UMT MOOC
Massive Open Online Course

MINISTRY OF HIGHER EDUCATION

UMT

UMT MOOC
Massive Open Online Course

BIOLOGICAL CLASSIFICATION OF MARINE ORGANISMS

BIOLOGICAL CLASSIFICATION OF MARINE ORGANISMS

MINISTRY OF HIGHER EDUCATION

UMT

UMT MOOC
Massive Open Online Course

TOPIC 1 :

TAXONOMY & NOMENCLATURE

BIOLOGICAL CLASSIFICATION OF MARINE ORGANISMS

OBJECTIVES

MINISTRY OF HIGHER EDUCATION

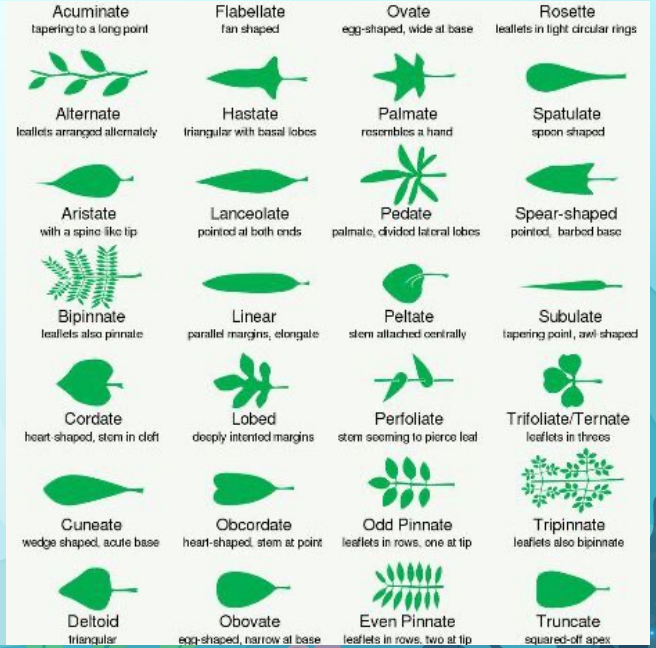
- Key concepts
  - Taxonomy
  - Classification
  - Evolution
  - Systematics
- His-story
- Modern Taxonomy
  - Binomial nomenclature
  - Hierarchical classification

- Why is taxonomy important
- Challenges of taxonomy and classification

KEY CONCEPTS

MINISTRY OF HIGHER EDUCATION

- **Taxonomy**:
  - **Grouping, classifying, identification** and **naming** of organisms
- **Classification**
  - grouping based on **physical** and **genetic** characteristics.
- **Evolution**
  - **change in the heritable characteristics** of biological populations over successive generations.
  - characteristics are the expressions of genes that are passed on **from parent to offspring** during reproduction
- **Systematics**
  - **diversification** of living forms, **both past and present**, and the **relationships** among living things through time.
  - relationships are visualized as evolutionary trees (synonyms: cladograms, phylogenetic trees, phylogenies).



HIS-STORY: Aristotle

MINISTRY OF HIGHER EDUCATION

- **Aristotle** (384-322BC):
  - Greek philosopher
  - Grandfather of Alexander the Great
  - His writings (together with his mentor Plato) cover many subjects – including physics, biology, zoology, metaphysics, logic, ethics, aesthetics, poetry, theatre, music, rhetoric, psychology, linguistics, economics, politics and government.

