FAPPZ B125

- 15.3. 2016 Overview of the system
- 22.3.2016 Demonstration of Fishes
- 29.3.2016 Chondrichthyes
- 7.4.2016 9:30 Jevany
- 12.4.2016 Example of ichthyological reserach "Fish and mussels - a peculiar host parasite relationship"
- 19.4.2016 Example of ichthyological reserach - Fish behaviour on example of European catfish
- 26.4. Exam and the end of course

What is a Fish?

What Is a Fish?

This question is not as simple as it sounds at first reading. What makes it a difficult question is that there are many exceptions for each character used to define "fish." For example,

Character: Fishes swim in water. Exception: The mudskipper, *Periophthalmus*, skips about on mangrove flats completely out of water; grunions, *Leuresthes*, spawn on beaches above the low tide mark; the walking catfish, *Clarias*, ambles overland from pond to pond.

Character: Fishes respire by means of gills. Exception: Lungfishes, *Protopterus*, can breathe atmospheric air via lungs and can even remain encysted in a dry mud cocoon; anabantids have a labyrinth organ in their

If we allow room for these and other exceptions, we can define a fish as a poikilothermic, aquatic chordate with appendages (when present) developed as fins, whose chief respiratory organs are gills and whose body is usually covered with scales. This broad definition makes no mention of skeletal material and therefore includes the cartilaginous lampreys and elasmobranchs as well as the bony fishes.

dorsal fins exist only as ridges.

Character: Fishes are cold-blooded. Exception: Many fast-swimming species such as tunas and their relatives develop muscle temperatures in excess of ambient water temperatures.

If we allow room for these and other exceptions, we can define a fish as a poikilothermic, aquatic chordate with appendages (when present) developed as fins, whose chief respiratory organs are gills and whose body is usually covered with scales. This broad definition makes no mention of skeletal material and therefore includes the cartilaginous lampreys and elasmobranchs as well as the bony fishes.

Is it fish?

YES

NO

Is it fish?

YES

Is it fish?

YES

NO

Is it fish?

NO

Is it fish?

YES

NO

Is it fish?

YES

Is it fish?

Yes

NO

Is it fish?

YES

Is it fish?

YES

NO

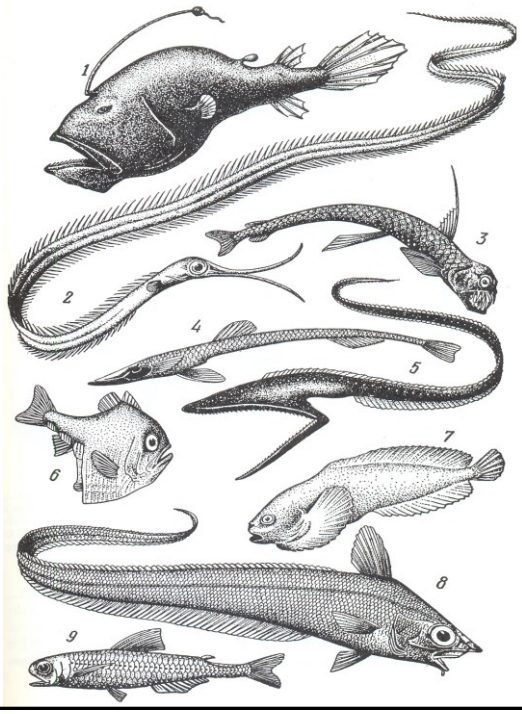
Is it fish?

