“There have been many authorities who have asserted that the basis of science lies in counting or measuring, i.e. in the use of mathematics. Neither counting nor measuring can however be the most fundamental process in our study of the material universe - before you can do either to any purpose you must first select what you propose to count or measure, which presupposes a classification.”

R. A. Crowson 1970 Classification and Biology (p.2) [italics added]

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**Systematic and Comparative Biology**

D. S. Sikes
University of Alaska

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**Lecture 1:**
**Introduction to Biological Systematics**

**Outline:** The role and value of Systematics

**Taxonomy (α taxonomy)**
Describing species
Identification, Classification
Collections, Conservation

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

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**Systematics**

In short:

Discover what is “out there”

and

Fit it to the tree of life

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**α (alpha) taxonomy**

- Describing species
  (what are “species”?)

- “mapping biodiversity”

- Finding “new” species, new traits

- Originally to distinguish beneficial from harmful organisms
**α (alpha) taxonomy**
- ca. 1.5 - 1.75 million species named
- Not sure, no single list / database
- ca. 10-15k new species named / year
- ca. 5-15 million awaiting description
- ca. 500-1500 years, at this rate

**Kingdom Animalia**

*Known species*

~1.03 million animal species

- 96% of animal species are invertebrates
- 80% of animal species are Arthropods
- 73% of animal species are Insects

All life: ~1,413,000 spp
53% of all living species are insects

**Species Richness - Estimation**


- extrapolation from data about canopy insects
- one hectare ~ 41,000 spp*
- global ~ 30,000,000!
  (not 1.5 million)
- hypothesis proposed, not a claim

*Canada: 30,000 insect spp
(55,000 est. total)

**α (alpha) taxonomy**
- Description of nature
  (basic / pure, research)
- Same pursuit as the cataloging of astronomical bodies like stars, planets, galaxies, etc.
- Exciting! (usually)


α (alpha) taxonomy

• Character states that are **unique**

• Character states that are **shared**
  
  = suggest relationships
  
  = **phylogenetics**

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**Introduced Predators Transform Subarctic Islands from Grassland to Tundra**

D.A. Crow*1, J.L. Harris1, A. Davis1, E.M. Darner1, G.Y. Rydb1

The predators often have powerful direct effects on prey populations, but whether these effects propagate to the base of intact food webs is debated. There are few examples of trophic cascades strong enough to alter the structure and function of entire communities. The presence of novel predators is linked with major changes in plant productivity and community structure on a previously unaltered tundra. By pasting in canvas, these novel arthropod transporters and transforming vectors to develop

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**Scathophaga impudicum**

![Image](image-url)

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α (alpha) taxonomy

• Develop a system of **names**

• Names at & above species level: Classifications

• Ideal: **stable** and **universal** language

• Names are primary anchors for information storage & retrieval

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"Nomina si nescis, perit cognito rerum"

— C. Linnaeus

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"If you don't know the names, the knowledge of things is lost"

— C. Linnaeus
**α (alpha) taxonomy**

*Tyrannosaurus rex*
*Biston betularia*
*Drosophila melanogaster*

Easier to remember (& communicate?) with than:
9088-8980.6783
A793K2
or
Dm001.05

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**α (alpha) taxonomy**

Taxonomists provide *identifications*

Identifications are:

Hypotheses that the unknown is conspecific with the *type* of the species

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**α (alpha) taxonomy**

Taxonomists provide *identifications*

- Directly (if still alive & willing)
- Indirectly - publications (fraction of…)
  - Keys
  - Monographs
  - Field guides
  - Digital - websites, CDs

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**α (alpha) taxonomy**

Identifications for:

- All who “use” organisms
- Many disciplines depend on identifications provided by taxonomy, e.g.
  - ecologists
  - biostratigraphers
  - agriculturalists, (plants & pests)
  - public health officials, doctors
  - conservation biologists, etc.
Identifications for:

Conservation Biology
1. Identify “hot spots” of diversity
2. Identify species at greatest risk

Do we need taxonomic names?

α taxonomy

“useless knowledge?” - identification of species
is rarely taught as part of a biology degree…
c.f. “use” of knowledge of astronomical bodies

α taxonomy

Most identifications are done for free
Often not considered a valuable use of time
for a scientist
Charge a fee similar to lawyer or doctor’s fees? ($100 - $500 / hour)
Importance of identifications so great
...of such widespread value

But many people often forget or don’t appreciate the work that was/is involved.
Or they think the work is finished

Or they think the “old way” is too difficult and want to replace it with new technology
e.g. DNA barcoding

Systematists make & maintain collections

Have the training to collect, process, identify specimens

To curate and manage depositories of Earth’s biodiversity

Value of collections (brief overview)

1. Critical role in identification
   - ecology, monitoring, pests, aliens, etc.
   - majority of described species have yet to be revised, keyed, etc.
   - MCZ type database, on-line

2. Voucher specimen deposition
   - allowing identifications to be checked

3. Revisionary taxonomy requires collections
   - impossible re-collect
   - myriad “new” species await discovery in collections

**Small Carcass Monopolization**

Character evolution:
Melanism

homology or homoplasy?
4. Specimens are data
   - locality data for GIS work
   - historic occurrences, conservation bio
   - as global climate changes...

5. Specimens have specimens
   - Symbionts, pollen & fungal spores

6. Archive of molecules - DNA data
   - Dry: some taxa more than others
   - Frozen collections

7. Teaching - biodiversity
   - university, public, etc.

“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 the same demographic trends were found in a newly discovered lemur, specimens would be brought into a zoo and a captive breeding program initiated.”
### α (alpha) taxonomy

Systematics training in universities -
- molecular systematics
- phylogenetics
- rarely any training in alpha taxonomy
- NSF PEET grants

### You should be able to

- Describe biological systematics - its role, components, etc.
- Distinguish alpha from beta taxonomy (phylogenetics)
- Describe the value of alpha taxonomy - descriptions, identifications, collections, etc.