HIS-STORY: Aristotle

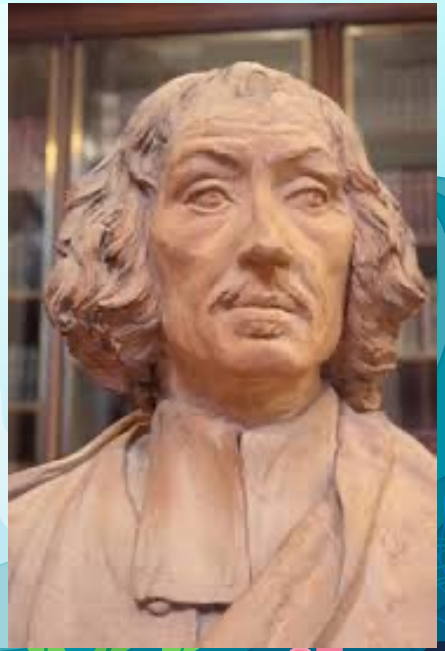
MINISTRY OF HIGHER EDUCATION

- **Aristotle** (384-322BC):
  - first scientist to attempt classifying living things
  - classified **animals** based on **structure and behavior** (e.g. red blood)
  - classified **plants** using **shape and size** (e.g. trees, shrubs, herbs)

HIS-STORY: John Ray

MINISTRY OF HIGHER EDUCATION

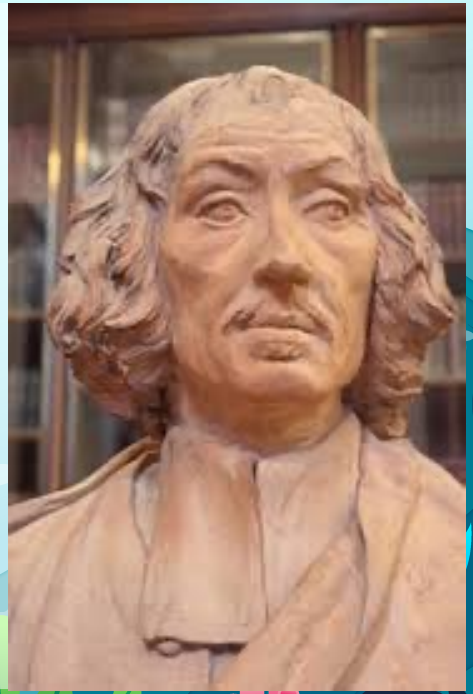
- **John Ray** (384-322BC):
  - English naturalist
  - important works on botany, zoology, and natural theology. His classification of plants in his *Historia Plantarum*, was an important step towards modern taxonomy.



HIS-STORY: John Ray

MINISTRY OF HIGHER EDUCATION

- **John Ray** (384-322BC):
  - first scientist to develop complex classification system
  - rejected the system of dichotomous division by which species were classified according to a pre-conceived, either/or type system, and instead classified plants according to similarities and differences that emerged from observation.
  - was among the first to attempt a biological definition for the concept of *species* (next lecture)



HIS-STORY: Carl Linnaeus

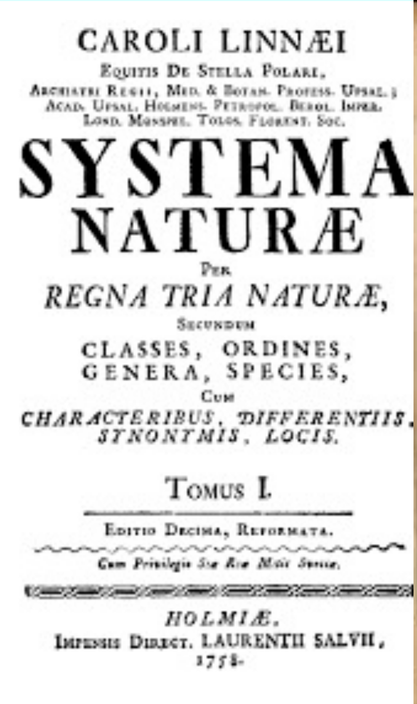
MINISTRY OF HIGHER EDUCATION

- **Father of Modern Taxonomy**
- **1735**:1st edition of *Systema Naturae (System of Nature)*
- **1758:** The tenth edition of Systema Naturae was published and is considered the most important edition.
  - System of Nature through the 3 kingdoms of Nature according to Classes, Orders, Genera and Species, with Characters, Differences, Synonyms, Places.
- **1777**:
  - 12 editions of *Systema Naturae*
  - **named** 4,400 animal **species** and 7,700 plant **species** using his binomial nomenclature system.
- **Important contribution:**
  - Hierarchical classification system
  - Binomial nomenclature

