Outline

1. Loose ends - nomenclature, classification, web resources
2. Collections, specimens, curation (readings)
3. Collections, specimens, curation
4. Ethics

Classification

Noun: an arrangement of names
Verb: “to classify” - to create or change an arrangement of names

- e.g. to put a new species into a genus
- e.g. to describe a new species (putting a series of populations into a species)
- e.g. to move 3 genera into a new subfamily
- e.g. to change a phylum into a family

Use of the word ‘classification’ as a noun:
The classification that we are using follows that of binomial and Linnaeus (1758). Not included in our treatment are taxa that are not accepted by the World catalogue of Invertebrates and their subtaxa. See a full list at: http://uio.mbl.edu/NomenclatorZoologicus/

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Nomenclature

Synonyms & taxonomy

- e.g. Compare two families with ca. 100 species in each
  - one has 300 junior synonyms
  - the other has no junior synonyms

explain this pattern … (2 reasons)

Nomenclator Zoologicus

You want to describe a new genus.

How do you know the name you chose is unique in the animal kingdom?

A catalog, now on-line, that includes all generic names from 1758 to 1994

http://ui.ub.mbl.edu/NomenclatorZoologicus/
Nomenclature
Binomials (binomials)
- specific epithet never capitalized
- Authors of names - often required for first mention of name in a scientific paper (remember homonym problem)
- In zoology, only two authors can be referred to using one letter:
  Linnaeus = L., Fabricius = F.

Taxonomy - Species per genus
“What is a genus?”
1. Branching pattern = distinct clade, group of species (deeper branches = higher ranks)
2. Degree of distinctness = very unusual lineages (long branches) given higher ranks (e.g. pentastomids, birds)
3. Species richness of group = more species means more likely to split into multiple genera

Taxonomy - Species per genus
“What is a genus?”
4. Amount of taxonomic study
   e.g. US butterflies
<table>
<thead>
<tr>
<th>year</th>
<th>spp</th>
<th>gen</th>
<th>ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1938</td>
<td>692</td>
<td>146</td>
<td>4.7 spp/gen</td>
</tr>
<tr>
<td>1964</td>
<td>682</td>
<td>177</td>
<td>3.2 spp/gen</td>
</tr>
<tr>
<td>1981</td>
<td>763</td>
<td>241</td>
<td>3.2 spp/gen</td>
</tr>
</tbody>
</table>

Taxonomy
My thoughts on your homework:
- species names are used as if species are real
Implications:
- Taxonomists as ‘stamp collectors’ - assigning names to things (not hypothetico-deductive) “anyone could do it”
- Taxonomists do not get cited when their species names or redescriptions etc. are used (lower citation counts)
- Obscures reality that a species name is associated with a demarcation, a hypothesis of what variation is included in the species - the hypothesis is of a taxonomist but is rarely cited (credited)

Taxonomy - other web resources
*Biologia Centrali Americana*
- massive undertaking, 58 volumes, late 18th & early 19th century
- 50,000 plant & animal species described from Central America
- Out of print
- Now digitized & on-line:
  http://www.sil.si.edu/digitalcollections/bca/

Nomenclature - other web resources
Nomenclature - other web resources

e-types

Digitized images of primary type specimens are now being called 'e-types'

-informal term, not recognized by ICZN

e.g. Harvard University’s Museum of Comparative Zoology Insect collection: 28,000 primary type specimens - rapidly being digitally imaged & put on-line

Nomenclature - other web resources

Zoological Nomenclature Discussion Group

An email listserv of zoologists to discuss & deal with nomenclatural problems

If a careful study of the code fails to provide the answer, submitting your question to this listserv will usually result in multiple answers from specialists (+/-) on the code

iczn-list@yaht.blip.icebox.org

NOT TO BE USED FOR HOMEWORK!!!

