I. Diversity. Historical Development.

The study of systematics, taxonomy, and nomenclature is in fact a study of the ways that we as humans describe the diversity of life.

In this course we will look at the historical development of systematics; who (at least those writings that still exist) it was that first recorded a classification and ideas about the natural world, why that system was used and how things developed from Greek and Chinese historical times up to the present.

This course is called "biosystematics and nomenclature" because it will be broadly based. As Brooks and McLennan indicate, we will be on a voyage of discovery, looking at history, working with and understanding the tools of the trade, learning definitions, and working to connect new neurons and new pathways in our brains.

Today we will begin by starting a tour of the historical development of the study of diversity. We will take data from several sources and insert them into the lectures, so that we can follow the flow in the book and in the lecture.

From page 22. Brooks and McLennan:

4 Guiding principles to studies of diversity.

- 1) Phylogenetic trees are necessary but rarely sufficient for explaining evolutionary origins and diversification
- 2) We (as scientists) must always be responsible for well-formulated questions
- 3) We (as scientists) must always be responsible for the quality of the data used in any level of our analyses, from generating phylogenetic hypotheses to testing general theories
- 4) Everything we learn implies more cycles of discovery and evaluation.

History of Systematics / Taxonomy / Nomenclature

Study of Local Faunas.

Naturalists exist in all human societies, especially where the natives must use the plants and animals for their daily existence. This was evident to me where I grew up in on a farm in western Oregon. We also encountered true naturalists when we first went to the field in Bolivia in 1984 - 1985.

Non-Formal Explanations of Diversity.

Usually developed from the Description of Local Faunas.

- In New Guinea – One tribe had 137 specific names for 138 of the birds in the area in which they lived.

Nunamiut Eskimos – All had names for each of the specific mammals, birds, insects, and plants that lived in the area where the Eskimos of Anaktuvik Pass lived. These were the last nomadic eskimos in the US territory and they quit moving their camps in the 1940's.

Period of Enlightenment and the Description of Local Faunas.

Hippocrates (460-377 B.C.) - Enumerated types of animals but no useful classification

Aristotle (384-322 B.C.) Brought together the initial material and stated "animals may be characterized according to their way of living, their actions, their habits, and their bodily parts." He is the father of classification. His surviving works show that he recognized: birds, fishes, whales, insects (several subdivisions of the insects, including beetles). However, no orderly consistent classification was produced.

- His thinking dominated animal classification for the next 2000 years, and kept biology in the dark for that long, too. He stated that spontaneous generation was a fact and nobody disputed this.

The Chinese were much more enlightened:

2700 B.C. Nematodes were first mentioned in the surviving literature in the Huang Ti Nei Ching or "*The Yellow Emperor's Classic of Internal Medicine*"

-Foods to avoid. -Symptomatology. -Treatment.

217 AD. Chang Chi noted: During ordinary abdominal pains, the pulse becomes feeble and thready. If on the contrary it is full and bounding, it indicates the sure presence of *Ascaris* in the abdomen.

1174 AD. "The three causes and one effect of disease" Some people become parasitized through eating fruits and vegetables or animals viscera, which contains their progenies."

->They knew that eggs and parasites were transmitted via microbial infection. ->It was not until 1864 that the experiments of Louis Pasteur showed that spontaneous generation was false.

John Ray 1627 - 1705 Botanist – (recognized the difference between a genus and a species). He published in 1690 *Historia Generalis Panatrum* covering 18,625 species. He was influential in the later work of Linnaeus.

Carolus Linnaeus (1707 - 1778) or Carl Linné or later Carolus von Linné, Swedish Naturalist

-Born in 1707 in Råshult southern Sweden - father was a Lutheran curate

- In 1758 he used the total binomial system and applied the method consistently to animals and plants. He was working to try to prove the scala naturae.
- 1735 First Edition of *Systema naturae*. -14 pages.
 - 1758 10th Edition of *Systema naturae*.
 - ???? 12 Edition of Systema naturae. with 3 volumes and 2,300 pages.

His first system of nomenclature was numerical applied to plant genera. Such as *Convolvulus* 1 (bindweed)

Convolvulus 2

- Then he realized that the binomial system was more useful, and he first intended to use the binomial system for everything clouds, rocks, diseases, winds anything in nature.
- phanerogamic plants (Angiosperms and Gymnosperms)

This work became the foundation of systematic zoology. Later in the course we will discuss the development of the code of nomenclature.

Nomenclature is a latin word composed of two parts (*Nomen* = "name" and *Calare* "to call"). Binomial = two names (basically two name name calling).

Reference: Brooks and McLennan, 2002; Maggenti - history of Nematology systematics.

Teleonomic: A process or behavior that owes its goal-directedness to the operation of a program. Teleological - goal oriented

Second Period Acceptance of Evolution.

- **Georges Buffon, 1707 1788** Worked at the National Museum of Natural History in France. First to discard the "hypothesis of special creation." Clearly stated that they way to design an instructive and natural method of classification was to group together things that resemble each other and separate things that differ from each other.
- Jean Baptiste Lamarck (1744-1829)- The first to maintain (p51 Simpson) that all taxa have arisn by evolution and are a phylogenetic continuum. This is the most original and the most acceptable part of Lamarckism – that species originated from other species via evolution and phylogeny. Lamarck said that "Relationships are greater according to whether the part involved is more essential." See Simpson p. 52.

The period of exploration in the 1800-1900's was characterized by an intense interest in the in the faunas of far away places. This led to the collection of vast numbers of specimens from all over the earth and allowed the monographic treatment of genera and families.