Latin: Carolus Linnaeus

http://tonsoffacts.com/30-awesome-and-interesting-facts-about-carl-linnaeus/

MINISTRY OF HIGHER EDUCATION


CAROLI LINNÆI
Equitis De Stella Polari,
Archiatri Regii, Med. & Botan. Profess. Upsal.; Acad. Upsal. Holmens. Petropol. Berol. Imper. Lond. Monspel. Tolos. Florent. Soc.

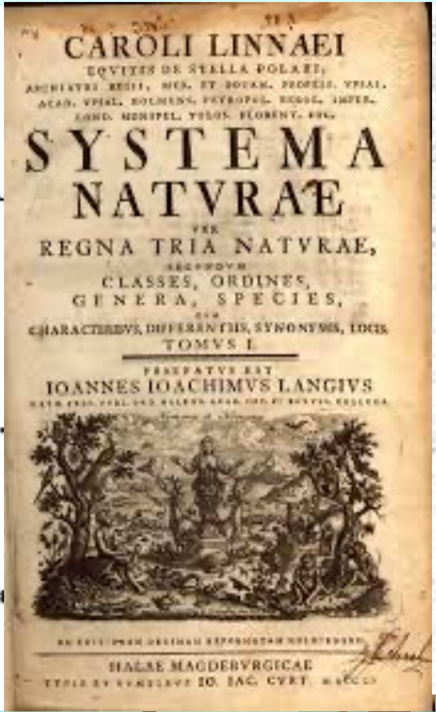
SYSTEMA NATURÆ
Per
REGNA TRIA NATURÆ,
Secundum
CLASSES, ORDINES, GENERA, SPECIES,
Cum
CHARACTERIBUS, DIFFERENTIIS, SYNONYMIS, LOCIS.

Tomus I.

Editio Decima, Reformata.

Cum Privilegio S:æ R:æ M:tis Sveciæ.

HOLMIÆ.
Impensis Direct. LAURENTII SALVII, 1758.


CAROLI LINNAEI
EQVITIS DE STELLA POLARI,
ARCHIATRI REGII, MED. ET BOTAN. PROFESS. VPSAL. ACAD. VPSAL. HOLMENS. PETROPOL. BEROL. IMPER. LOND. MONSPEL. TOLOS. FLORENT. SOC.

SYSTEMA NATVRAE
PER
REGNA TRIA NATVRAE,
SECVNDVM
CLASSES, ORDINES, GENERA, SPECIES,
CVM
CHARACTERIBVS, DIFFERENTIIS, SYNONYMIS, LOCIS.
TOMVS I.

PRAEFATVS EST
IOANNES IOACHIMVS LANGIVS

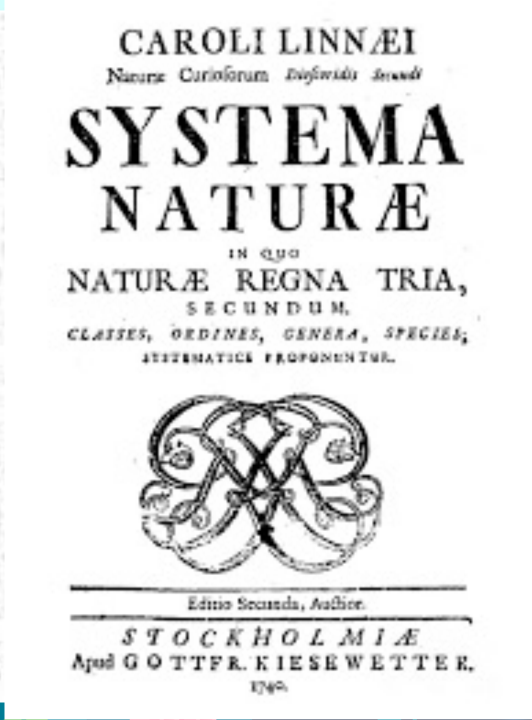
HALAE MAGDEBVRGICAE
TYPIS ET SVMTIBVS IO. IAC. CVRT.


