



iBOL 2017 Pre-conference Workshop

DNA Barcoding Natural History Collections

 Centre for
Biodiversity
Genomics

Introduction

Reference Library Building

Ideal: maintain permanent link to authoritatively-identified voucher specimens

Two approaches:

- 1 Barcode freshly-collected material, worry about identifications later
- 2 Barcode specimens held in national and regional natural history collections

international
BARCODE
OF LIFE



Canada



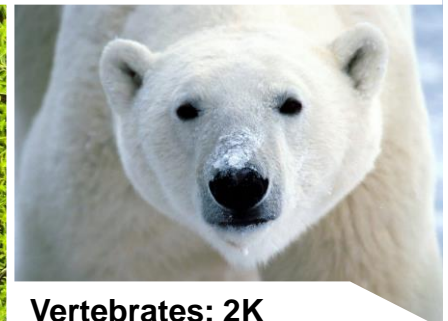
Vascular Plants: 6K



Invertebrates: 70K



Other Plants: 3K



Vertebrates: 2K

Introduction

Reference Library Building

Fresh collections offer ease and numbers

- various ways to identify after barcoding



Introduction

Reference Library Building

- Museum harvesting offers well-prepared, curated, and identified specimens



Introduction

Reference Library Building

Advantages:

Fresh Specimens	Museum Harvesting
Little to nil DNA degradation	Expert identifications
Can choose DNA friendly preservation	Type material
Large abundances/series	Rare and rarely-collected specimens
Control ownership of specimens, data, images, etc.	Can easily target your group
Low assembly and analytical costs	Specimens from across species range, including restrictive countries
Build library for encountered spp.	Value-added specimens

Introduction

Reference Library Building

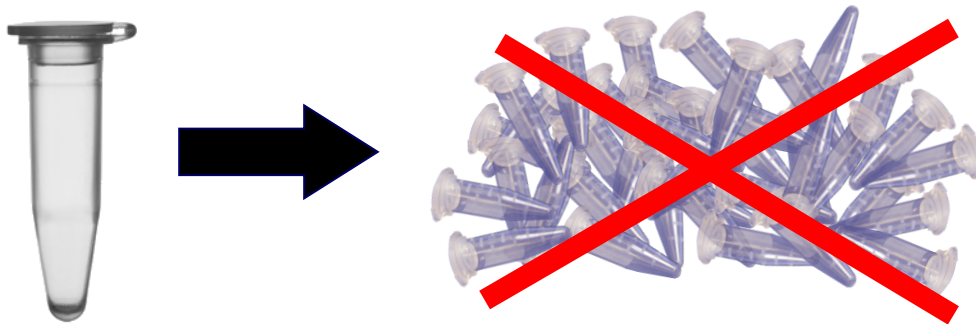
Disadvantages:

Fresh Specimens	Museum Harvesting
Not identified – sorting to higher taxonomy usually possible, but difficult beyond	DNA degradation due to age/preservation/other
Large quantities to sort through	May be restrictions on access and sharing data/images/DNA
Hollow-curve species abundance pattern	High assembly and analytical costs
Taxonomic impediment for some taxa	Travel and specimen transport costs

Introduction

Throughput and Scale

Single sample approach



NOT SCALABLE!

