Outline:

- The role and value of Systematics
- Taxonomy (α taxonomy) - in decline?
  - Identification, Classification
  - Collections, Conservation
- Phylogenetics (β taxonomy)
  - Phylogeny
  - Classification (?)
  - Evolutionary processes / patterns
  - Conservation

Course Website:
http://users.ibh.uaf.edu/~derek_sikes/Biol615/2575_home.htm
Check weekly for lecture updates, readings, etc.

Course Content:
- Theory & Practice of Systematics
- Not taxon-specific
- 25 % alpha taxonomy
- 75 % phylogenetics

Lecture 2:
Introduction to Biological Systematics

Outline: The role and value of Systematics

Taxonomy (α taxonomy) - in decline?
  - Describing species
  - Identification, Classification
  - Collections, Conservation

Phylogenetics (β taxonomy)
  - Phylogeny
  - Classification (?)
  - Evolutionary processes / patterns
  - Conservation

Godfray (2002)

- alpha taxonomy / phylogenetics
  - (descriptive taxonomy / phylogenetic tax.)
  - suffering from lack of prestige & resources
- Solutions?
- “web monographs” ?
- unitary taxonomy ?

Biosystematics

Lecture 1: Introduction to biological systematics (value)

*Flowers et al. (2002) Does the decline in systematic biology matter? Chapter 4 of report to the House of Lords (UK). Select Committee on Science & Technology. [webpage]

Lecture 2: Value of biosystematics continued; History of taxonomy


Gould - Linnaeus’s Luck

“Descriptive” taxonomy
  - Describing
  - Cataloging
  - Classifying
  - Stamp collecting?

Hypothetico-deductive taxonomy
  - Descriptions based on theory & hypotheses
  - Seek a ‘natural’ classification
Systematic biology has contracted at British universities to such an extent that it may be in danger of extinction as a sustainable discipline."

- 1992 the Dainton Report on Systematics in the UK

Demographic trends in alpha taxonomy:
1990 survey
63% of taxonomists > 46 years old
Only 8% < 35 years old

"If we found these demographic trends in a newly discovered species of lemur, we would bring specimens into a zoo and start a programme of captive breeding.
But if these trends continue among taxonomists and systematists, how soon will it be before we cannot recognize a new species of lemur?"


Systematics training in universities -
- molecular systematics (your text)
- phylogenetics
- rarely any training in alpha taxonomy
- knowledge & skills are being lost

Results of this decline -
- systematists who can’t do identifications
- orphaned taxa
- fewer people to describe species
- lots of new trees, but fewer taxonomic changes

“We sit on the brink of a crisis”

Not enough trained taxonomists to describe remaining 5-15 million species - even if we had the money
α (alpha) taxonomy

Solutions -
- Modernization - new technology
- digitization, web-publication, DNA
- NSF PEET grants
  (Partnership for Enhancing Expertise in Taxonomy)

Classification - usage of term

Standard:
“Activity of grouping entities or phenomena and giving names to the resulting groups”
-Wiley (1981) p. 194

Actual usage today:
“Activity of grouping entities or phenomena and giving names to the resulting groups”

So what is it?
- is an arrangement of names - names for groups (of names…)
- Linnaeus prepared classifications
- many modern phylogeneticists do not
  -new trees are not new classifications
  -new classifications can be based on new trees however
Example Classification
Phylum Annelida
  Class Polychaeta
    Family Siboglinidae
  Class Clitellata
    Subclass Oligochaeta
    Subclass Hirudinea
  Class Echiura
Phylum Sipuncula

We’ll do more on classifications and trees later

Systematics - value

1. Provide **Classifications** for our millions of species

Provide *natural* classifications
  = reflect evolutionary history
  = based on sound phylogenetic analyses

Natural classifications allow *predictions*

Systematics - value

Allow prediction of attributes of taxa not yet studied

- medicines (antibiotics, etc.)
- biological control agents
- predict ecological relationships
- extinct taxa - singing dinosaurs?