CAROLI LINNÆI
Naturæ Curiosorum Dioscoridis Secundi

SYSTEMA NATURÆ
IN QUO
NATURÆ REGNA TRIA,
SECUNDUM
CLASSES, ORDINES, GENERA, SPECIES,
SYSTEMATICE PROPONUNTUR.

Editio Secunda, Auctior.

STOCKHOLMIÆ
Apud GOTTFR. KIESEWETTER.
1740.


CAROLI LINNÆI
Naturæ Curiosorum Dioscoridis Secundi

SYSTEMA NATURÆ
IN QUO
NATURÆ REGNA TRIA,
SECUNDUM
CLASSES, ORDINES, GENERA, SPECIES,
SYSTEMATICE PROPONUNTUR.

Editio Secunda, Auctior.

STOCKHOLMIÆ
Apud GOTTFR. KIESEWETTER.
1740.

SCIENTIFIC NAMES: THEN

MINISTRY OF HIGHER EDUCATION

- Latin; Non-binomial nomenclature
  - E.g. *dianthusfloribus solitariis, squamis calcycinis, subovatis brevissimis, corollis crematis*

SCIENTIFIC NAMES: NOW

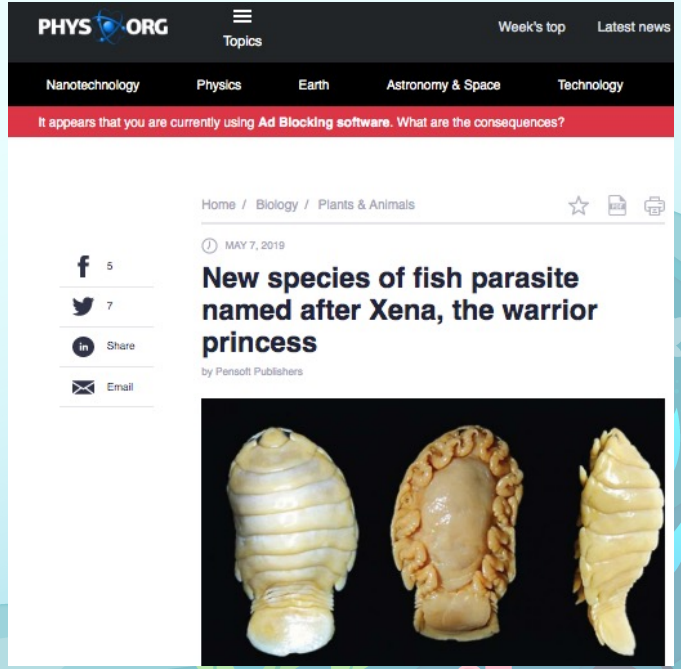
- Binomial nomenclature
  - Uses 2 names to identify an organism
  - First letter of the genus must be **CAPITALISED** and the entire name must be written in ***italics*** **or** **underlined**
    - **Parastromateus niger (Bloch, 1795)** or ***Ceratothoa baraccuda*** **Martin, Bruce & Nowak, 2015**
- Genus (a kind), second name often descriptive

The International Code of Zoological Nomenclature dictates how new animal species are named. The 3 main rules are:

- **The name must be unique.** The combination of genus name and species name cannot have been used for any other animal.
- **The name can't be rude.** The ICZN states that no name should give offence on any grounds. Historically, some scientists waged war on each other this way, but that's no excuse so just play nice.
- **You can't name the species after yourself.** Nobody — and I mean nobody — names a species after themselves. It's tacky

MINISTRY OF HIGHER EDUCATION
UMT
UMT MOOC Massive Open Online Course

Finding Inspiration



SCIENTIFIC NAMES: NOW

- A newly discovered blind and burrowing amphibian is to be officially named *Dermophis donaldtrumpi,* in recognition of the US president's climate change denial.
- The name was chosen by the boss of EnviroBuild, a sustainable building materials company, who paid $25,000 (£19,800) at an auction for the right. The small legless creature was found in Panama and EnviroBuild's Aidan Bell said its ability to bury its head in the ground matched Donald Trump's approach to global warming.
- Trump's distinctive hair has already led to comparisons to a poisonous furry caterpillar and a golden-plumed pheasant, while a yellow-crowned moth was called *Neopalpa donaldtrumpi* in 2017.

