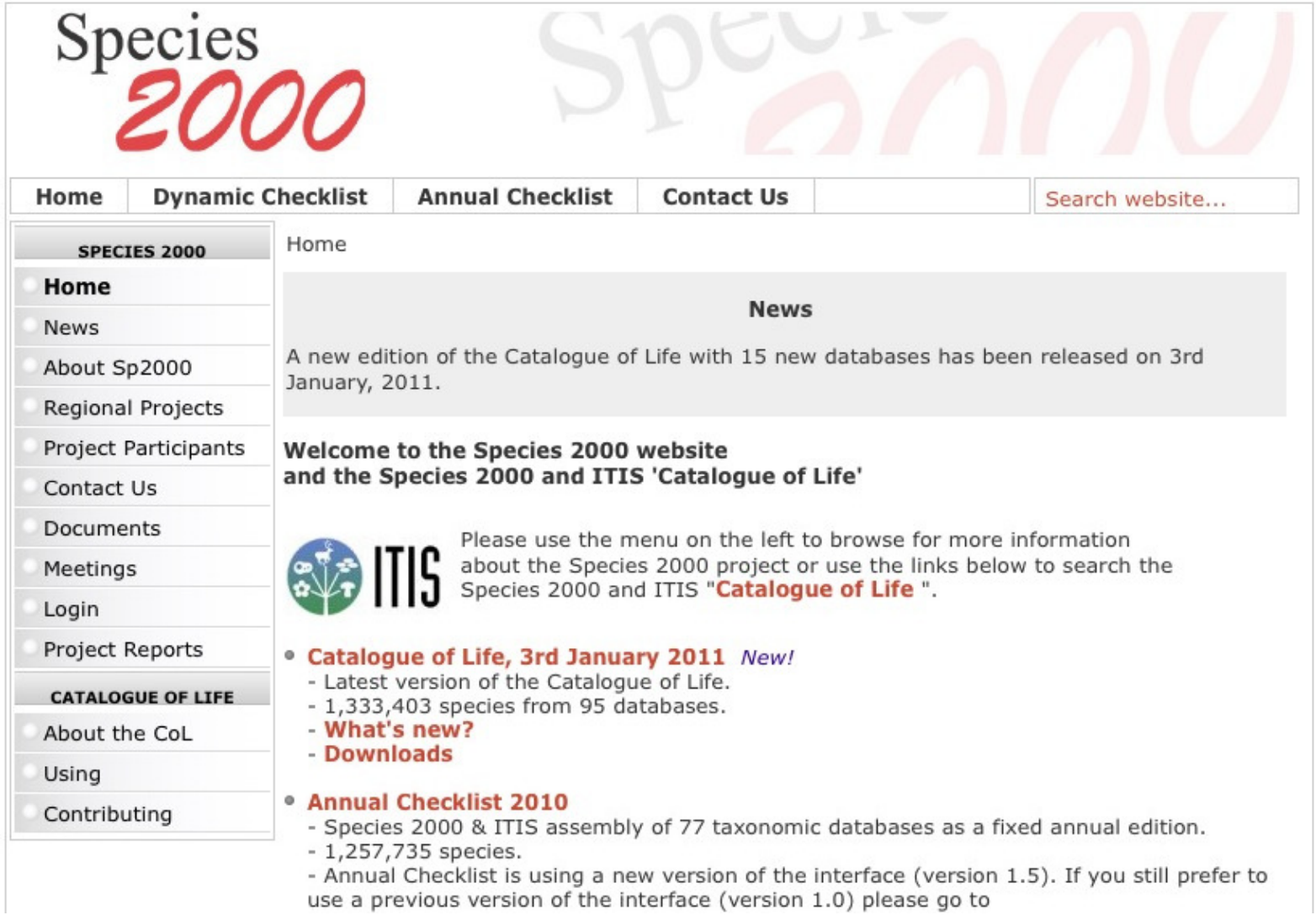
Part Modifier:

Relationship:

Derived Relationship:

Help | equals | Pick (units)

http://mczbase.mcz.harvard.edu/SpecimenSearch.cfm



http://www.sp2000.org/

ITIS

Integrated Taxonomic Information System

- What's New
- About ITIS
- Data Access
- Submit Data
- Tools
- Bee Checklist
- NBII Links
- Web Services
- Comments