Systematics - value

Bad, “unnatural” classifications can be **disastrous**

e.g. Gypsy moth - brought to Boston by a frenchman, Leopold Trouvelot
  - hoped to start a business in silk
  - chose this moth because of its name at that time: *Bombyx dispar*
  - oriental silk moth = *Bombyx mori*

Systematics - value

Moth was no good for silk

Was very good at eating native trees

Escaped & is still a major pest species

Current name: *Lymantria dispar*
(different superfamily from *Bombyx*)
Systematics - value

(Bad) Taxonomy used for conservation assumed 1 species when there were 2+

Resulted in
- possible extinction of a subspecies
- near extinction of a second species
  (extinction of 10 of 40 populations)

Described in Nature: 347, 177-179 (1990)

Systematics - value

2. Infer phylogenies
- inform our classifications
- to know what a organism “is” requires phylogeny
e.g. tongue worms - pentastomids
  bizarre parasites of vertebrates
- what are they?

Systematics - value

3. Understanding evolutionary processes
   a tree is required to study:
   - Cospeciation
   - Historical biogeography, phylogeography
   - Macroevolutionary patterns
     explosive radiations
     extinctions
   - Trait correlations
     Are warning colors related to the evolution of gregariousness?
   - Adaptations

Systematics - value

Classified in their own phylum

Only in last few decades have we determined they are Arthropods specifically Maxillopod Crustaceans!
Evolution of Swim Bladders & Lungs
- Both derived from outpocketings of the gut
- Both structures hold gas
  - Swim bladders to adjust buoyancy
  - Lungs for gas exchange
- Tetrapods & some fish have lungs
- Many fish have swim bladders

Which is the came first?
Need a tree...

Systematics - value
Sound natural classifications or phylogenies enable biologists to
- intelligently frame their hypotheses
- understand the direction of evolutionary change
- know which taxa are appropriate for comparative studies

Conservation
Global Warning - ~0.8°C so far; target <2°C (if we burn 565 Gigatons of CO₂), but plans are set to burn 2,795 Gigatons...
Global Warming

>50% of species live in rain forests
~2% of these forests disappear each year

e.g. Ghana - 1990 and 2005, Ghana lost 25.9%

Conservation Biology - Biodiversity crisis

- Massive habitat destruction

- ca. 1 species extinction / 20 minutes (26k/yr)

CENTINELAN EXTINCTION = named for Centinela Ridge in Ecuador
Gentry & Dodson, 1978, 90 new species endemic to ridge, 8 yrs later destroyed for a plantation

- current extinction rates 100 to 1,000 times greater than "normal", Earth’s 6th mass extinction?

Systematics - value

Phylogenies help identify unique lineages

- e.g. “living fossils”
- e.g. a duckbilled platypus

History of Taxonomy

Aristotle
384-322 B.C.

Father of Biological Classification

Used concept of nested sets

Named various taxa
e.g. Coleoptera
“Sheath-wing”

Oldest scientific names still in use

Phylum Annelida

Class Polychaeta

Subclass Oligochaeta

Subclass Hirudinea

Class Clitellata

Class Echiura

Nested Sets

History of Taxonomy

Botanical taxonomy developed faster than zoological

Plants used for medicines & foods

Theophrastes 371-287 B.C. - classified 500 species of plants (e.g. Asparagus)

Books on plants (herbals) with illustrations, descriptions & names became common

History of Taxonomy

Phrase names:
Joseph Pitton de Tournefort - paved the way for Linnaeus

Key work published in 1700 instituted the genus name
e.g. Mentha floribus spicatis, foliis oblongis serratis

"mint with flowers in a spike, leaves oblong and toothed"

History of Taxonomy

Herbals copied without improvements throughout the Middle Ages

Very little progress until the 15th century - Gutenberg’s printing press

Botanists began using phrase names - descriptive names of species

Latin, usually < 12 words

History of Taxonomy

First Bioinformatics crisis - too many new species & names, chaos reigned

Linnaeus instituted a simpler, more organized system - binominal nomenclature, 1753, [6,000 plants]

Based on binomen - species name composed of two words - as an abbreviation for the full phrase names

(Note: not binomial nomenclature)
History of Taxonomy

The binominal system was actually first used by Gaspard Bauhin (1623) but never caught on.

Linnaeus reintroduced & imposed it on the world - chaos was averted.

Zoological nomenclature began with the 10th edition of Linnaeus's Systema Naturae (1758) - why this edition?

You should be able to

Describe the decline of alpha taxonomy & ideas to reverse it

Understand the term Classification (not easy!)

Describe the value of phylogenetics

Describe the key people & their influence on the development of Systematics

History of Taxonomy

Linnaeus’s 5 ranks:

Kingdom - Animalia
   Class - Insecta
   Order - Coleoptera
   Genus - Silpha
   Species - Silpha vespillo

All animals in 312 genera