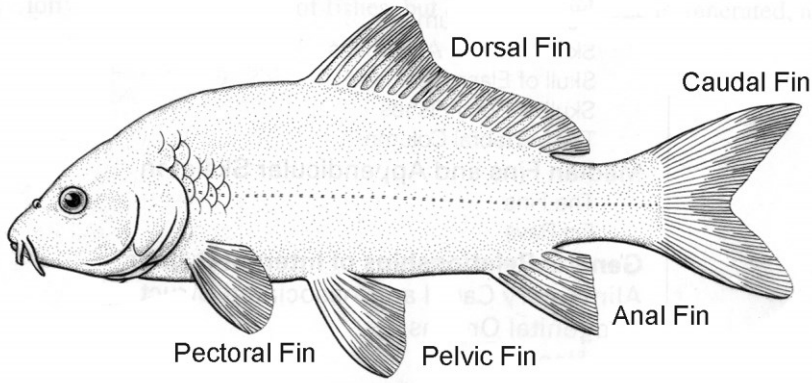
Difficult to judge

Why ichthyology

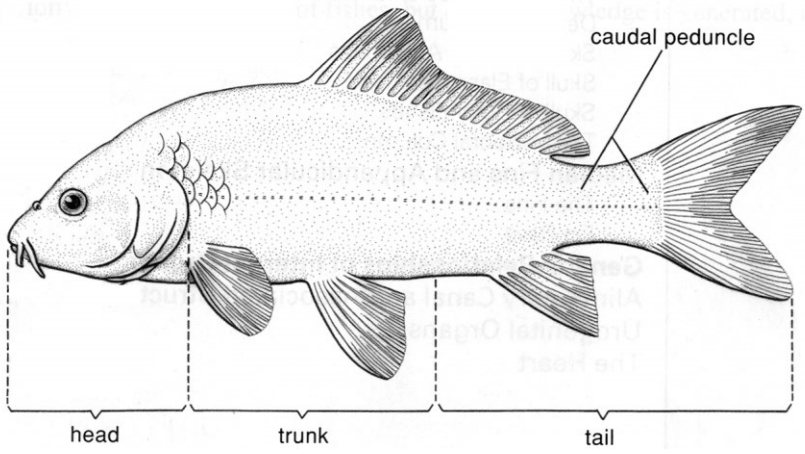
- T
  –
  –
  S uld ☺

This project started on a sunny Sunday in July 1961 when a younger first author, armed with a small bucket, finally caught his first fish (a minnow) in the River Doubs and proudly brought it back home and released it into an inflatable swimming pool. The ichthyophily slowly evolved into ichthyology to reach the final stages of the ichthyomania now observable. (MK)

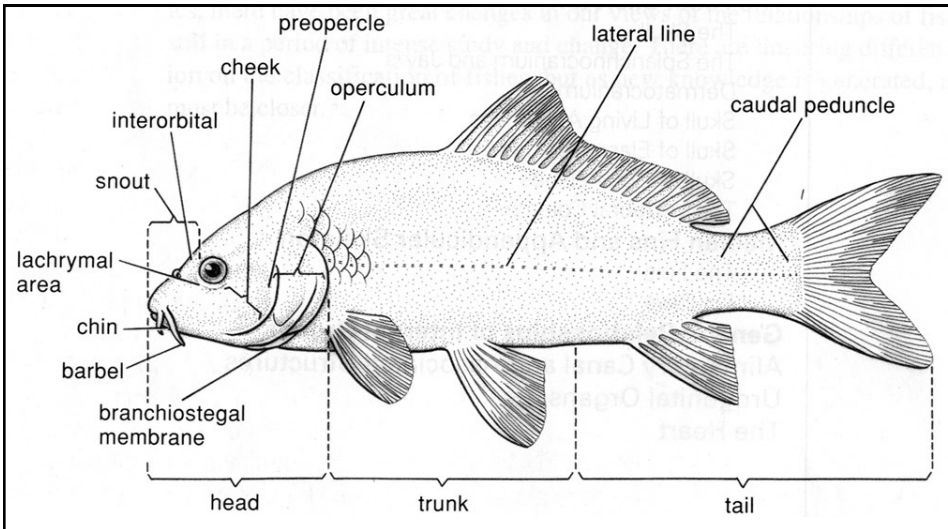




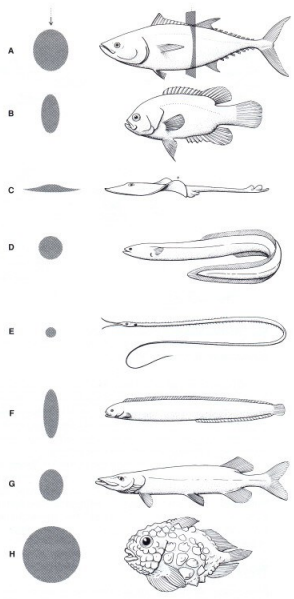
External anatomy



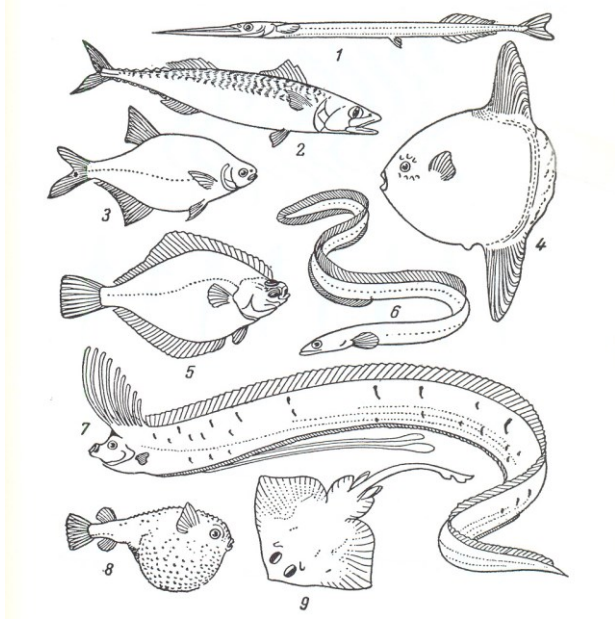
External anatomy of carp



External anatomy of carp



Representative body shapes in fishes, with typical cross sections. **A,** Fusiform (tuna, Scombridae); **B,** compressiform (sunfish, Centrarchidae); **C,** depressiform (skate, Rajidae) dorsal view; **D,** anguilliform (eel, Anguillidae); **E,** filiform (snipe eel, Nemichthyidae); **F,** taeniform (gunnel, Pholidae); **G,** sagittiform (pike, Esocidae); **H,** globiform (lumpsucker, Cyclopteridae). (**H** based on Jordan and Evermann, 1900.)