**Core labs operate in
96-well plate format**

- Requires compatible front-end solutions



Introduction

Throughput and Scale

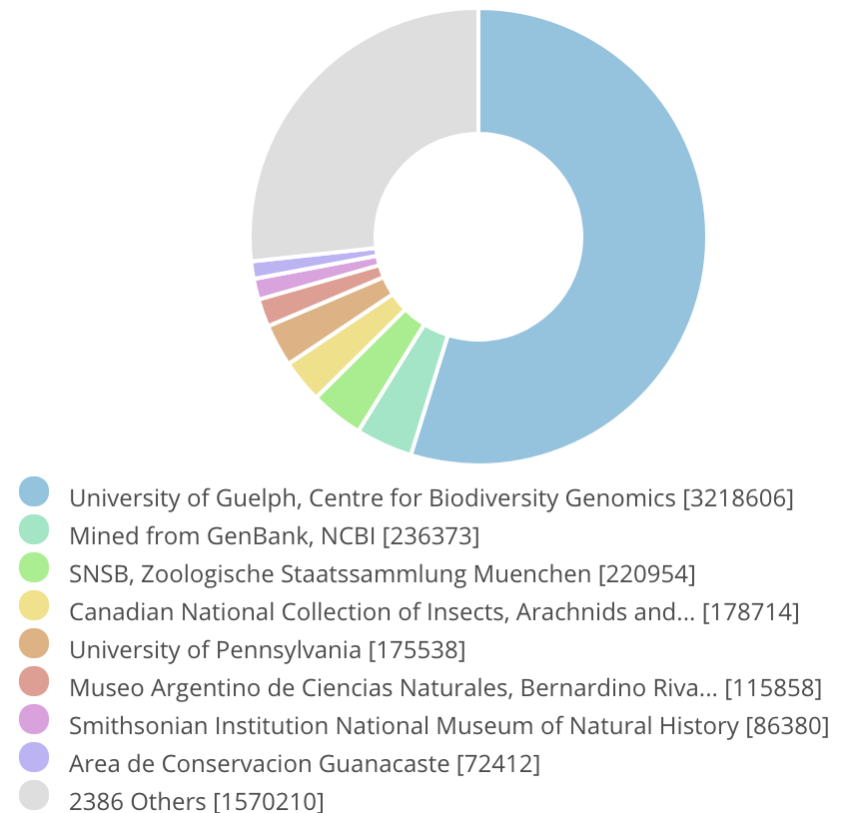
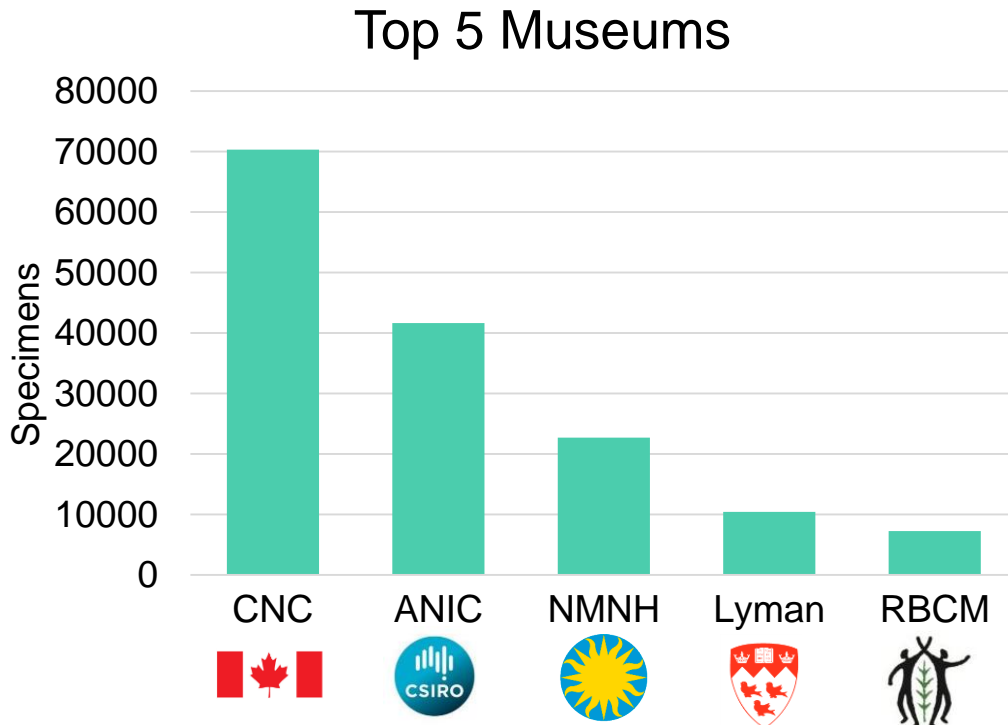


Introduction

CBG's Work with Museums

- Museum harvesting by our team:
 - > 172,000 specimens

Major BOLD contributors



Introduction

CBG's Work with Museums

Day 2 - 22nd November 2017 - 13:30, Room 5:Mhelembe, Parallel 3 - Methodological Advances: Collections

Eco Friendly Error-free Workflows for High-throughput DNA Barcoding

Natalia V. Ivanova

Opening up collections of barcoded samples through GGBN

Jonas J Astrin

DNA Barcodes from old museum specimens for completion of DNA libraries and for realizing difficult XXL-revisions (Lepidoptera, Geometridae)

Axel Hausmann

Museum harvesting in major natural history collections

Valerie Levesque-Beaudin

Retrieval of Genetic Information from Herbarium Specimens

Chun-Xia Zeng

Barcoding African Freshwater Sponges holotypes & the Sponge Barcoding Database v2.0