Welcome to ITIS, the Integrated Taxonomic Information System! Here you will find authoritative taxonomic information on plants, animals, fungi, and microbes of North America and the world. We are a partnership of U.S., Canadian, and Mexican agencies (ITIS-North America); other organizations; and taxonomic specialists. ITIS is also a partner of Species 2000 and the Global Biodiversity Information Facility (GBIF). The ITIS and Species 2000 Catalogue of Life (CoL) partnership is proud to provide the taxonomic backbone to the Encyclopedia of Life (EOL).

Quick search on:

(•) Any Name or TSN* ( ) Common Name ( ) Scientific Name ( ) TSN*

In: every Kingdom containing viridissima Search

* Taxonomic Serial Number (TSN)

Go to Advanced Search and Report

New & Edited Scientific Names this month: **7,081**

Monthly Export	Scientific Names (any rank, any usage)	Common Names
25-Mar-2011	**527,310**	**111,305**
28-Feb-2011	**521,148**	**111,289**

Last Updated:Monday, 22-Nov-2010 11:15:28 MST

Privacy statement and disclaimers

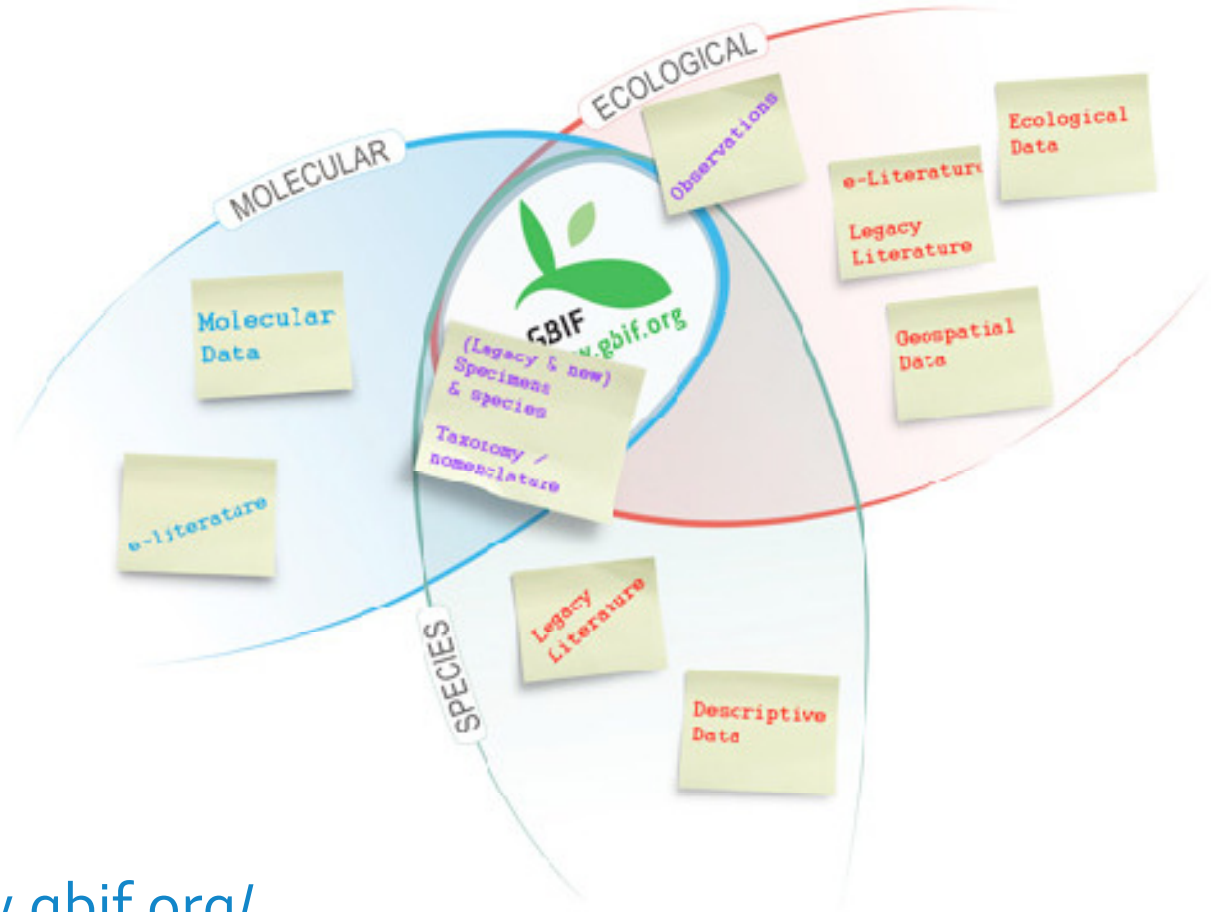
http://www.itis.gov/index.html

http://www.itis.gov/

Home § Iris Email Project

free and open access to biodiversity data

GLOBAL BIODIVERSITY INFORMATION FACILITY



http://www.gbif.org/

Examples of specimen data entry protocols: **Digital Bee Collection Network** (AMNH, UC Riverside, UC Davis, UC Berkeley, CSCA, Cornell, UConn, Rutgers, Vermont, USDA Bee Systematics Lab)

TAXONOMIST:

1. Identification
   - Check all prior identifications
   - Identify as much as possible from among undetermined specimens prior to data entry
   - If necessary, change header labels where epithet has been changed
2. Gender Determination
   - Orient males upside-down so they are obvious
   - Pass to data entry technician
3. Proof all entered data (later stage)