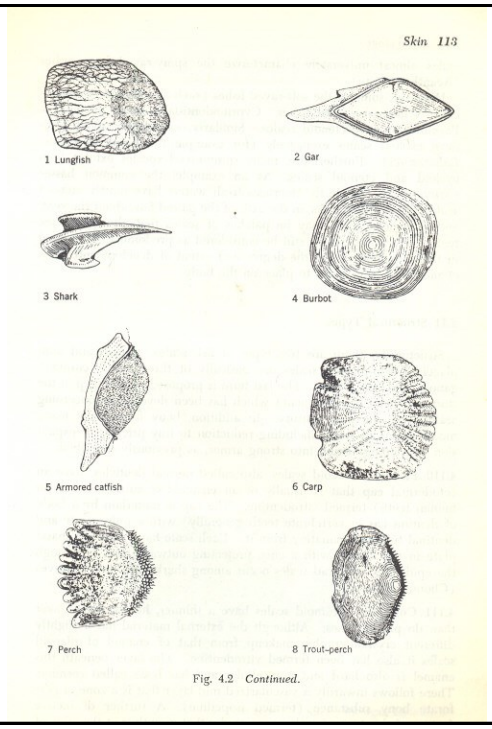
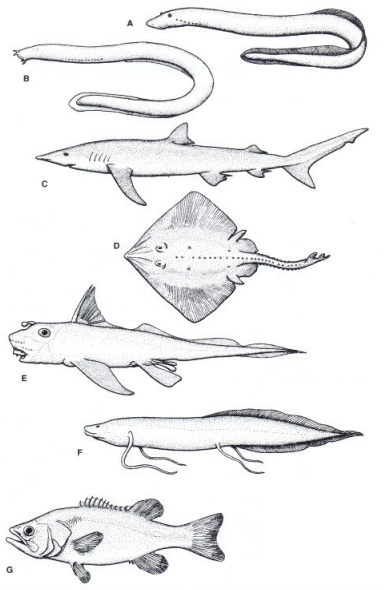


Fig. 4.2 *Continued.*

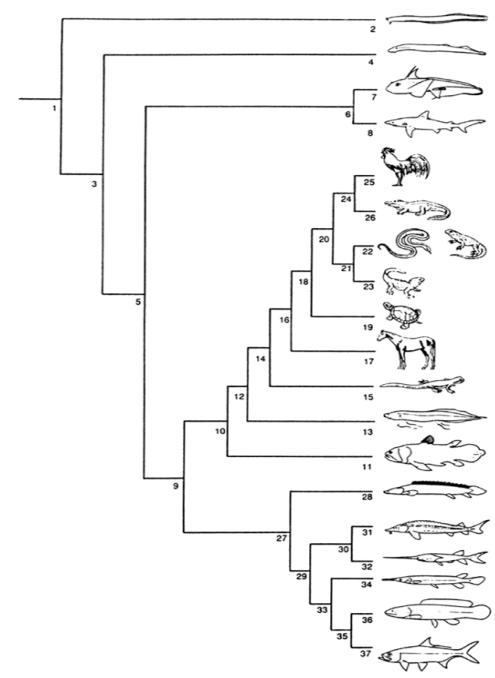
Introduction to Systematics

Five major extant (= living as opposed to fossil) clades of fishes

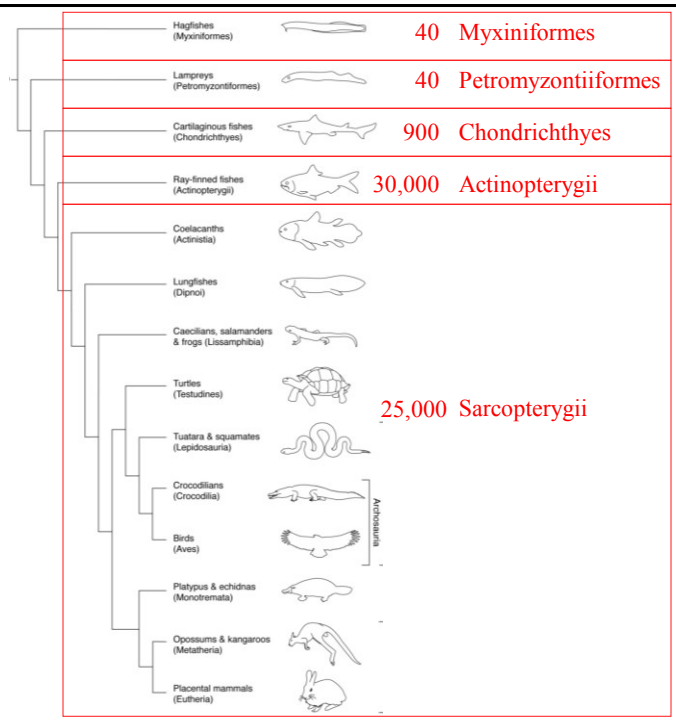
1. Hagfishes - Myxiniformes
2. Lampreys - Petromyzontiformes
3. Sharks, rays and chimaeras - Chondrichthyes
4. Lungfishes and coelacanths - Sarcopterygii
5. Ray finned fishes - Actinopterygii



