# FISH & FISHERIES BIOLOGY (BIOL 458)

BY

F. E. AWORTWI, PhD

# OVERALL AIM OF COURSE

"equip students with **knowledge** & **understanding** about fish & fisheries biology & explore how their growth & production are assessed & also **understand** how unsustainable fisheries exploitation & improper management of aquatic resources affect fisheries & human health & how these problems can be mitigated"

# Intended learning outcomes (ILOs)

- To achieve this aim students are expected to:
  - **know** (**review**) the basic taxonomy & general characteristics of fishes;
  - **know** & understand the functional anatomy of fishes;
  - **know** & **understand** how the growth & dynamics of fish populations can be assessed;

# Intended learning outcomes (ilos)

- **know** how fisheries are being exploited & **understand** some management practices associated with it;

- **know** some fish diseases & **understand** how various kinds of pollutants can affect fish & hence human health; **&**

- **know** & **understand** some basic concepts in aquaculture.

# COURSE REQUIREMENTS

- Students are expected to:
  - Participate fully in class/lectures/seminars.
  - Do out of class assignments & complete them on time.
  - Take impromptu & scheduled quizzes & tests.
  - Write lab, field, & research reports if any.

# REFERENCES


- Castro, P. & M. E. Huber. 1992. **Marine Biology**. Mosby Year Book. 592pp

- Hart, P. J. B, & J. D. Reynolds (ed). 1999. **Handbook of Fish & Fisheries**. Vol. 1& 2. Blackwell Publishing.

- Moyle, P. B. & J. J. Cech Jr. 2004. **Fishes: an introduction to ichthyology**. 5th ed. Pearson/Benjamin Cummings. N.Y. pp726.

# COURSE ASSESSMENT

| Part of Assessment | % of marks |
|---|---|
| Assignments/seminars/lab or field practicals, attendance, etc | 15 |
| Mid-semester | 15 |
| Final examination | 70 |

# COURSE INSTRUCTOR INFORMATION

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- **Contact**:
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  - Email addresses:
    - francisemmanuel.awortwi@knust.edu.gh
- **Available days**:
  - Mondays from 10 am – 12 noon

# COURSE OUTLINE

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# COURSE OUTLINE

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- **UNIT ONE:** **INTRODUCTION TO FISH & FISH TAXONOMY**
- UNIT TWO: **INTRODUCTION TO FUNCTIONAL ANATOMY OF FISHES**
- UNIT THREE: **FISH POPULATION DYNAMICS, EXPLOITATION, & THREATS**

# UNIT ONE
# INTRODUCTION TO FISH & FISH TAXONOMY

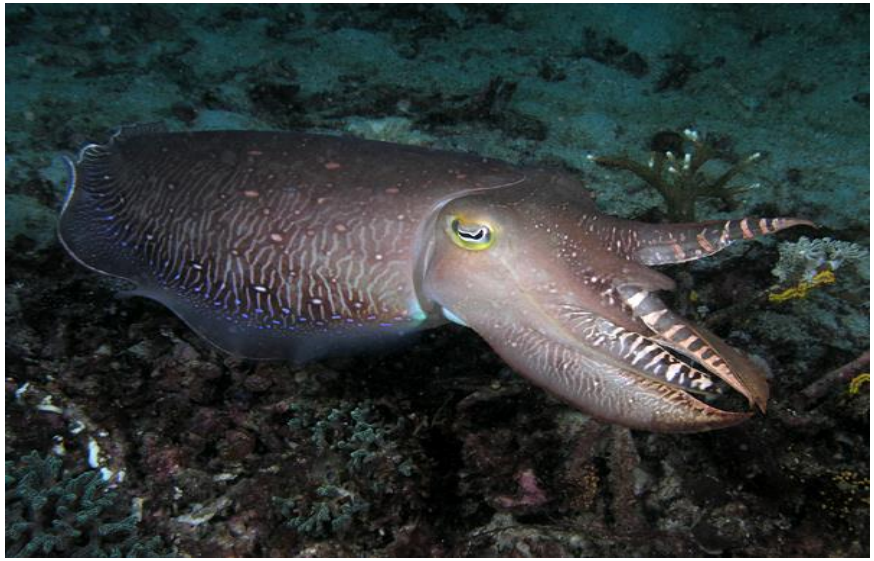
# Unit 1: Fish & Fish Taxonomy: introd.