SCIENTIFIC NAMES: NOW

MINISTRY OF HIGHER EDUCATION

- Five species of fungus beetle — a beastie that is small and round — were named *Gelae baen* (sounding like "jelly bean"), *Gelae balae* ("jelly belly"), *Gelae donut* ("jelly doughnut"), *Gelae fish* ("jelly fish"), and *Gelae rol* ("jelly roll").

SCIENTIFIC NAMES: NOW

MINISTRY OF HIGHER EDUCATION

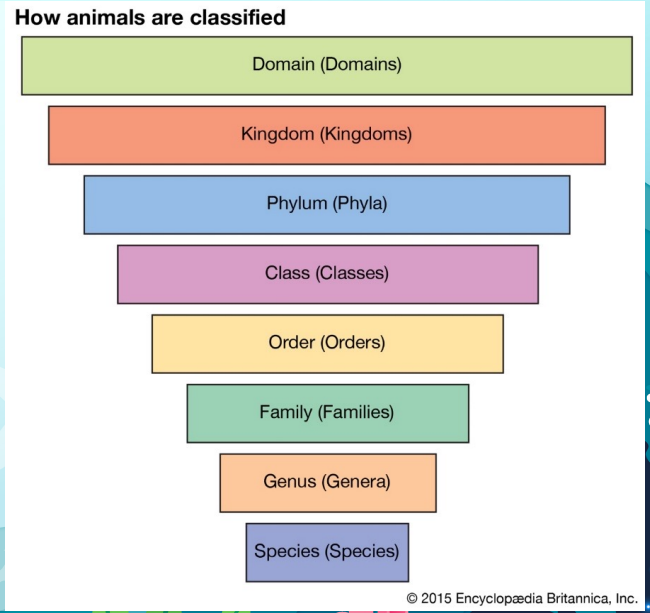
- The spider *Aphonopelma johnnycashi* was named after Johnny Cash because the the 'species can be found near the area of Folsom Prison in California, and like Cash's distinctive style of dress ... mature males of this species are generally black in colour.'

- A giant fossil turtle was named *Ninjemys oweni*, Owen's Ninja Turtle, with the authors explaining that the name was from "ninja, in allusion to that totally rad, fearsome foursome epitomising shelled success" and "emys" from the Latin for turtle.

HIERARCHICAL CLASSIFICATION

MINISTRY OF HIGHER EDUCATION

- Broadest to most specific
- Carl Linnaeus (Kingdom → Species)
- Classification of living things is based on the number of shared characteristics.
- **The higher up this hierarchical** tree of life you look, **the rarer new** discoveries become