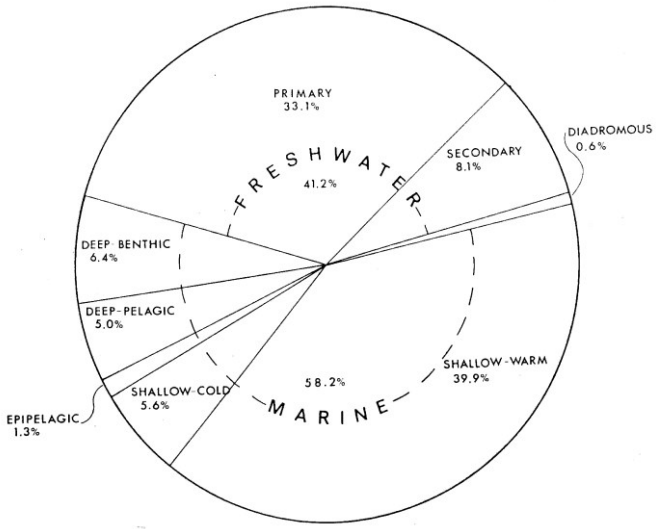
Examples of groups of living fishes. **A,** Lamprey (class Cephalaspidomorphi, order Petromyzontiformes); **B,** hagfish (class Myxini, order Myxiniformes); **C,** shark (class Chondrichthyes, subclass Elasmobranchii); **D,** ray (skate) (class Chondrichthyes, subclass Elasmobranchii); **E,** chimaera (class Chondrichthyes, subclass Holocephali); **F,** lungfish (class Sarcopterygii, superorder Ceratodontimorpha); **G,** teleost (class Actinopterygii, subclass Neopterygii).



Craniate phylogeny and diversity of living species



(Cohen 1972)



Systematics is the study of the study of biological diversity and the evolutionary relationships among organisms.

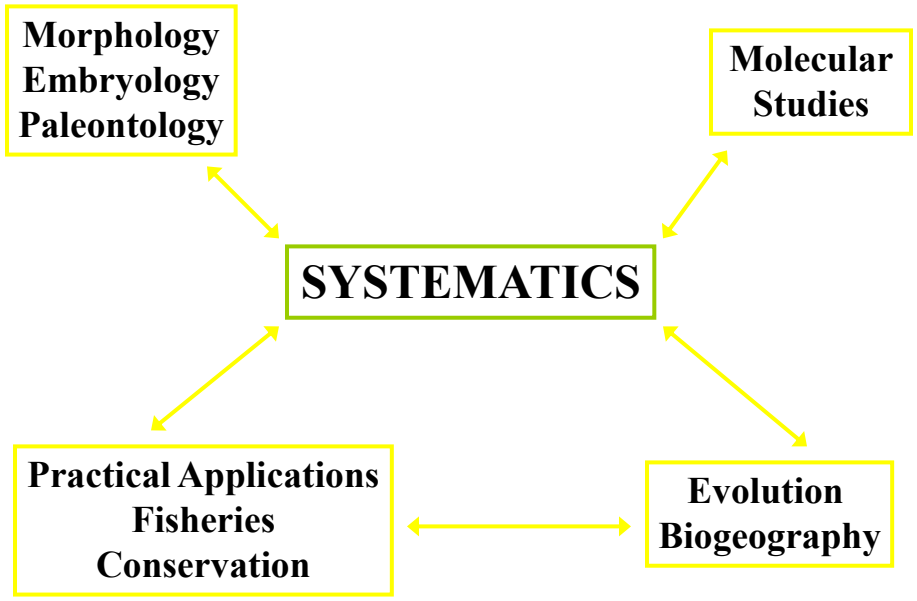
Systematics has two main components: Taxonomy and Phylogenetics.