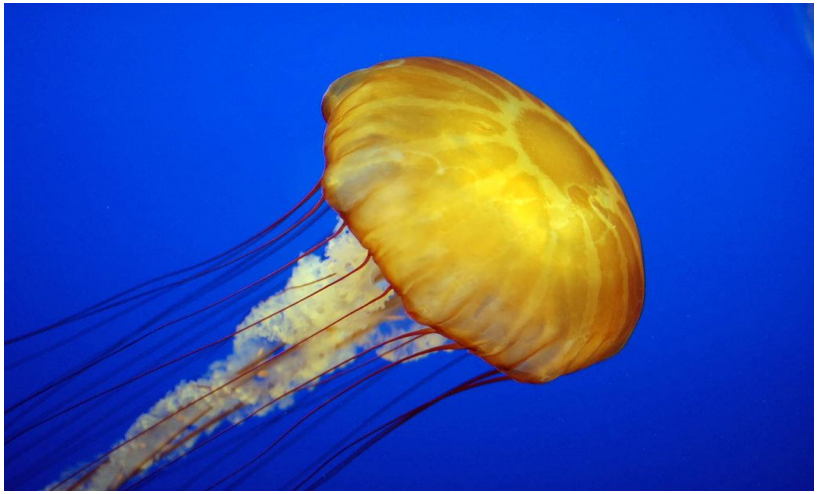
- Definition of fish & fish studies.

- "Fish" but not fish?
  - e.g. Shellfish, Cuttlefish, Starfish, Crayfish, Jellyfish, etc…

- Phylogeny of fishes.
  - Fishes are paraphyletic…

# Unit 1: Fish & Fish Taxonomy: introd.





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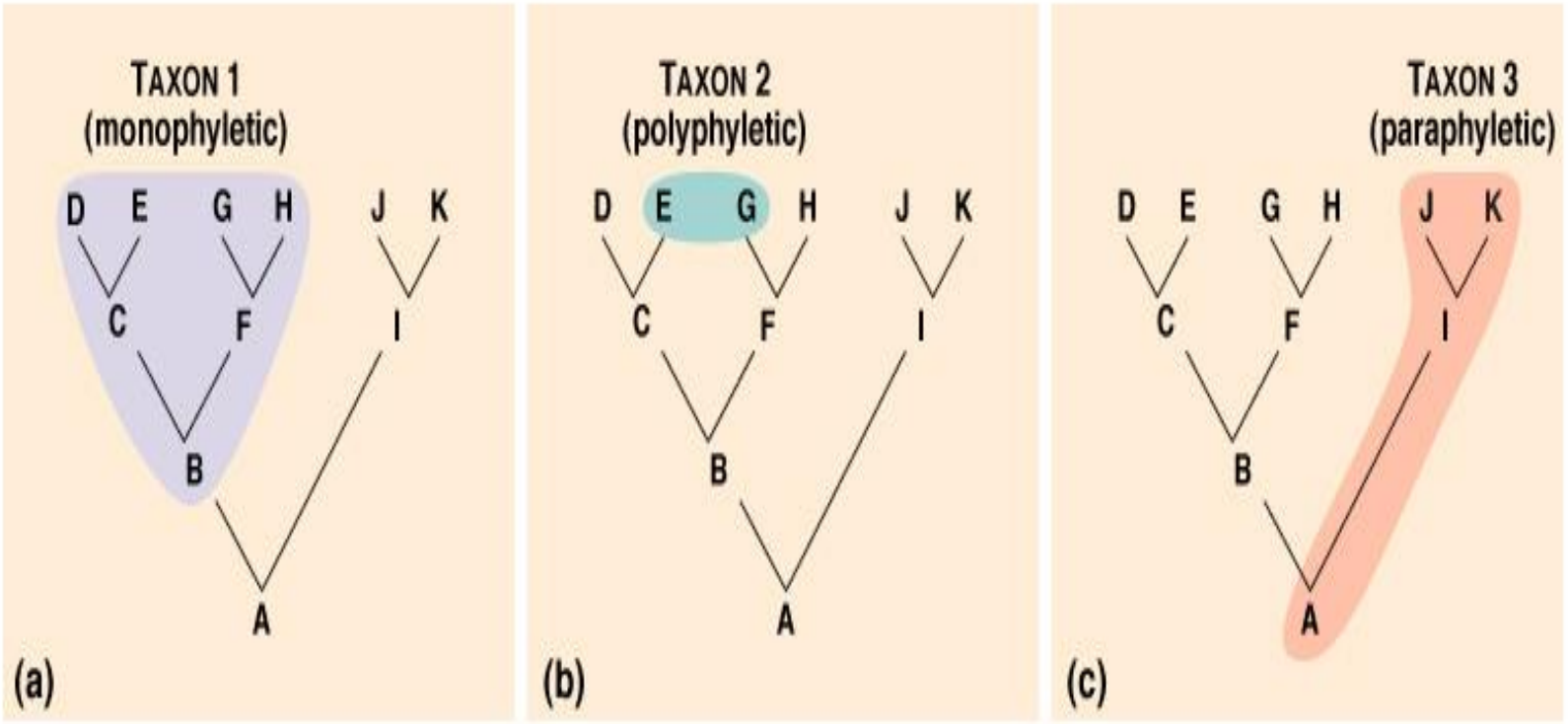
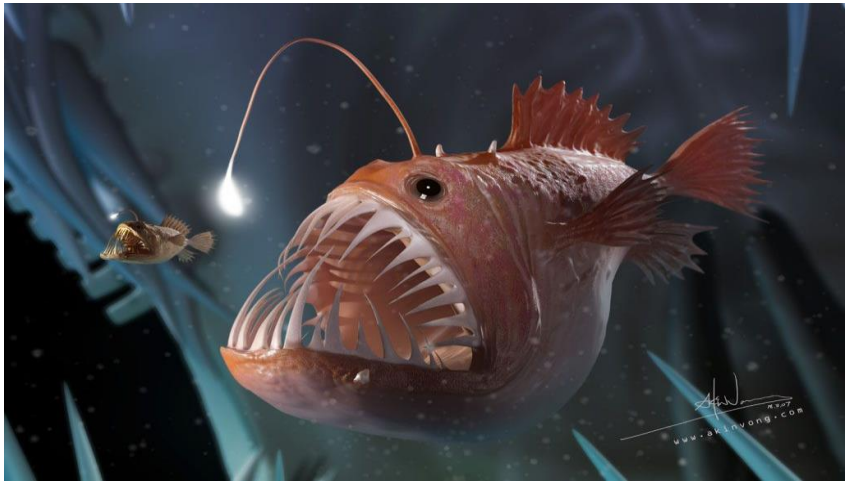