   - Correct errors, fill in blanks for difficult localities

Examples of specimen data entry protocols: **Digital Bee Collection Network** (AMNH, UC Riverside, UC Davis, UC Berkeley, CSCA, Cornell, UConn, Rutgers, Vermont, USDA Bee Systematics Lab)

DATA ENTRY TECHNICIAN:

4. Sorting
   - + Organizes specimens first by locality, then by date (if multiple dates from same locality), then by host (if multiple hosts for same date/locality); this maximizes overlap of data elements between successive records during data entry
   - + Secondary organization by gender where possible, to maximize number of successive records all of the same gender (e.g., if 10 males and 10 females, each from a unique locality, then group males and females)

5. Labeling and Transcription
   - + Pre-printed serialized unique labels with codens applied sequentially
   - + Essential data elements transcribed on paper worksheets

6. Data Entry

Examples of specimen data entry protocols: **Digital Bee Collection Network** (AMNH, UC Riverside, UC Davis, UC Berkeley, CSCA, Cornell, UConn, Rutgers, Vermont, USDA Bee Systematics Lab)

EXAMPLE

Unit tray labeled "*Bombus bifarius nearcticus*" from CSCA Specimen labeled "9 mi NW Fandango Pass, CA, 5/22/62, on *Artemisia tridentata*" Determiner label reads "*B. nearcticus*, det. R. Snelling 1962"

ID already confirmed (but this taxon name no longer valid)

Gender determined

Specimen numbers already in database, a few default fields (including source institution) auto-entered, record otherwise blank

First steps: needs species number, locality number

Secondary: various manual-entry data fields, including gender, host plant

Examples of specimen data entry protocols:
The MCZ Rhopalocera (Lepidoptera) Rapid Data Capture Project
(Museum of Comparative Zoology, Harvard University)*