Taxonomy is a subdivision of systematics, consisting of three associated activities; *identification, classification, and nomenclature.*

***Identification*: recognizing, researching, or redescribing a taxon for scientific publication according to the current rules of biological *nomenclature*. Referring a specimen to a previously described group.**

***Classification*: the ordering of organisms into groups based on perceived similarity or differences.**

Systematics is central to all other areas of research



Systematics

Two approaches (often differ among ichthyologists):

CLASSIFICATION

- Recognition
- Communication
- Arrangement in Logical Order

SPECIATION

- The evolutionary "why" of classification.
- And an attempt to explain variation.

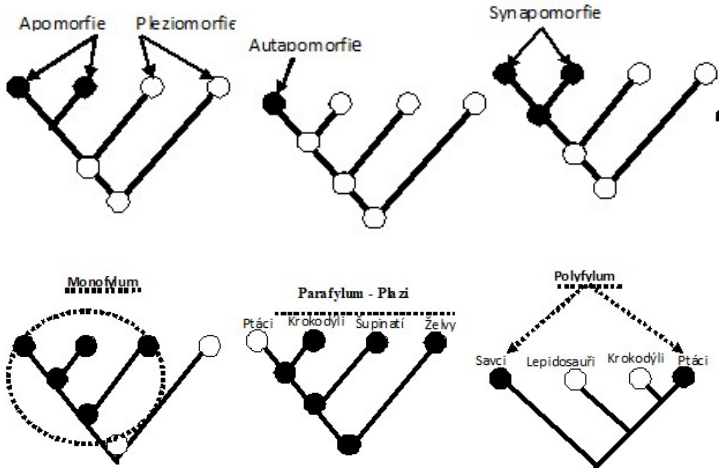
There are two Components to Systematics:

1. Taxonomy = The identification and naming of units of classification; e.g, Order, Family, Species

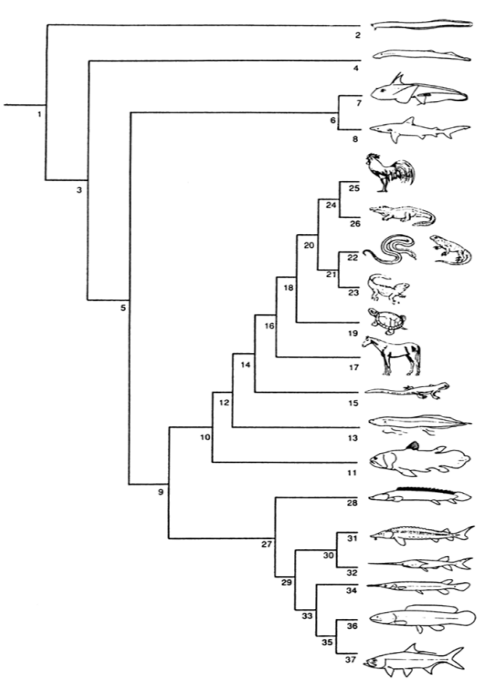
2. Phylogenetics (or Phylogenetic Systematics) = The practice of organizing taxonomic units on the basis of evolutionary relationships.

Cladistics is the primary method used by systematists in the practice of phylogenetic systematics. The foundation of cladistics is the **Synapomorphy** - shared, derived character.

Groups united by one or more synapomorphies are **Monophyletic** and include an ancestor and all descendants.



32



Do New Species Still Exist? Yes !

Estimates range from 5 to 30 million species are undescribed. In other words there is a lot we do not know about life on earth.

Where/how do you find them?

- **Where to look?**
- **Best place to find new species is……..in a museum!**
- **Most new species are generally found by field biologists or ecologists.**
- **Even in relatively populated areas that would seem to be well studied we are still finding new species and or range extensions of known species.**

The "art" of systematics is in some ways becoming an extinct science, especially as genetics has become the new form of taxonomy.

So what to do if you think you may have a new species?