# Unit 1: fish & fish taxonomy: typical traits

| | Typical trait | Exceptions |
|---|---|---|
| 1 | **Ectothermy** | **Endothermy** is some fishes e.g. tunas, swordfish, some sharks. |
| 2 | **Streamlined bodies..** | Several variations e.g. eels, rays, seahorses, pufferfishes, anglerfishes, gulpers, etc are not as streamlined as tunas, etc. |
| 3 | **$O_2$ extraction** using **gills..** | Some have several other adaptations including use of **lungs**, **intestines**, **stomach**, **labyrinth organ** (modified gill), **cutaneous**, etc. |
| 4 | **Fin arrangements** | All fishes have fins but this is highly variable on their bodies; 2 paired (**pectoral** & **pelvic**), a **dorsal**, **anal**, & **caudal**. |
| 5 | **Scales..** | Several types e.g. **placoid** (sharks & rays), **cosmoid** (fossil lungfish & coelocanths), **ganoid** (gars & bichirs), **cycloid** & **ctenoid** (bony fishes).<br>But some are <u>without scales</u> (e.g. moray eels, catfishes, etc). |
| 6 | **Egg laying** or **oviparity** | Several are **ovoviviparous** (*Gambusia*) & some are even **viviparous** (most sharks). |
| 7 | **Jawed** | **Agnathans** are jawless fishes |