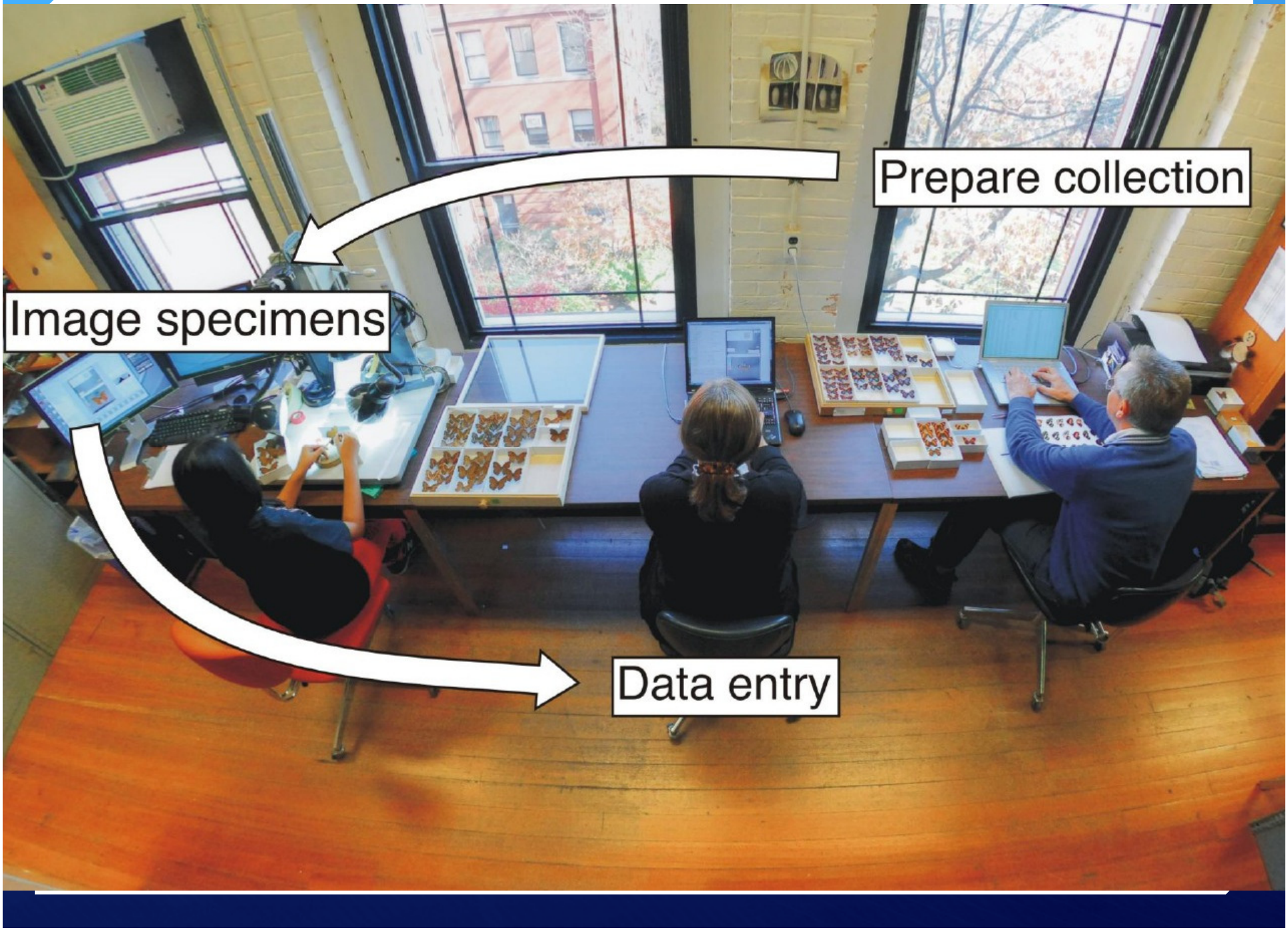
MCZ holdings:

Natural history specimens	21 million
Entomological specimens	7.5 million
Lepidoptera specimens	600,000
Pinned butterflies	200,000

Separate data entry from specimen handling in a three step process

1. Prepare the collection
2. Photograph specimens and data labels
3. Transcribe data from high resolution images

*Based on the ECN 2010 presentation by Morris, P. J., Eastwood, R., Ford, L., Haley, B., Pierce, N.


Prepare collection
Image specimens
Data entry

Examples of specimen data entry protocols:
The MCZ Rhopalocera (Lepidoptera) Rapid Data Capture Project
(Museum of Comparative Zoology, Harvard University)

Protocol:

1. Identify specimens and record in data sheet
2. Ensure only a single species in each unit tray
3. Expand spacing so that staff can remove and replace specimens without damage

Examples of specimen data entry protocols:
The MCZ Rhopalocera (Lepidoptera) Rapid Data Capture Project
(Museum of Comparative Zoology, Harvard University)