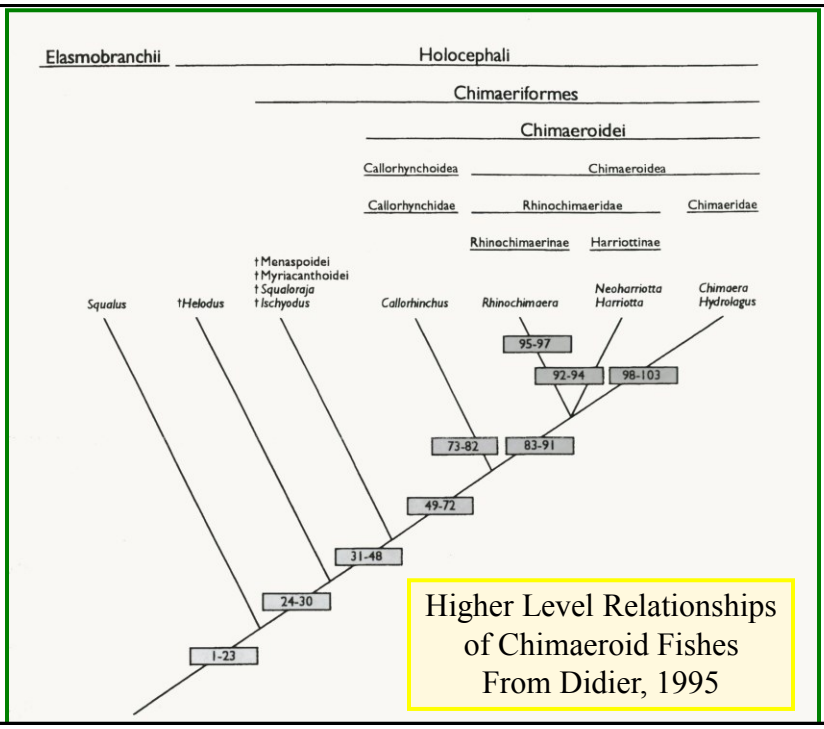
Levels of Taxonomy

Alpha: Basic species description. This is the level at which species are characterized and named.

Beta: The arrangement of species into a natural system of lesser and higher categories.

Gamma: The analysis of intraspecific variation and evolutionary studies.

All of these categories overlap and are integrated with each other.



Higher Level Relationships of Chimaeroid Fishes
From Didier, 1995

Systematic Methods

- **NOMENCLATURAL METHODS & RULES**
  - **ICZN**
- **BIBLIOGRAPHIC METHOD**
  - **Must read the literature**
- **STATISTICAL METHODS**
  - **Extremely important to test significance of trends**
- **CLASSIFICATION METHODS**
  - **Phylogenetic Trees and Cladograms**
- **EXPERIMENTAL METHODS**
  - **Reproduction or Breeding Experiments**
  - **Genetics**

NOMENCLATURE

COMMON NAMES

- Vary from location to location
- Various combinations of descriptions (yellowtail snapper, blackgill rockfish)
- No rules govern

SCIENTIFIC NAMES

- Remain relatively unchanded
- Monominal (higher categories – Orders)
- Binominal (Genus, species)
- Trinominal (SubGenus or subspecies)

NOMENCLATURAL RULES

- **Books:**
  - **Mayr et al. (1969) Principles of Systematic Zoology. McGraw-Hill.**
  - **Ax (1987) The Phylogenetic System**
  - **Winston (1999) Describing Species: Practical Taxonomic Procedure for Biologists. Columbia University Press.**
- **References:**
  - **Tubbs (1992) The International Commission on Zoological Nomenclature: What it is and how it operates. Syst. Biol. 41(1):135-137.**
  - **Jennings (1982) The nomenclatural enigma of single versus double –I endings for scientific patronyms emended to represent a man's name. Fisheries 7(6):9-10.**

The Concept of Type

Type: For every new species, there is at least one specimen put in some institution to be available for later study.

Holotype: One specimen of the type species as in a published description. Usually the original specimen.

Neotypes, Lectotypes, Paratypes, Syntypes

NOMENCLATURAL RULES

- **Rule of Priority – after 1758 (Linnaeus' *Systema* Naturae the earliest used "available" name for a species is its valid name.**

- **Available – Requires following rules, publication with picture or drawing or good description, binomen in Latin with genders correct, and "valid" if available name under which species first was described after 1758.**

- **Endings:**
  - **Superfamily = "oidea"**
  - **Family = "idea"**
  - **Subfamily = "inae"**

Taxonomic classification

Kingdom – The largest unit of classification. Estimated five kingdoms:

	estimated sp #	
Animalia –	**1,000,000+**	**(invertebrates, vertebrates)**
Plantae –	**350,000+**	**(trees, grasses)**
Fungi –	**100,000+**	**(mushrooms and lichen)**
Protista –	**100,000+**	**(green, golden, brown, and red algae)**
Monera –	**10,000+**	**(blue-green algae or cyanobacteria)**

Phylum/Division – The next most specific unit of classification. there are ~20 or so phlya (animals) or divisions (plants)

Class – Separates organisms into categories that make them similar in terms of basic features, i.e. fish, mammals, birds, etc.

Order – Families that share similar characteristics.

Family – Genera that share similar characteristics.

Genus – Species that share similar features.

Species – The specific name of an organism.

Biological nomenclature: the system of scientific naming of organisms was developed to ensure that every organism can have a name that is unambiguous and globally understood. The naming of organisms according to the rules developed for the process.

A species name becomes known in the scientific sense when a Latin binomial, a name consisting of two parts, and a description are published in the scientific literature. Descriptions must follow the rules zoological (ICZN) nomenclature.