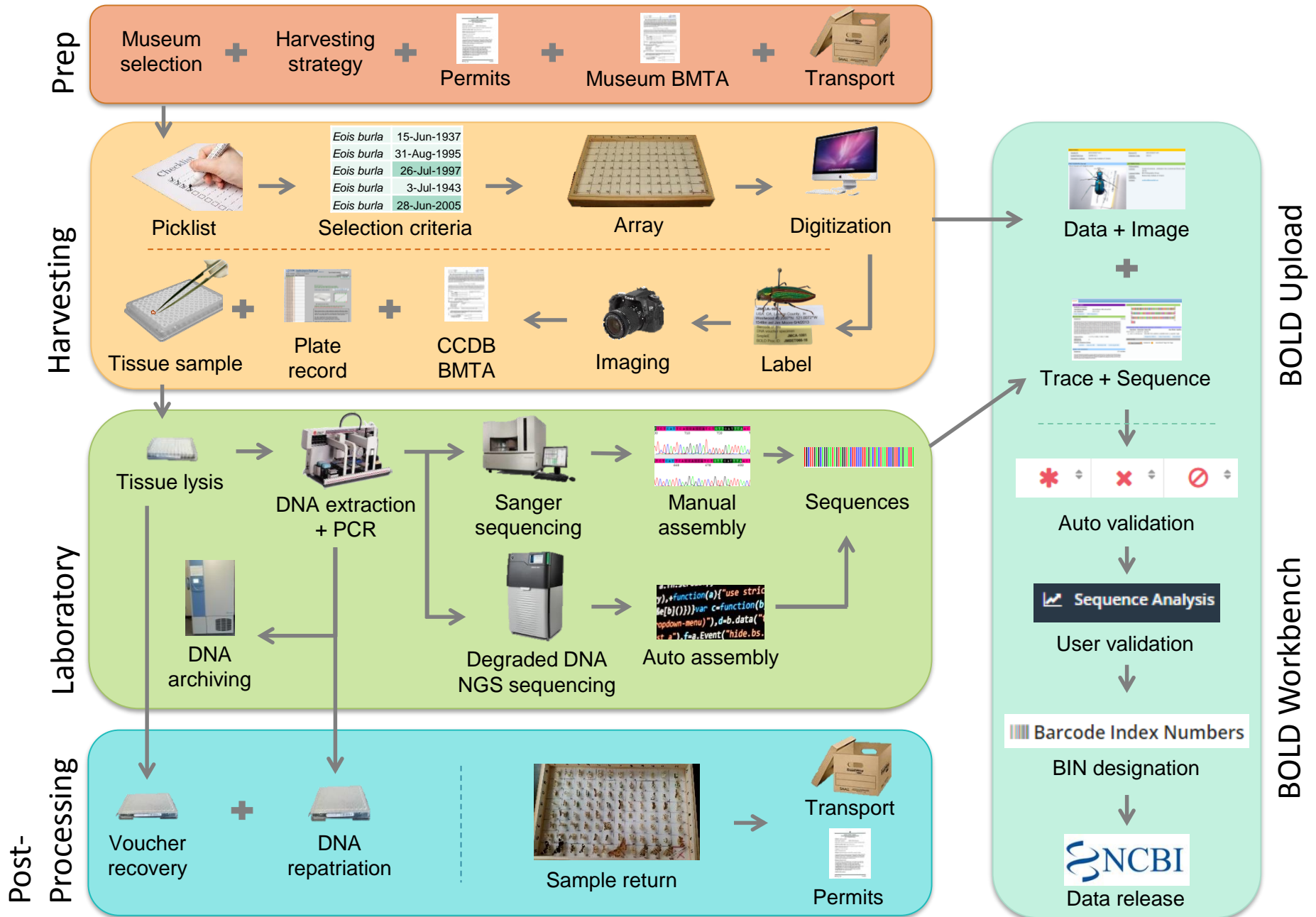
Dirk Erpenbeck

Introduction

CBG's Services for Reference Library Building

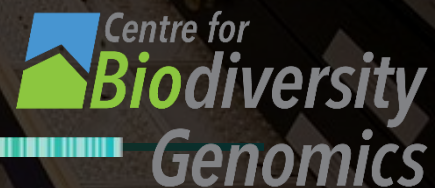


www.biodiversitygenomics.net

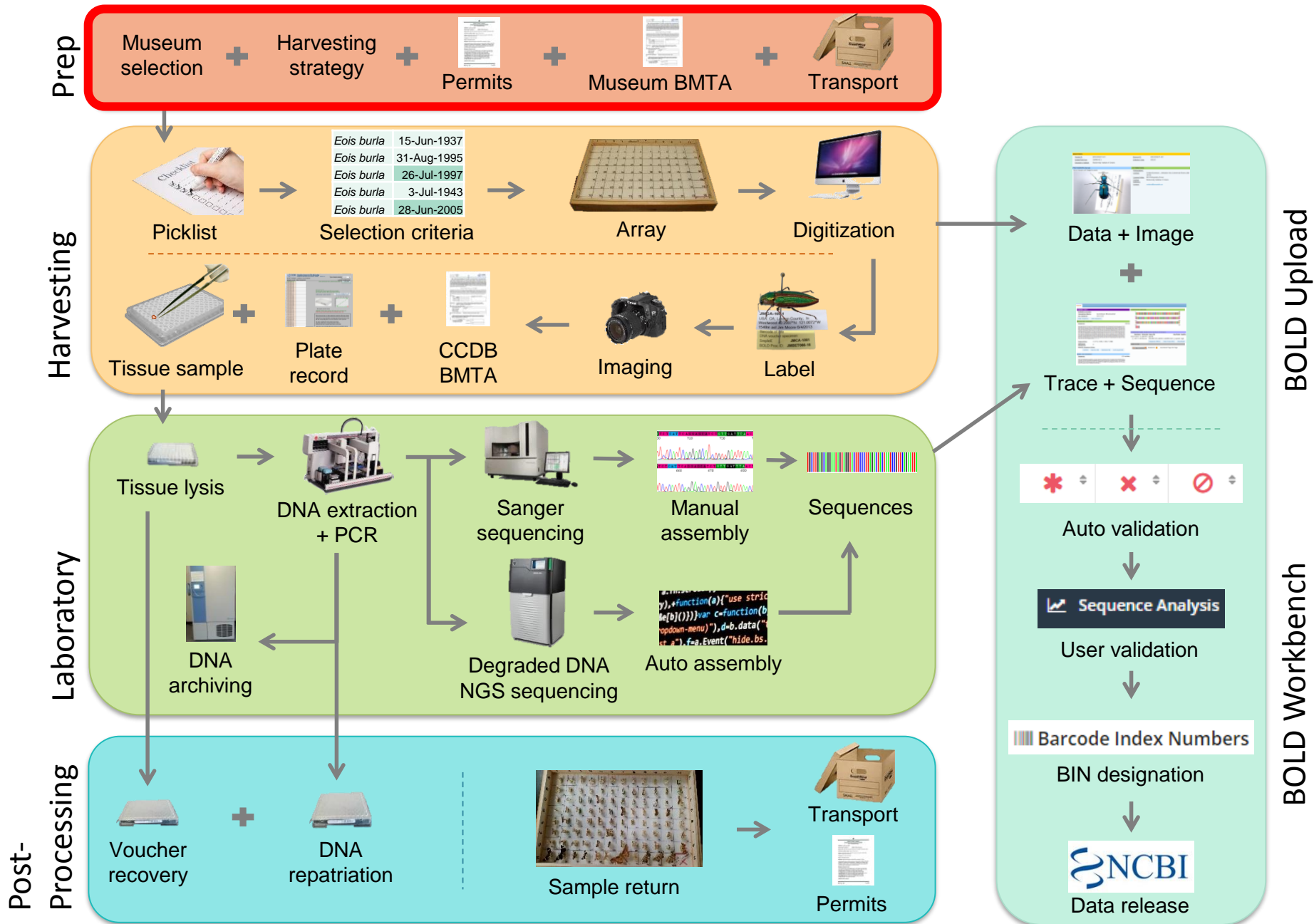




9:15 - 9:45 – Jeremy deWaard
Natural History Collection Harvesting
Strategies & Logistics



DNA Barcoding Natural History Collections



Harvesting Strategies & Logistics

Considerations for Museum Selection

Considerations for Harvesting Strategy

Sampling On Site vs. Off Site

Import/Export Permits

BMTA/Museum Agreements

Transportation

Considerations for Museum Selection

Depends on several factors:

- 1 Strength of collection in target taxon or region
- 2 One or more steps completed (i.e. databased, imaged, sub-sampled)
- 3 Collection database online or available
- 4 Actively researched, recently curated or visited by taxonomic expert(s)
- 5 Permanence of collection
- 6 Access to DNA or frozen tissue archive

Sao Paulo fire destroys one of the largest collections of dead snakes

Brazil police investigate cause of blaze which wiped out 85,000 dead snakes used to develop vaccines

Tom Phillips in Rio de Janeiro
guardian.co.uk, Sunday 16 May 2010 17:55 BST

[A](#) [larger](#) | [smaller](#)



Considerations for Museum Selection

Depends on several factors:

- 7 Infrastructure and space for various steps
- 8 Policies on destructive sampling
- 9 Policies on biological material transfer
- 10 Restrictions placed on image and data accessibility



Contact the directors/curators/collection managers

- Generally glad to highlight the advantages of their collection
 - Often have to defend the value of their collection for continued funding/support/existence

Considerations for Harvesting Strategy

- Broad or specific taxonomic coverage