4. Taxonomic information & drawer numbers entered into spreadsheet from which 2D barcode labels will be generated
5. Barcoded taxonomic data labels generated from data spreadsheet (encoded in QRCode 2D Barcode)

Family	SubFamily	Tribe	Genus	Species	Subspecies	Infra Rank	Infraspecific	Authorship	UnNamed F...	Drawer	Collection	Sort	To Print	Printed
Riodinidae	Riodininae		Calydna	caieta				Hewitson, 1854		108.06		0	0	1
Riodinidae	Riodininae		Calydna	calamisa						108.05		0	0	2
Riodinidae	Riodininae		Calydna	calamisa						108.06		0	0	1
Riodinidae	Riodininae		Calydna	carneia						108.06		0	0	1
Riodinidae	Riodininae		Calydna	carneia						108.06		0	0	1
Riodinidae	Riodininae		Calydna	charila						109.10		0	0	1
Riodinidae	Riodininae		Calydna	hiria						108.06		0	0	1
Riodinidae	Riodininae		Calydna	sturnula						108.06		0	0	2
Riodinidae	Riodininae		Calydna	thersander						108.05		0	0	4
Riodinidae	Riodininae		Calydna	venusta	venusta			Godman & Salvin, [1886]		108.05		0	0	2
Riodinidae	Riodininae		Dianesia	carteri	carteri			(Holland, 1902)		108.09		0	0	1

Nymphalidae: Nymphalinae:
Epiphilini
Epiphile iblis plusios
Godman & Salvin, [1883]
56.22

Examples of specimen data entry protocols:

The MCZ Rhopalocera (Lepidoptera) Rapid Data Capture Project

(Museum of Comparative Zoology, Harvard University)

Drawer prepared for imaging -with Taxon ID barcode labels positioned above unit trays

Individual specimen prepared for imaging and assigned a unique Specimen ID barcode