INTERNATIONAL CODE OF ZOOLOGICAL NOMENCLATURE

PREAMBLE

The International Code of Zoological Nomenclature is the system of rules and recommendations adopted by the International Congresses of Zoology; since 1973, by the Division of Zoology of the International Union of Biological Sciences, and, since 1982, by the General Assembly of that Union.

The object of the Code is to promote stability and universality in the scientific names of animals and to ensure that the name of each taxon is unique and distinct. All its provisions and recommendations are subservient to these ends and none restricts the freedom of taxonomic thought or action.

Priority is the basic principle of zoological nomenclature. Its application may be moderated, however, under conditions specified in the Code to conserve a long-accepted name in its accustomed meaning. When stability of nomenclature is threatened in an individual case, the strict application of the Code may under specified conditions be suspended by the International Commission on Zoological Nomenclature.

Precision and consistency in the use of terms are essential to a code of nomenclature. The meanings given to terms used in this Code are given in the Glossary which is an integral part of the Code.

The International Commission on Zoological Nomenclature should be cited as the author of this Code.

Notorynchus cepedianus

Examples of How Scientific Names are Constructed and Why…

Scientific names are often followed by the name of the person who originally described the family, genus, or species and the year in which it was first described.

Family	**Hexanchidae**	**Gray, 1851**
Genus	***Notorynchus***	**Ayres, 1855**
Species	***cepedianus***	**(Peron, 1807)**

***Originally described as *Squalus cepedianus*, but later placed into the genus *Notorynchus* by William Ayres (1855). Thus, the proper citation is *Notorynchus cepedianus* (Peron, 1807)**

If the species was subsequently placed into a different genus, the person's name is put in parentheses.

The person's name and date of description allow researchers to trace the taxonomic history of a specific species to determine whether it was previously described or is undescribed.

If two species are found to be the same, the oldest description has precedence over the newer name, which then becomes invalid or is commonly referred to as a junior synonym.

Kinds of taxonomic studies & publications:

New species description – Most common publication. Usually accepted as a standalone paper by itself.

Redescriptions – Involves examination of existing material and information to make a more complete description of a species or group. Usually done when additional material becomes available, i.e. juvenile or adult forms, or if the original description is poor.

Descriptions of higher taxa – These include descriptions of taxonomic problems at the genus level and higher. Not as common among vertebrates as invertebrates.

Synopses – A general overview summarizing the current state of knowledge including morphology, ecology, terminology, and classification of a group of organisms.

Reviews – A review publication is where an author(s) critically examines previous work and material on a group. May include synonymyzing species.

Catalogs – A taxonomic catalogue usually describes the specimens and or species of a group of organisms. May also be used to discuss all the species from a region, research cruise, or expedition. Challenger or Discovery expeditions, FAO catalogue series.

Kinds of taxonomic studies & publications (continued):

Revisions – A restudy of a group to correct or improve its diagnosis, description, or phylogeny. These include literature reviews and new material that may alter, change, or shift species from one group to another. Examples include generic, family, or order revisions of specific groups.

Monographs – This is the most complete systematic treatment of a group of organisms. These publications usually include full descriptions, summarizing all of the known information including taxonomic, biological, ecological, and distributional. Usually worldwide in coverage, but not always, and they are often the compilation of a researchers lifetime of work.

Classifications and phylogenies – These publications usually include a synthesis of published works combined with original material. They may include new higher taxa and relationships between organisms.

Checklists and field guides – Descriptions of local flora and fauna, i.e. your bird and fish guides. Perhaps one of the most useful publications for amateur naturalists and outdoor enthusiasts, especially if written in layman's term.

Atlas - Illustration of all the species in a particular taxonomic group. A distributional atlas usually provides maps of the distribution of a taxa within a certain geographic area.

Miscellaneous – Notes on new records or additions to a fauna.

Reasons for writing species descriptions:

Become famous?

How we can best communicate what species we have?

A species is only recognized as such in the scientific sense if it has been named and described in a scientific publication.

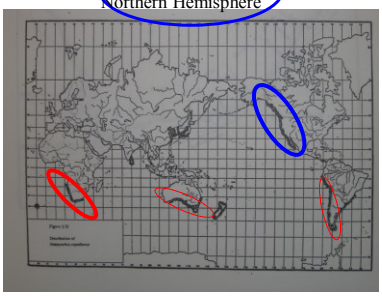
There are a lot of species that still need to be described.

Often times field ecologists and biologists will have to incorporate some systematics into their research papers, at least partially, so that it is clear to the reader what species they are discussing.

South Africa
Southern Hemisphere

?