- Targeting species missing from a checklist
- Targeting species without DNA barcode representation
- Databased or not databased collections
- Preservation methods
- Permit and shipping restrictions



Sampling On Site vs. Off Site

- Choose the approach for your situation/needs

On Site



Off Site



Sampling On Site vs. Off Site

On Site

- May be necessary for sampling restricted specimens
- Time-consuming stages limits what can be processed
- Reduces risk of damage to specimens
- Direct curator knowledge about collection



Sampling On Site vs. Off Site

Off Site (Borrowing Specimens)

- Lab space and equipment needs met
- Time commitment can be lengthened
- Increases risk of damage to specimens
- Loan documents and permits needed



Import/Export Permits

Requirements

- Depends on taxon (invertebrates/plants/vertebrates)
- CITES permits for threatened species
- Government regulations
- Border inspections and declarations

Available Trade Permits
GPS Box 787
Canberra ACT 2601, Australia

AUSTRALIAN NATIVE EXPORTS (NON-CITES)

Environment Protection and Biodiversity Conservation Act 1999

Importer: (name, address, country) Exporter: (name, address, country)

Specimen Export Record No. **N 52624**

No. _____
Valid to: _____
Page: 1 / 1

This is an original, uniquely numbered Permit. The following conditions apply:

1. Not valid unless a copy of the original multiple consignment authority is attached.
2. Must meet conditions of attached multiple consignment authority.
3. Species not listed on multiple consignment authority are not to be exported.
4. Exporter name and address must match attached multiple consignment authority.
5. The export of specimens is not a valid export unless the permit holder has signed and dated this document.