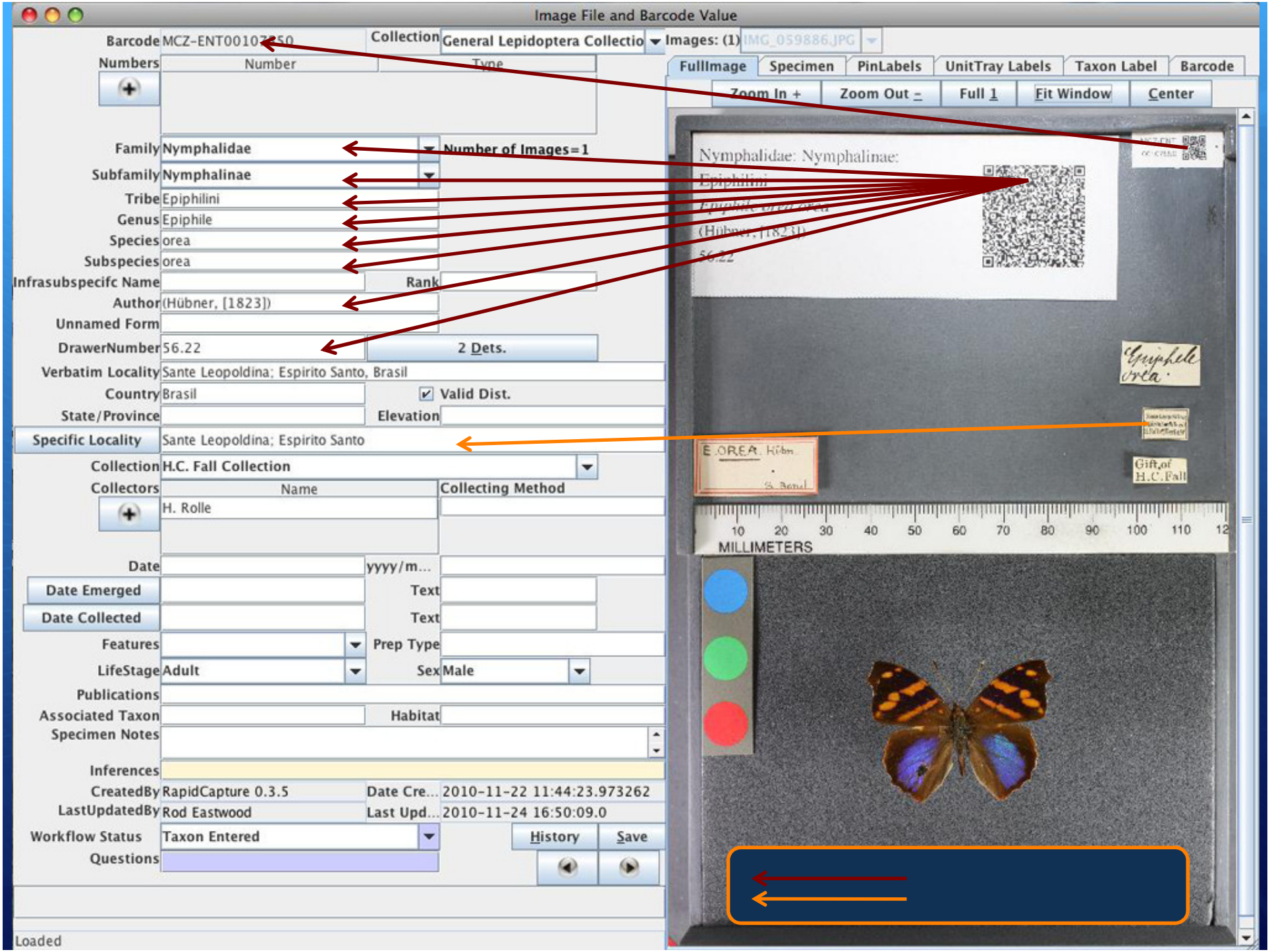


Image File and Barcode Value
Barcode MCZ-ENT00107350
Collection General Lepidoptera Collectio
Images: (1) IMG_059886.JPG
Numbers
Number
Type
FullImage
Specimen
PinLabels
UnitTray Labels
Taxon Label
Barcode
Zoom In +
Zoom Out -
Full 1
Fit Window
Center
Family Nymphalidae
Number of Images=1
Subfamily Nymphalinae
Tribe Epiphilini
Genus Epiphile
Species orea
Subspecies orea
Infrasubspecifc Name
Rank
Author (Hübner, [1823])
Unnamed Form
DrawerNumber 56.22
2 Dets.
Verbatim Locality Sante Leopoldina; Espirito Santo, Brasil
Country Brasil
Valid Dist.
State/Province
Elevation
Specific Locality Sante Leopoldina; Espirito Santo
Collection H.C. Fall Collection
Collectors
Name
Collecting Method
H. Rolle
Date
yyyy/m...
Date Emerged
Text
Date Collected
Text
Features
Prep Type
LifeStage Adult
Sex Male
Publications
Associated Taxon
Habitat
Specimen Notes
Inferences
CreatedBy RapidCapture 0.3.5
Date Cre... 2010-11-22 11:44:23.973262
LastUpdatedBy Rod Eastwood
Last Upd... 2010-11-24 16:50:09.0
Workflow Status Taxon Entered
History
Save
Questions
Loaded
Nymphalidae: Nymphalinae:
(Hübner, [1823])
56.22
E. OREA. Hübn.
S. Brasil
Gift of H.C. Fall
MILLIMETERS

Examples of specimen data entry protocols:
The MCZ Rhopalocera (Lepidoptera) Rapid Data Capture Project
(Museum of Comparative Zoology, Harvard University)

1. Collection preparation (identification, sorting, label printing)

+ Average of 60 seconds per specimen (timing is highly variable depending on the state of curation)
+ Done by entomologist