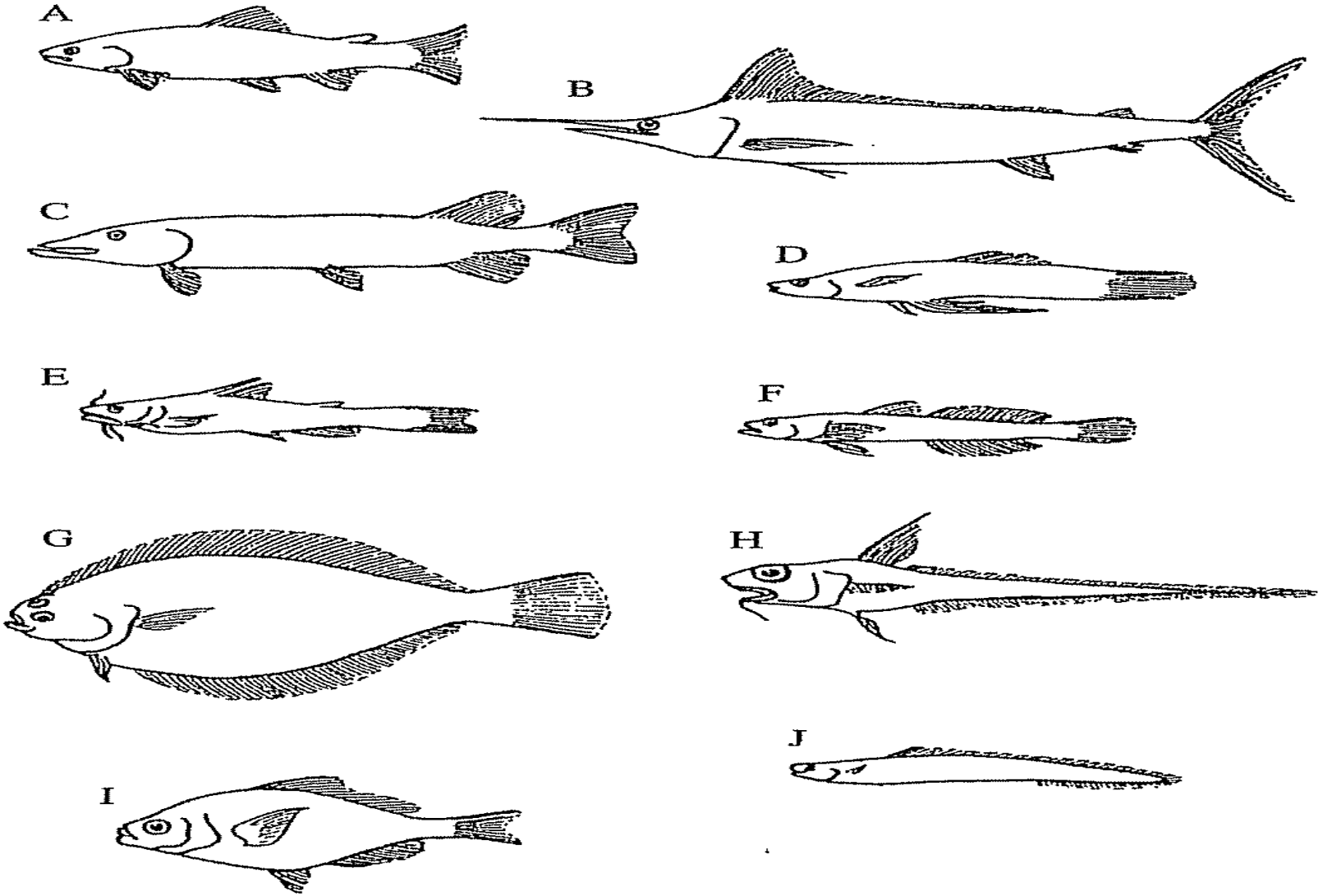
# Unit 1: fish & fish taxonomy: typical traits



# Unit 1: fish & fish taxonomy: typical traits

Lung fish with paired lungs

# Unit 1: fish & fish taxonomy: typical traits



# Unit 1: fish & fish taxonomy: typical traits

Placoid

Ctenoid

Cycloid

Ganoid

| | Habitat | Examples of fishes |
|---|---|---|
| 1 | **Mostly land..** | Mostly land e.g. some mudskippers e.g. *Phraetobius,* & the species *Alticus kirki* are truly **amphibious**. |
| 2 | **Deep ocean fishes..** | *Abyssobrotula galatheae* (8372 m – in the Peurto Rican trench) – the **deepest living fish**. |
| 3 | **Other depths..** | Epipelagic (sharks, tunas); mesopelagic (hatchet & lancet fishes); bathypelagic (anglerfish, gulper eel); abyssopelagic (rat-tails); benthic fishes (tripod fish). |
| 4 | **Very high altitudes..** | The tebetan stoneloach, *Triplophysa stoliczkae,* lives at an altitude of 5200 m in the Himalayas. |
| 5 | **Cave fishes..** | Usually blind e.g the Northern cavefish *(Amblyopsis spelaea)*, *Lucifuga* sp., etc. |
| 6 | **Freshwater fishes.** | Elephant snout fish, paddlefish, catfish, etc. |
| 7 | **Other habitats.** | Intertidal fishes; estuarine fishes; tropical fishes; temperate fishes, lotic fishes, lentic fishes, etc. |

# Unit 1: Fish & Fish Taxonomy: habitats

*Phraetobius*

*Alticus kirki*

Amphibious fishes

# Unit 1: Fish & Fish Taxonomy: habitats

*Triplophysa stoliczkae* – found at the highest altitude

# Unit 1: Fish & Fish Taxonomy: habitats


*Abyssobrotula galatheae* – found at the deepest depth

# Unit 1: Fish & Fish Taxonomy: habitats

*Lucifuga* sp.