Scientific name	Common name	Product Description	Source	State of Origin	Quantity	Unit

This permit has been issued under s303DG of the Environment Protection and Biodiversity Conservation Act 1999

Permit Holder
Name: _____
Signature: *Paul Holt*
Date of issue: ____/____/____
Export Declaration Number: _____

Minister / Delegate of Minister
Signature: *[Signature]*
Date of Export: ____/____/____

001
Australian Government
Department of the Environment and Energy

80112/0016 Distribution: Original - To accompany shipment Pink - Complete and return to Issuing Authority within two weeks of export SEP/NOV-CITES - 11/10

Import/Export Permits

Requirements

- Make a plan with museum you are visiting
- Discuss with curators permit requirements
- Apply for permits promptly with governing body

Australian Government
Department of the Environment

Type of document:
☒ Export
☐ Re-export
☐ Import
☐ Other

NON-CITES

Original - Valid for Multiple Consignments
1. Multiple Consignment Authority No.: FVPS2015-AJ-000015
2. Valid until: 8/12/2018
Page 1 of 1

3. Importer (Name, Address, and Country)
Dr Paul Hackett
BIODIVERSITY INSTITUTE OF ONTARIO, UNIVERSITY OF GUELPH
80 STONE ROAD EAST
GUELPH N1G2W1
CANADA

4. Exporter (Name, Address, and Country)
Dr Bob Ward TIA CSIRO
GPO BOX 1538
HOBART TAS 7501
AUSTRALIA

5. Conditions
- This permit is not transferable
- If for live animals, this permit or certificate is valid only if the transport conditions comply with the IATA Live Animals Regulations; if for live plants, with the IATA Perishable Cargo Regulations
- For special conditions specific to this permit also refer below.

6. Name, Address and Country of Issuing Authority
Wildlife Trade and
Biossecurity Branch
GPO BOX 787
CANBERRA ACT 2601

5a. Purpose: Not Required

7/8. Scientific & Common Name (Genus and Species of Animal or Plant)	9. Description	10. Source	11. Quantity and Unit
1. Invertebrate plants	dead animals, other dry mounted or fluid preserved	(W)	
2. Arthropod spiders	dead animals, fluid preserved	(W)	

Special Conditions
Under Part 13A of the EPBC Act all Commonwealth and State/Territory requirements in relation to this specimen(s) must be met.
The researcher must publish, or make available for inspection, the results of the research.
If requested by the Issuing Authority, the researcher must provide written information about the progress and results of the research.
During and after the research, the importer must not allow the specimen(s), or progeny or products of the specimen to be used for primarily commercial purposes.
On completion of the research, any specimen that has been designated as the holotype specimen, or where the holotype specimen is not designated the syntype, lectotype or neotype specimen, must be returned to Australia and lodged in a museum or similar organisation.
This permit does not authorise the export of (i) specimens of taxa included in an appendix to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); or, (ii) unless specifically listed, specimens of eligible listed threatened species, as defined in section 303BC of the Environment Protection and Biodiversity Conservation Act 1999.
A specimen export record (SER) must be completed for each consignment exported under this permit, including all specimens and quantities to be exported. Copies must be distributed in accordance with the instructions at the bottom of the front page of the SER form. All damaged/in error/cancelled not exported SER forms must be marked unused and returned to the Issuing Authority within two weeks.

For Exports, a photocopy of the Multiple Consignment Authority should accompany the original Specimen Export Record which details the specific items in each consignment

13. Authority for Permit/Certificate
Issued By: Ms Megan Smith
Issue Date: 08/01/2015
Issued under s303DG of the Environment Protection and Biodiversity Conservation Act 1999

Australian Government
Department of the Environment

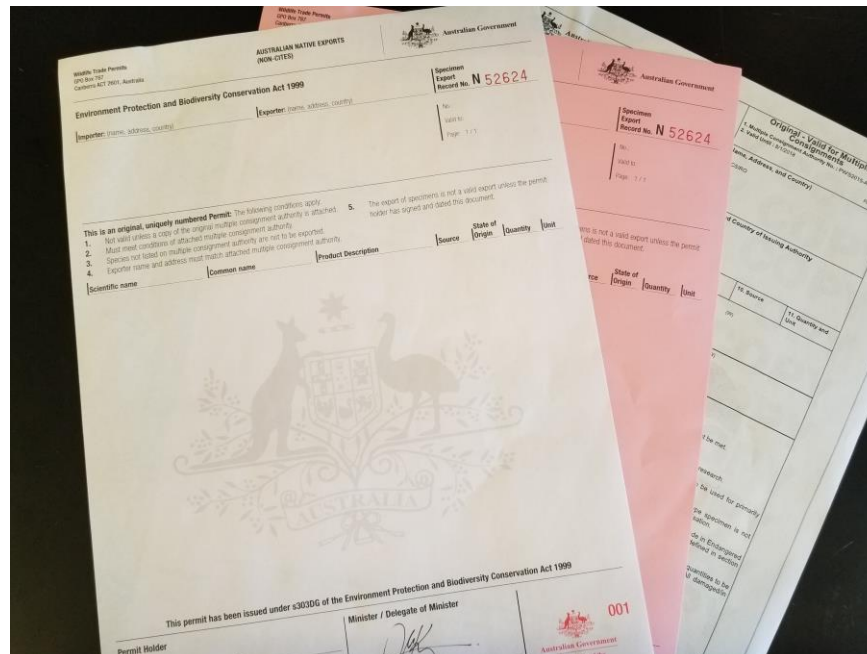
M. Smith
Signature

Official seal

Import/Export Permits

Approved permits can be used for:

- Crossing country borders with specimens
- Sending specimens from museum to your institution
- Returning specimens from your institution to museum



BMTA/Museum Agreements

Museum Agreements

Agreement between museum and collaborator


- Determine use and ownership of specimens, DNA, sharing of information
- Destructive or non-destructive sampling
- If borrowing specimens – time table for completion of work

**Natural History
OUTGOING LOAN AGREEMENT**

RBCM Loan Number: LQ2017.40 (ENT08-2017)

RBCM Contact: Claudia Copley

Borrower Contact Name & Address:
Jeremy deWaard, PhD
Director, Bio-Inventory & Collections, Biodiversity Institute of Ontario
University of Guelph
Guelph, ON, Canada N1G 2W1
dewaardj@uoguelph.ca
Start date: 18 Sept 2017
Due date: 18 Sept 2018
Loan description: 69 spiders, mecoptera, bees, beetles




Specimen list attached: Yes ☒ No ☐

ENT000-000311	Boreus	ENT016-016198	Caurinus
ENT017-006740	Porrhomma	ENT017-004435	Agyneta
ENT017-006741	Linyphiidae	ENT017-004457	"Dictyna"
ENT017-006742	Tibbioplus	ENT017-004486	Agyneta
ENT017-006743	Scotinotylus	ENT017-004449	Pityohyphantes
ENT017-005089	Caurinus	ENT017-003250	Dictyna/Embylna
ENT017-005090	Caurinus	ENT012-013226	Linyphiidae
UAM100177080	Caurinus	ENT017-001660	Agyneta
ENT016-016200	Caurinus	ENT017-001758	Pityohyphantes
ENT016-016096	Caurinus	ENT016-019766	Erigonoploides
ENT016-016149	Caurinus	ENT016-019725	Lepthyphantes
ENT016-016171	Caurinus	ENT015-011201	Micargus herbigradus

25 Bombyx, 4 Cicindela, 20 spiders - uncatalogued

This material is loaned in accordance with the RBCM Collections Policy. Destructive sampling paperwork is on file.

Authorized by: 
Kelly Sendall, Head of Collections Care & Conservation

Please indicate the condition of the received specimen(s) and sign the pink copy and return it to Office of the Senior Registrar, Royal British Columbia Museum, 675 Belleville Street, Victoria, BC, V8W 9W2. Please keep the white copy for your records.

Specimens have been received in good order: Yes ☐ No ☐

Borrower's Signature: _____ Date: _____

White: Borrower; Pink: Borrower sign and return; Blue: Senior Registrar; Green: Collections Manager

ARCS NH703 ORCS 23260-25

Royal BC Museum 675 Belleville Street Victoria, BC V8W 9W2 royalmuseum.bc.ca

BMTA/Museum Agreements

3rd Party Transfer

Agreement between collaborator and molecular lab

- Determine use and ownership of specimens, DNA, sharing of information
- Ensure third party use does not violate original agreement with donor institution

As with all steps, it's important to discuss thoroughly with directors/curators/collection managers

Transportation

Shipping – Customs Declaration



Centre for Biodiversity Genomics, University of Guelph

50 Stone Rd. East, Guelph, Ontario, Canada N1G 2W1

Tel. +1 519 824-4120 ext. 53600; Fax +1 519 824-5703

Shipping documentation / Customs declaration

"scientific research specimens; no commercial value"

This package contains dead insect museum specimens for scientific research, preserved in 95% Ethanol (UN1170, PG II) (for Latin species names refer to included loan agreement). Preserved specimens packed are not subject to the initial selection list of products for veterinary checks at border inspection posts under Art. 3 Council Directive 2007/275/EC, Annex I, EX 9705 00 00. Preservation of specimens agrees with requirements for Safe Treatment laid down in Point (8) (a) (e) (ii) in the ANNEX to the Commission Regulation (EU) No 294/2013, amending Commission Regulation (EU) No 142/2011, ANNEX XIII, CHAPTER VI.

Transfer of scientific specimens

From:

Centre for Biodiversity Genomics, Collections unit (BIOUG)
50 Stone Rd. East, Guelph, Ontario, N1G 2W1
Canada

To:

Stefan Schmidt
Zoologische Staatssammlung München
Münchenstr. 21
D-81247 München
Germany
+49 (0)89-8107 159

Important

Postal inspectors: This package contains dead, preserved insects for scientific research without any commercial value. If this shipment is inspected, it is **ABSOLUTELY IMPERATIVE** that enclosed samples/vials are returned into their boxes and repacked shock-proof. **DO NOT REMOVE** samples/specimens from the vials or boxes! The material may easily become useless for scientific research. It is **ABSOLUTELY IMPERATIVE** that all specimens remain intact and that they remain in their vials and boxes. We thank you very much for taking care of this important scientific resource.

staatliche
naturwissenschaftliche
sammlungen bayerns



Freistaat Bayern, staatliche naturwissenschaftliche sammlungen bayerns

The Bavarian State Collection of Zoology, Münchhausenstr. 21, 81247 Munich (Germany)

arr: Stefan Schmidt, Bf: museumservice, email: Stefan.Schmidt@zsm.mn.zoo, Tel. ++49 / 89 / 8107-159, Fax: ++49 / 89 / 8107-200

Shipping documentation / Customs declaration

"scientific research specimens, not restricted, special provision A180 applies"

For your Attention: Include this legal document ACCESSIBLE on the OUTSIDE of your SHIPMENT when returning this loan!