Collecting = Documentation

eye witness vs physical evidence

collecting:

specimens
photographs
audio recordings
artifacts
tissue (DNA)

Collections, specimens, curation


Specimens, “Systematic series”

1. Geographic variation - study series throughout range of species
2. Species-level studies - see #1, also type specimens, & periphery of range & areas of sympathy
3. Higher-level studies - enough to represent variation in higher taxa (DNA studies too often use only 1 specimen per taxon - except phylogeographic studies)

Collections, specimens, curation


Field collecting advice & data standards

Mantra: Always use complete labels in the field

e.g. good field label: CANADA: Alberta Prov. Kananaskis, Galatea trail to Lilian Lake 50°51.946’N 115°12.662’W 1762m (GPS) 550’ (altimeter) talus, snow-covered, slope 30 Oct 2004 R. Longair, T. Mousseau, P. Naskrecki, D. Sikes

e.g. poor field label: Site 3, 8/4/04
Collections, specimens, curation

Darwin’s Specimens:

- 1836 returned from 5 year voyage on the Beagle (still a creationist)
- thousands of valuable specimens
- moved to London to oversee their proper identification and publication of the results
- Darwin had misidentified his finch specimens thinking they belonged to many different families
- John Gould, an ornithologist, told Darwin that 25 of his 26 finch species were new & closely related

Collections, specimens, curation

Darwin’s Specimens:

- Darwin began to realize that the simplest explanation for these finches was evolution. Needed data
- But Darwin had not labeled his finch specimens properly - only 3 of his 32 specimens were labeled by island
- Luckily, others, including the captain (Fitzroy), had collected finches & labeled them by island

Collections, specimens, curation

Darwin’s Specimens:

The identifications by Gould and the label data of Fitzroy were critical to the understanding of the case
Darwin might not have become an evolutionist (and the major force behind the theory of natural selection)
if he had not had:
1) help from specialist taxonomists who curated growing collections of world species
2) proper field-data

Collections, specimens, curation

SO...

Make sure you have the correct identifications!
- verify with a specialist if there is doubt

Label your specimens thoroughly and with great care - in the field

Collections, specimens, curation

Wiley, cont. - Biological Collections

- like libraries
- held in trust for biological community
- public access, loans for study
- identification: determination “det label”

Collections, specimens, curation

Type specimen
Label - usually red determination label
Det label ALWAYS separate label from locality label

- Using collections, finding material, borrowing specimens (types often not loaned)
- loans to advisors, not students
- many museum specimens are not identified or are mis-identified, few are cataloged (taxon dependent…)

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- Help from systematists: most spend no more than 5% of their time helping others solve taxonomic problems
- More help if co-authorship is offered
- Contact & ask before sending specimens

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- Voucher specimens
  - enable verification of identifications
  - can make the difference between your study being useful or worthless
  e.g. which species of a complex did you really work on?
- good information on types

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- Processing fees to deposit types?
  - contact museum & make arrangements
- permanent ink, acid-free papers, climate control & pest prevention
  (don’t write field notes or specimen labels with ball-point pens!)

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- Nice summary of value of collections to society - know some examples
- Cost savings to have access to large samples
- Historic data: pathogen outbreaks, habitat loss, biological invasions, climate change

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**Value of collections**

1. Provide a permanent record of Earth’s biota
   - each specimen like a book in a library
   - really important for fragile biotas,
     - islands
     - old freshwater lakes (e.g. lake Baikal)
Introduction to Biosystematics - Zool 575

Collections, specimens, curation

Value of collections

2. Primary resource for revisionary systematics
   - provide large samples across range
   - most "new" species are found in collections
   - critical for:
     - fossils
     - rare taxa (too rare to collect..)
     - recently extinct taxa
     e.g. passenger pigeons

Collections, specimens, curation

3. Collections are a tremendous source of geographic data
   a) basic organismal distribution
   b) monitor historic changes
   1. Geological events
   2. Changes during human history
   3. Tracking biological invasions
   c) infer ecological associations
      e.g. soil type associations

Collections, specimens, curation

4. Collections are a rich source of ecological association data
   a) host associations, symbionts, parasites
   b) pollinator association (bees w/ pollen)
   c) overwintering stages / phenology
   d) thermoregulation studies - wing coloration
   e) migrations - in Costa Rica discovered sphingid (hawkmoth) migration as result of pollen loads on tongues & bodies