2. Specimen/data imaging

+ Average of 60 seconds per specimen
+ Performed by unskilled personnel

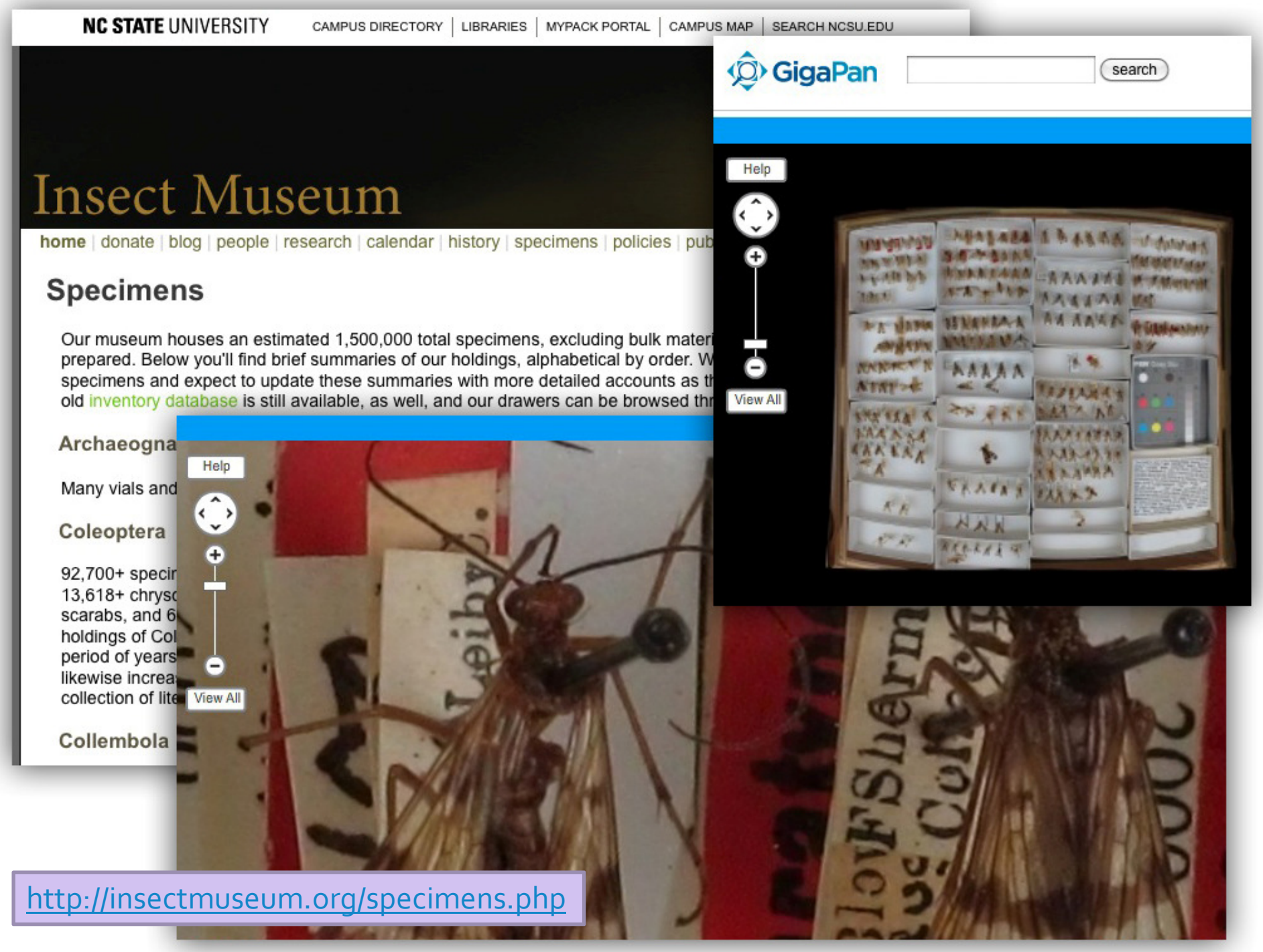
3. Data entry

+ Is slower but can be done simultaneously by multiple personnel
+ Specimens are not handled
+ Basic data entry done by unskilled personnel
+ Quality control by specialist/entomologist

Dealing with specimen backlog

The example of NC State Insect Museum

- Specimens are not identified/curated *a priori*
- All specimens are photographed and the images are made publicly available
- Specialists will (hopefully) identify the specimens and data will be entered into a specimen-level database



http://insectmuseum.org/specimens.php

Exercises

1. Confirm the identification of specimens provided using available online resources
2. Place the identified specimens into most recent taxonomic hierarchy (Class: Order: Family: Subfamily: Genus)
3. Confirm the validity of the species names and their authorship
4. Place provided barcodes on the specimens and enter them into a simple spreadsheet