This package contains dead insects for scientific research, preserved in 95% Ethanol (UN1170, PG II); these specimens are not infectious due to the preservation technique. Preservation agrees with requirements for SAFE TREATMENT laid down in Point (8) (a) (e) (ii) in the ANNEX to the Commission Regulation (EU) No 294/2014, amending Commission Regulation (EU) No 142/2011, ANNEX XIII, CHAPTER VI. The package contains no endangered or venomous species. The specimens packed are returned from loan for biodiversity (morphological / taxonomic) research and legally belong to the State of Bavaria (Country of Origin: Germany); no commercial value, not for resale.

HS-Code: 9705.00 (Collections of zoological/botanical/mineralogical/archaeological/paleontological interest)

Declared value: 5.00 €

Stefan Schmidt
i.A. S. Schmidt

Important

Postal inspectors: This package contains dead, preserved insects for scientific research without any commercial value. If this shipment is inspected, it is **ABSOLUTELY IMPERATIVE** that enclosed samples/vials are returned into their boxes and repacked shock-proof. **DO NOT REMOVE** samples/specimens from the vials or boxes! The material may easily become useless for scientific research. It is **ABSOLUTELY IMPERATIVE** that all specimens remain intact and that they remain in their vials and boxes. We thank you very much for taking care of this important scientific resource.

Wichtig

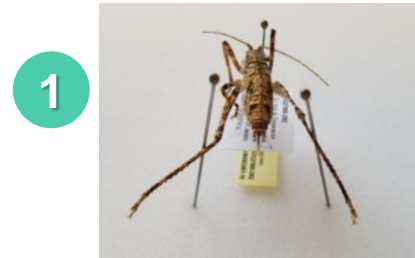
Sendungskontrolle: Dieses Paket enthält tote, konservierte Insekten für wissenschaftliche Zwecke ohne irgendeinen kommerziellen Wert. Sollte diese Sendung aus irgendeinem Grund geöffnet werden müssen, ist es **ZWINGEND ENFORDERLICH**, dass die Proben bzw. Probenbehälter wieder in die entsprechenden Behälter verpackt und schockfest verpackt werden. **Probenbehälter nicht öffnen und Proben bzw. Tiere NICHT BEFRIEDELN!** Das Material wird für wissenschaftliche Untersuchungen dadurch ggf. unbrauchbar. Es ist **ZWINGEND ENFORDERLICH**, dass die Proben in den Probenbehältern und/oder der Box verbleiben. Eventuelle Komplikationen könnten durch das Hinunterfallen eines Beutels aus der Zoologischen Staatssammlung München (Tel. +49 (0)89-8107-0) zur Öffnung der Sendung vermieden werden. Haben Sie vielen Dank für Ihre Bemühungen und Sorgfalt mit diesem wichtigen wissenschaftlichen Material.

Fachbehörde für das Washingtoner Artenschutzübereinkommen und Bundesnaturschutzgesetz Sachgebiet: „alle Tiere“ (Bundesanzeiger, 22.VI.2009, Nr. 105, 2458 ff.)
Technical authority for the Convention on International Trade in Endangered Species of Wild Fauna and Flora, Institutional CITES – No. DE 202-03
Registered scientific research organisation (overseas) for exchange of NATIVE Australian species: Reg. No.: DE118A (Australian Government, Department of the Environment, Water, Heritage and the Arts)
Zollnummer DE44 20 667
Zulassung der Zollabfertigung nach vereinfachter Zollanmeldung, Warengruppe 2 (zoologische und botanische Sammlungstücker, Ziffer 9705.00) gem. Zollanmeldungsnummer DE: 7600 / SI / 0011, IZZA München
Gestellungsort: Generaldirektion der Staatlichen Naturwissenschaftlichen Sammlungen Bayerns, Menzinger Str. 71, 80438 München

Transportation

Shipping Dry Invertebrate Specimens

- 1 Ensure pins are firmly in foam and cross pin any specimens/labels that may rotate
- 2 Add cardboard toppers to boxes
- 3 Pack specimen boxes securely inside another box
- 4 Include documentation for customs declaration
 - Mark as “Scientific research specimens, no commercial value”



Transportation

Shipping Invertebrate Specimens in Fluid

- Each vial/jar cannot exceed 30mL
 - Max 1L of fluid per box
- When possible, wrap and heat seal all containers
- Pack specimen boxes securely inside another box with bubble wrap
- Include documentation for customs declaration
 - Mark as “Scientific research specimens, not restricted Special Provision A180 applies”



Plastic wrap the flat to limit movement of vials



Add the wrapped flat in a Ziploc bag with absorbent paper and heat seal it.