Collections, specimens, curation

5. Reference collections vital for identification
   - especially important as experts dwindle in numbers
   - & for identification of invasive species
   - majority of described species have yet to be revised, keyed, etc. (most people don’t realize this... think there is a guide to every species somewhere)

Collections, specimens, curation

6. Storage of voucher specimens
   - both type specimens ("super-vouchers") and regular voucher specimens:
     - molecular
     - ecological
     - ethnobotanical
     - paleontological, etc.
   - correct identifications vital to replicability

Collections, specimens, curation

7. Biological prospecting
   - screening for pharmaceuticals e.g. alkaloids, steroids, antibiotics
   - DNA extraction (taxon dependent)

Collections, specimens, curation

8. Teaching & public outreach
   - raw material for displays, exhibits etc on biodiversity
9. Basis for many evolutionary studies

- Darwin & Wallace’s theories resulted from extensive collecting & well-run collections
- Studies on mimicry
- Evolutionary trends, e.g. cranial capacity in humans, body size or color vs latitude
- Correlation studies - functional morphology

Kinds of collections:

1. Exhibit collections - education
2. Teaching collections - students “man-handle” specimens - lots of wear & tear thus NOT for valuable specimens

Kinds of collections:

3. Identification collections - short series, local area, e.g. field station collections
4. Research collections - long series, rare specimens, large population samples, authoritative identifications (dets made by systematists during revisionary work)
   - type specimens

Some Large NA Entomological Collections

<table>
<thead>
<tr>
<th>Name</th>
<th>holdings</th>
<th>loans</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMNH (DC)</td>
<td>25x10^6</td>
<td>103,722</td>
</tr>
<tr>
<td>AMNH (NY)</td>
<td>16x10^6</td>
<td>50,563</td>
</tr>
<tr>
<td>Bishop (Hawaii)</td>
<td>13.5x10^6</td>
<td>37,640</td>
</tr>
<tr>
<td>Field (Chicago)</td>
<td>10.3x10^6</td>
<td>53,724</td>
</tr>
<tr>
<td>Cal Academy</td>
<td>7.6x10^6</td>
<td>75,167</td>
</tr>
</tbody>
</table>

Problem: backlog of specimens - more efficient collecting methods (e.g. canopy fogging) yielding too many specimens for current work force

Ethics of collecting:

- Millions of animals are sacrificed each day for human consumption (6x10^5 chickens/day)
- Billions of organisms die each day from predation, illness, accident
- “If you are going to kill something you should prepare it as a specimen for perpetuity, for study…”

Specimens are required

- Attempts to eliminate collecting in society e.g. “butterflies through binoculars” are well-intentioned but are naïve or worse…
- They can be dangerous!
**Collections, specimens, curation**

**Ethics of collecting:**

- Scientific collections are suffering from lack of funding in many institutions
  - attack from above... but also attack from below:
- Also suffering from lack of appreciation and input from society that mistakenly thinks “collecting” is somehow unethical
  - fewer children making biological collections
  - fewer children learning about taxonomy

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**Collections, specimens, curation**

**Ethics of collecting:**

- **Conservation:** collecting more of an issue for k-selected organisms (e.g. vertebrates) & collecting benefits conservation biology more than harms
- r-selected organisms (spawners) produce huge numbers of young & typically have enormous population sizes
- permits help prevent abuses but in some cases handicap legit science

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**Collections, specimens, curation**

Current distribution - *Nicrophorus americanus*

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**Collections, specimens, curation**

This endangered species would not have been recognized as such without historic collections

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**Terms - from lecture & readings**

- Nomenclator Zoologicus
- eType
- Det label
- Determination
- Voucher specimen
- Revisionary systematics
- Systematic series of specimens
- Biological prospecting
- Exhibit collections
- Teaching collections
- Identification collections
- Research collections

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**You should be able to**

- Confirm your understanding of the word “classification” and be able to use it as a noun and a verb (to classify)
- Describe 2 reasons why two taxa might have very different ratios of valid to invalid names (lots vs few synonyms)
- What resource would you use to check if a genus name is unique?
- Know reasons to explain small vs large ratios of # species per genus
- Why use complete field labels rather than site codes?
- Describe at least 7 points for value of collections