HIERARCHICAL CLASSIFICATION

MINISTRY OF HIGHER EDUCATION

UMT

UMT MOOC Massive Open Online Course

<table>
<tr><th>Linnaeus 1735</th><th>Haeckel 1866</th><th>Chatton 1925</th><th>Copeland 1938</th><th>Whittaker 1969</th><th>Woese et al. 1977</th><th>Woese et al. 1990</th><th>Cavalier-Smith 1993</th><th>Cavalier-Smith 1998</th><th>Cavalier-Smith 2015</th></tr>
<tr><td>2 kingdoms</td><td>3 kingdoms</td><td>2 empires</td><td>4 kingdoms</td><td>5 kingdoms</td><td>6 kingdoms</td><td>3 domains</td><td>8 kingdoms</td><td>6 kingdoms</td><td>7 kingdoms</td></tr>
<tr><td rowspan="3">Not treated</td><td rowspan="3">Protista</td><td>Prokaryota</td><td>Monera</td><td>Monera</td><td>Eubacteria</td><td>Bacteria</td><td>Eubacteria</td><td rowspan="2">Bacteria</td><td>Bacteria</td></tr>
<tr><td></td><td></td><td></td><td>Archaebacteria</td><td>Archaebacteria</td><td>Archaebacteria</td><td>Archaea</td></tr>
<tr><td rowspan="4">Eukayote</td><td rowspan="3">Protista</td><td rowspan="3">Protista</td><td rowspan="3">Protista</td><td rowspan="5">Eukarya</td><td>Archezoa</td><td rowspan="2">Protozoa</td><td rowspan="2">Protozoa</td></tr>
<tr><td>Protozoa</td></tr>
<tr><td rowspan="2">Plantae</td><td>Chromista</td><td>Chromista</td><td>Chromista</td></tr>
<tr><td>Plantae</td><td>Plantae</td><td>Plantae</td><td>Plantae</td><td>Plantae</td><td>Plantae</td><td>Plantae</td></tr>
<tr><td>Plantae</td><td>Plantae</td><td>Fungi</td><td>Fungi</td><td>Fungi</td><td>Fungi</td><td>Fungi</td><td>Fungi</td></tr>
<tr><td>Animalia</td><td>Animalia</td><td>Animalia</td><td>Animalia</td><td>Animalia</td><td>Animalia</td><td>Animalia</td><td>Animalia</td><td>Animalia</td></tr>
</table>

BIOLOGICAL CLASSIFICATION OF MARINE ORGANISMS

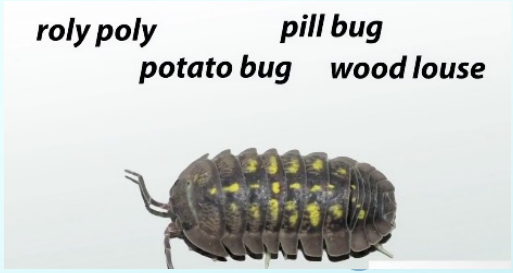
MINISTRY OF HIGHER EDUCATION
UMT
UMT MOOC Massive Open Online Course

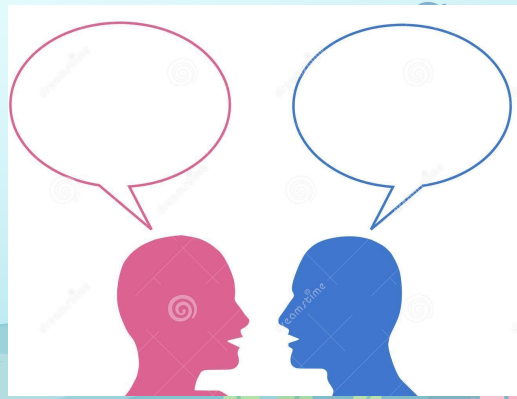
Why is taxonomy & classification important?

- 1. Enables scientists to make sense of the millions of kinds of living things and see how they are related

WHY IS TAXONOMY & CLASSIFICATION IMPORTANT?

- 2. Provides and acceptable scientific name to every specimen
  - Imagine how confusing to keep of different names in different regions or cultures
- 3. Enable scientist to communicate and share information about organisms