California
Northern Hemisphere



***Notorynchus maculatus* Ayres, 1855**

Or

***Notorynchus cepedianus* (Peron, 1807)**

***Notorynchus maculatus* Ayres, 1855** **(At the time this was the accepted name for the eastern North Pacific)**

Synonymy:

***Squalus cepedianus* Peron, 1807**
***Squalus platycephalus* Tenore, 1810**
***Notidanus indicus* Agassiz, 1835**
***Heptanchus indicus* Muller & Henle, 1841**
***Notorynchus maculatus* Ayres, 1855**
***Notorynchus borealis* Gill, 1864**
***Heptranchus indicus* McDonald & Barron, 1868**
***Heptranchus griseus* McDonald, 1873**
***Heptranchias maculatus* Jordan & Gilbert, 1873**
***Notidanus indicus* McCoy, 1880**
***Heptranchias pectorosus* Garman, 1884**
***Notidanus ferox* Perez Canto, 1886**
***Heptranchias haswelli* Ogilby, 1897**
***Notidanus medinae* Philippi, 1901**
***Heptranchias indicus* Waite, 1907**
***Notorynchus indicus* Zeitz, 1908**
***Notorynchus platycephalus* Garman, 1913**
***Notorynchus pectorosus* Garman, 1913**
***Heptranchias spilotus* La Hille, 1913**
***Heptranchias indicus* Thompson, 1914**
***Heptranchus maculatus* Daniel, 1916, 1928, 1934**

Synonymy:

***Notorynchus ocellatus* Devincenzi, 1920**
***Notorynchus platycephalus* Fowler, 1925**
***Heptranchias platycephalus* Lahille, 1928**
***Notorynchus griseus* McCulloch, 1929**
***Notorynchus macdonaldi* Whitley, 1931**
***Notorynchus cepedianus* Whitley, 1934**
***Heptranchias cepedianus* Smith, 1965**
***Notorynchus cepedianus* Ebert, 1990**

Why are there so many species names?

Most differences were attributed to differences in tooth and vertebral counts as well as the presence or absence of medial teeth.

Examination of ~1,200 specimens from various parts of the world revealed that these characters were variable and that most were within a fairly narrow range.

Types of Synonymies

1. Chronology by Names: All scientific names by which a species has been designated. Start with the original description.

***Notorynchus cepedianus* (Peron, 1807)**

***Squalus cepedianus* Peron, 1807: 337. *Squalus platycephalus* Tenore, 1810: 241. *Notidanus indicus* Agassiz, 1835: pl. E (fig. 1); 1838: 92. *Heptanchus indicus* Muller & Henle, 1841: 82; Bleeker, 1860: 58. *Notorynchus maculatus* Ayres, 1855: 72-73; Gill, 1862: 495; Jordan and Evermann, 1896: 17. *Notorynchus borealis* Gill, 1864: 150.**

Types of Synonymies (continued):

2. Chronology by Bibliography: Arranged by publication date, followed by the year, name used, and author bibliography.

***Notorynchus cepedianus* (Peron, 1807)**

***Squalus cepedianus* Peron, 1807: 337.**
***Squalus platycephalus* Tenore, 1810: 241.**
***Notidanus indicus* Agassiz, 1835: pl. E (fig. 1); 1838: 92.**
***Heptanchus indicus* Muller & Henle, 1841: 82; Bleeker, 1860: 58.**
***Notorynchus maculatus* Ayres, 1855: 72-73; Gill, 1862: 495; Jordan and Evermann, 1896: 17.**
***Notorynchus borealis* Gill, 1864: 150.**
***Notorynchus indicus* Zeitz, 1908: 289.**
***Notorynchus pectorosus* Garman, 1884: 56; LaHille, 1928: 299; Fowler, 1941: 7. Smith, 1965: 39.**
***Notorynchus platycephalus* Garman, 1913: 18.**
***Heptranchus maculatus* Daniel, 1916: 349; 1928: 4; 1934: 1.**
***Notorynchus cepdianus* Whitley, 1934: 181; Clemens and Wilby, 1946: 51; Compagno, 1984: 22; Ebert, 1984: 1. 1990: 10.**

Synonymy

- **A synonymy of a species serves two main purposes:**
- **It gives the history of the nomenclature of a species. The information it provides is not only necessary for further taxonomic work, but is often the best way to find older literature on a species.**
- **It presents the author's conclusions as to the taxonomic placement of the species and the validity of the names that have been applied to the species in the past.**

FishBase Exercise

FishBase

The following exercise is intended to get you familiar with FishBase. It should be accessible from any connected computer. In earlier days, you had to get it from a CD but now it is available on the internet at http://www.fishbase.org/search.html. Be sure to check out the links and other sections of the FishBase web site. Note that the taxonomic scheme is based on Bill Eschmeyer's Catalog of Fishes at California Academy of Sciences (http://www.calacademy.org/research/ichthyology/).

1. **To familiarize yourself with FishBase pick two freshwater species of fish from your country; one which you feel is well known and the other poorly known the best some endemit.**
2. **Write down who , when described the fish for first time and wtite down all synonyms. Mention also the local name of the fish.**

   A. Well known:_____

   B. Poorly known (Endemit) :_____