Transportation

Shipping Invertebrate Specimens in Fluid

□ **A180** Non-infectious specimens, such as specimens of mammals, birds, amphibians, reptiles, fish, insects and other invertebrates containing small quantities of UN 1170, UN 1198, UN 1987, or UN 1219 are not subject to these Regulations provided the following packing and marking requirements are met:

(a) specimens are:

1. wrapped in paper towel and/or cheesecloth moistened with alcohol or an alcohol solution and then placed in a plastic bag that is heat-sealed. Any free liquid in the bag must not exceed 30 mL; or

2. placed in vials or other rigid containers with no more than 30 mL of alcohol or an alcohol solution;

- (b) the prepared specimens are then placed in a plastic bag that is then heat-sealed;
- (c) the bagged specimens are then placed inside another plastic bag with absorbent material then heat sealed;
- (d) the finished bag is then placed in a strong outer packaging with suitable cushioning material;
- (e) the total quantity of flammable liquid per outer packaging must not exceed 1 L; and
- (f) the completed package is marked “scientific research specimens, not restricted Special Provision A180 applies”.

The words “not restricted” and the special provision number A180 must be included in the description of the substance on the Air Waybill as required by 8.2.6, when an Air Waybill is issued.

International Air Transport Association
Dangerous Goods Regulations, 52nd Edition

Transportation

Shipping Herbarium Specimens

Irreplaceable plant specimens from France destroyed in Australian quarantine blunder

By [Kerry Staight](#)

Updated 8 May 2017, 9:42am

A review of Australia's quarantine procedures has been undertaken after historic and valuable plant specimens from France were destroyed by biosecurity officers.

In March, a collection of rare flowering plants sent by the Museum of Natural History in Paris to Queensland's herbarium in Brisbane was incinerated.

Michelle Waycott, who chairs the Council of Heads of Australasian Herbaria, said the pressed plant specimens dated back to the mid-1800s.

"They were the first type specimens collected of a species," she said.



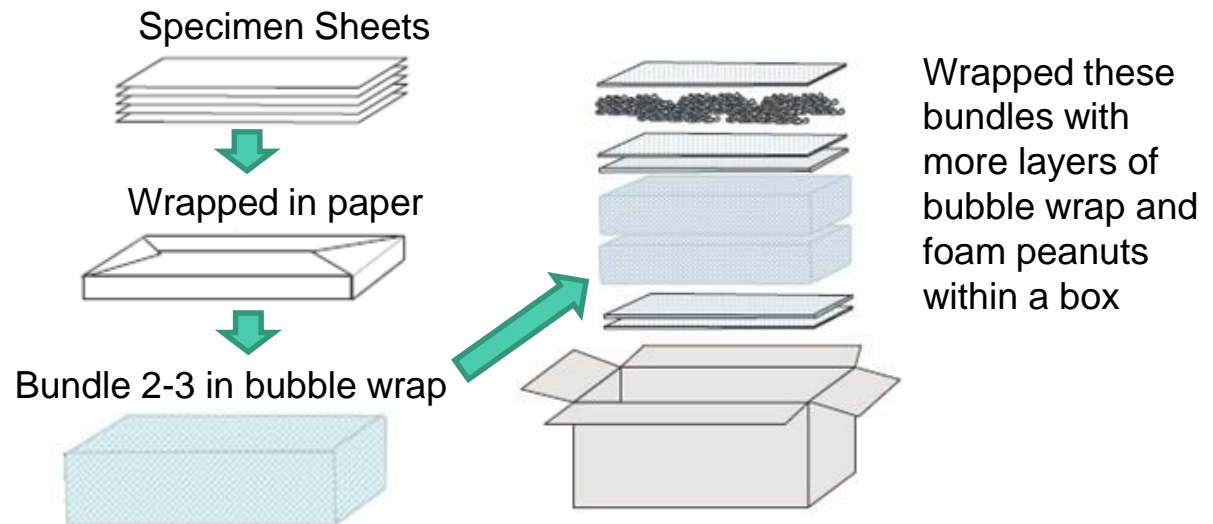
PHOTO: [Michelle Waycott says the plant destruction may have a major impact on research.](#) (ABC News: Kerry Staight)

MAP: [Australia](#)

Transportation

Shipping Herbarium Specimens

- Pack specimens securely
- Include documentation for customs declaration
- Mark as “Scientific research specimens, no commercial value”
- Include scientific names and preservation method



Transportation

Shipping Tissue Plates

- Ensure caps/lids are securely fastened
- Seal microplates in 'ziplock' bag
- Follow shipping requirements for Special Provision A180
- Mark as “Scientific research specimens, not restricted
Special Provision A180 applies”



Transportation

Transporting by Vehicle

- Pack specimen containers in large bins with bubble wrap to absorb shock
- Secure bins in vehicle so there is no movement
- No limitations on fluid specimens
- May require Transportation of Dangerous Goods training in your country
- May require cooler with ice or electric cooling container for tissues, DNA and PCR products
- Have loan and permit documentation readily available



Transportation

Return of Vouchers and Derivatives

- After completion of all analyses, return any borrowed vouchers and required derivatives
 - Voucher specimens and/or tissue
 - DNA extracts
- Some museums require copies of all digital metadata
 - Specimen data
 - Image files
 - Trace files/Sequences
- Keep museum informed of taxonomic revisions or associated publications