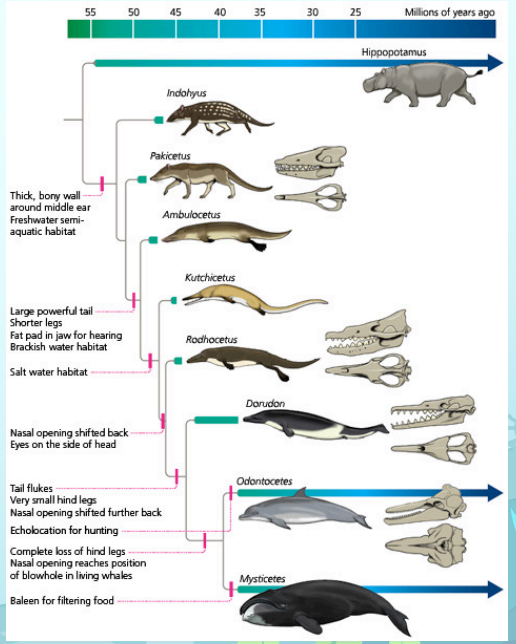




WHY IS TAXONOMY & CLASSIFICATION IMPORTANT?

MINISTRY OF HIGHER EDUCATION

- 4. Aid in identification
- 5. Helps descraibe an individual
- 6. Reveal numerous interesting evolutionary phenomena
- 7. Helps understand patterns of development of life on earth



CLASS ACTIVITY 1:
Similarities And Difference

MINISTRY OF HIGHER EDUCATION

- Have students
  - compare the two drawings and list at least two features that seals and sea lions share.
  - Have students find at least two features that differ in seals and sea lions.
- Discuss how these features relate to swimming in cold water. (Hair, blubber, and flippers all keep animals warm in icy water.)
- https://www.nationalgeographic.org/activity/seals-versus-sea-lions/

- Discuss how
  - these features relate to swimming in cold water.
    - (Hair, blubber, and flippers all keep animals warm in icy water.)
  - how to tell seals and sea lions apart
    - Seals do not have ear openings; sea lions do.
    - Seals have shorter front flippers; sea lions have longer front flippers.
    - Seals' rear flippers extend backward; sea lions' rear flippers extend forward.
    - Sea lions could move most easily on land (sea lions).

- *1749: Carl wrote to Abraham Back*
  - *Am I to work myself to death, am I never to see or taste the world? What do I gain by it? (Lindroth 1983:31)*
- *~300 years after:*

BBC News Sport Reel Worklife Travel Future More Search

NEWS

Home Video World Asia UK Business Tech Science Stories Entertainment & Arts More

Science & Environment

Species count put at 8.7 million

By Richard Black
Environment correspondent, BBC News

23 August 2011 Share

The natural world contains about 8.7 million species, according to a new estimate described by scientists as the most accurate ever.

But the vast majority have not been identified - and cataloguing them all could take more than 1,000 years.

The number comes from studying relationships between the branches and leaves of the "family tree of life".

The team warns **in the journal PLoS Biology** that many species will become extinct before they can be studied.

The vast majority of the 8.7 million are **animals**, with **progressively smaller numbers of fungi, plants, protozoa** (a group of single-celled organisms) **and chromists** (algae and other micro-organisms).

About 1.2 million species have been formally described, the vast majority from the land rather than the oceans.

The figure **excludes bacteria** and some **other types of micro-organism.**

https://www.bbc.com/news/science-environment-14616161

HOW DO YOU THINK ORGANISMS ARE CLASSIFIED INTO SPECIFIC CATEGORIES IN THE LINNAEAN SYSTEM?

MINISTRY OF HIGHER EDUCATION

- The classification of living things is based on the number of **shared characteristics.**
- Those organisms with the greatest number of shared characteristics **are most closely related.**
- Two organisms' relatedness reflects how recently they **diverged from a common ancestor.**
- All living things **are related evolutionarily** if you go back in time far enough.

CLASS ACTIVITY 2:
Grouping Challenge

MINISTRY OF HIGHER EDUCATION

- Group animals based on shared characteristics and by doing this, attempt to determine evolutionary relationships.
- Read the descriptions and consider how you might group these in as few as five or as many as nine groups.
- Mark with colored dots or highlight the shared characteristics you think are important in classification.
  - For example, mark with a color each instance of "**warm-blooded" or "feathers" to help with arranging visually**.
- **DO NOT** apply names to the groupings, such as **mammals or reptiles**; it is best to classify strictly according to their **characteristics** rather than relying on **prior knowledge**