The period of exploration and discovery led to the trip that Darwin took on the HMS Beagle.

Darwin first published "The Voyage of the Beagle" in 1860.

Charles Darwin (1809 - 1882) published the first edition of On the Origin of Species in 1859. Darwin provided the first mechanism of evolution - Depending on extremely long time scales (in apposition to Lord Kelvin who considered the earth to be only a few hundred thousand years old, at the most - calculated from cooling rate of a sphere...). While Darwin was on his trip on the Beagle with Fitz Roy, he received a copy of the tome by Charles Lyell on Geology, where the age of the earth was stated as much greater than Kelvin calculated.

This period included Studies of the development and evolution of of Higher Categories.

Third Period The study of Populations.

- The study of evolution within species. Typological Species Concept was abandoned and replaced by the polytypic species concept.

-Series of specimens is becoming important for study. No longer is a single specimen satisfactory for the foundation of a taxon name. However, see Scott's specimen.

-(late 1800's to mid 1900's) This period of time started around the time of the great collections that were being amassed by the collectors and museums.

Alexander von Humboldt - see slides (Darwin Day Talk) Alfred Russell Wallace Charles Darwin and Cap'n Fitz Roy of the HMS Beagle

George Gaylord Simpson (1902-1984)

GG. Simpson wrote many papers on paleontology, taxonomy, and systematics of mammals. A contemporary of Mayr and Usinger and others, Simpson was probably the most influential (to the development of modern aspects of systematics) of all Paleontoloigsts.

A famous quote by Simpson "The fact -- not theory -- that evolution has occurred and the Darwinian theory as to how it occurred have become so confused in popular opinion that the distinction must be stressed."

Ernst Mayer (1904 - 2005)

Ernst Mayr was the most influential evolutionary biologist of the 20th century. Certainly the most influential of all living systematists at the time. He lived through the birth, development, and beginning maturation of the field of Systematics. Unfortunately, he is also witnessed the start of a major extinction event on the earth caused by *Homo sapiens*. Read about this in our book "The 6th extinction"

The "New Systematics"

1940's - The purely morphological species definition

- replaced by a biological definition which takes ecological, geographical, genetic, and other factors into consideration (we will soon get into species definitions).

-The population, represented by an adequate sample, the SERIES of the museum worker has become the basic taxonomic unit.

Geographic variation is seen as important

The "Old Systematics"

- Characterized by the central position of the "typological species concept"
- Many species are known from only one or a very few specimens.
- Little importance is given to geographic variation.

Basic definitions:

George Gaylord Simpson 1961.

Systematics Definition: The scientific study of the kinds and diversity of organisms and of any and all relationships among them. Esentially, this is the study of biological diversity.

"Systematics is at the same time the most elementary and most inclusive part of zoology."

1. – Most elementary because organisms cannot be discussed or treated in a scientific way until some taxonomy has been achieved;

2. – Most inclusive because systematics ... gathers ..., utilizes, summarizes, and implements everything that is known about organisms"

Taxonomy Definition: The theoretical study of classification, including its bases, principles, procedures and rules.

This is part of systematics which includes

- theory and practice of classifying organisms, including
- naming
- identifying
- working with theoretical, philosophical mechanisms for classifying
- Systematics & taxonomy have comparative biology as the basis.
- 1. Provides a vivid picture of the existing organic diversity on the earth
- 2. Provides most of the information needed for reconstruction of the phylogeny of life
- 3. Reveals numerous interesting evolutionary phenomena and thus makes them available for causal study (shows patterns then we can begin to look at the processes which made the patterns).
- 4. Supplies, almost exclusively the information needed for many branches of biology: such as biogeography or zoogeography.

-Ernst Haeckel - Phylum in 1876

Nomenclature: (Nomen "name) calare (to call) = to call by name = nomenclature.

The application of distinctive names to each of the groups recognized in any given classification.

Classification: The ordering of organisms into groups or sets on the basis of their relationships, that is, of associations by contiguity, similarity, or both. (Simpson 1961)

-discuss this from the aspect of characters and character states.

(zoological) organizing organic diversity into a manageable, meaningful system -hierarchical format with an evolutionary basis

Identification: Placing organisms into a classification (established) TAXON (pl. TAXA):

Taxon: A group of real organisms recognized as a formal unit at any level of a hierarchic classification.

The rank of a category is either its absolute position in a given hierarchic sequence of categories or its position relative to other categories.

Taxonomic group; group of organisms / animals sharing a common ancestor -- at any rank in the hierarchy

Category: rank in the hierarchy

Classifications in general.

Ecological Classification (defines sets such as): Forest insects, grassland insects, fresh water fishes, cave salamanders.

Note: organisms involved in this broad classification are Identified and named according to other classifications before they are put into an ecological context.

Teleological classifications define sets (not taxa): according to their usefulness or lack of it with respect to humans. Examples:

1. Edible, non edible

2. Domesticated animals, draft animals, meat animals, pets.

Classifications are creations by us for our use. There can be natural classifications - those that after designation, the phylogeny can be reconstructed from the classification.

-There are arguments for and against using this kind of classification. We will talk about these.

Linnaeus was the founder of modern bionomial nomenclature, of which the classification system has been developed.

Classification: Linnaeus used only 5 of these categories in 1758. Linnaeus used Empire for the world of Phenomena.

Kingdom

Phylum Class

Order

Family

Genus Species

Of course we can add other sections of these such as super and sub and other sections - like tribes.