- **Fish**: 2—bluefish, 3—blue shark, 8—lungfish
- **Amphibians**: 5—blue-spotted salamander, 7—mudpuppy, 16—caecilian, 19—green frog
- **Reptiles**: 4—ichthyosaur, 6—blue racer, a snake, 11—pterosaurs, 12—*Tyrannosaurus rex*, 17—leatherback turtle, 18—blue-tailed skink, a lizard
- **Birds**: 9—blue penguin, 10—bluebird, 15—blue duck
- **Mammals**: 1—blue whale, 13—gray bat, 14—duck-billed platypus

EXAMPLES OF CHALLENGES OF CLASSIFICATION

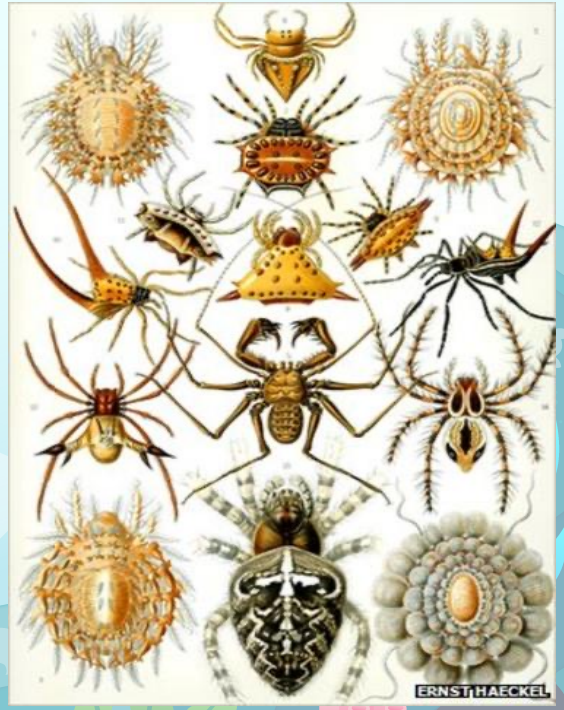
- Scientists can further analyze evolutionary relationships with technology that enables analysis of DNA.
- Fish are now usually separated into **3 separate classes**: Chondrichthyes or cartilaginous fishes (the blue shark), Actinopterygii or ray-finned bony fishes (bluefish), and Dipnoi (lungfishes).
- **Reptiles** traditionally have included **snakes, turtles, lizards, and crocodilians,** as well as **pterosaurs and dinosaurs**. Today**, turtles, crocodilians, and snakes and lizards** are often put into **three separate classes**.
- Prehistoric “reptiles” are more confusing still.
  - ***Tyrannosaurus rex*** may be closer **to birds than reptiles**, considering its skeleton and the strong possibility that it might have been warm-blooded and even had feathers in one stage of its development.
  - Recently, scientists have even been able **to extract proteins from *Tyrannosaurus*** fossils that further support the idea that these gigantic beasts might actually have been **more bird than modern amphibian.**
  - **Birds, in fact, might better be considered as a subgroup of reptiles**. Pterosaurs might have been warm-blooded with a fur-like skin covering unlike any present-day reptile.

OTHER CHALLENGES OF CLASSIFICATION

MINISTRY OF HIGHER EDUCATION

- 14% of the world's species have yet been identified - **and only 9% of those in the oceans.**
- The rest are
  - **primarily going to be smaller organisms**,
  - large proportion of them **will be dwelling in places that are hard to reach or hard to sample, like the deep oceans,**" said Dr Tittensor.

Discuss what are the challenges mentioned above



OTHER CHALLENGES OF CLASSIFICATION

MINISTRY OF HIGHER EDUCATION

- "But when you go to a tropical rainforest, it's easy to find new insects, and **when you go to the deep sea and pull up a trawl, 90% of what you get can be undiscovered species**."

Discuss what are the challenges mentioned above

SUMMARY

- Wrap up!
- http://www.catalogueoflife.org/