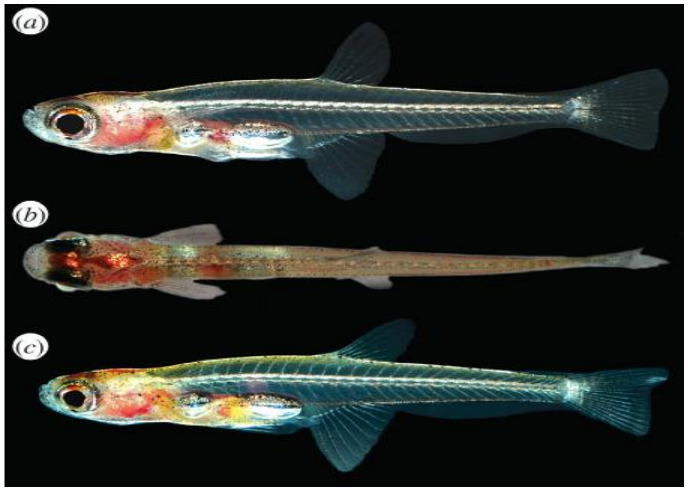
*Amblyopsis spelaea*

Cave fishes – usually blind

# Unit 1: Fish & Fish Taxonomy: sizes

- Fish range in size from the smallest - the Philippine goby, ***Paedocypris progenitica*** (~ 7.9 mm)… & to the largest - the whale shark, ***Rhinodon*** sp. (20+ m)…

# Unit 1: Fish & Fish Taxonomy: sizes





# Unit 1: Fish & Fish Taxonomy: diversity

| | Size (area cover of earth surface - %) | Volume of water (%) | # of fish species found (%) | Reasons for numbers |
|---|---|---|---|---|
| **Ocean** | **70** | **97** | **58** | - Mostly **open** unproductive ocean<br>- Light only available at the surface |
| **Fresh waters** | **1** | **0.00093**<br><br>**NB**: The remainder is locked up in **ice caps** & **glaciers**, atmosphere, etc | **41**<br><br>**NB: 1%** are **diadromous** | - 1000s of distinct water bodies or patches in a "sea" of land which favours **speciation**. |

# Unit 1: Fish & Fish Taxonomy: diversity

- Only 13% of all fish species are associated with the **open ocean**:
  - **1%** in the surface layer (**epipelagic fishes**),
  - **5%** in the unlighted sections of the water column (**deepwater pelagic fishes**), &
  - **7%** on the bottom (**deepwater benthic fishes**).

# Unit 1: Fish & Fish Taxonomy: diversity

- Marine fishes mostly (78%) live in water less than 200 m deep along at margins of land masses & close to human habitats.

- **Temperature** also affects # of fish species with a majority found in warmer areas with little temperature fluctuations in both salt & freshwaters.

# Unit 1: Fish & Fish Taxonomy: diversity

- Thus, the greatest diversity of fishes in found in the **tropics** e.g.
  - the **coral reefs** of Indo-West Pacific region for marine fishes, &
  - the tropical South America, Africa, & Southeast Asia for freshwater species especially in large river basins of tropical rainforests such as the Amazon, Congo, & Mekong basins.

# Unit 1: Fish & Fish Taxonomy: diversity

- Thus, fish have great significance in the life of mankind.

- But, the gradual erosion of commercial fish stocks due to **over-exploitation**, **habitat alteration**, **pollution**, etc is one reason why the science of fish biology came into existence.

# Unit 1: Fish &.. : economic importance

- Source of protein for many people globally;
- they have high feed conversion value requiring just 1.9 units of feed to produce 1 unit fish;
- Fish liver is the main source of liver oil containing vitamin A & D.
- **SMASH** (omega-3 fatty acids)

# Unit 1: Fish &.. : economic importance

- Fish body oils are used in soap & tannery industries;
- Many beautifully coloured fishes are used for aquaria.
- They also provide economic sustenance to many nations.

# Unit 1: Fish &..: Fish systematics

- Definition of **systematics**.

- It comprises taxonomy & phylogenetic analysis.

- Taxonomy is composed of 2 Greek words, **taxis** (arrangement) & **nomos** (law of science) & literally means "science of arrangement."

# Unit 1: Fish &..: Fish systematics

- Classification systems of fishes are frequently changing due to new knowledge & understanding.

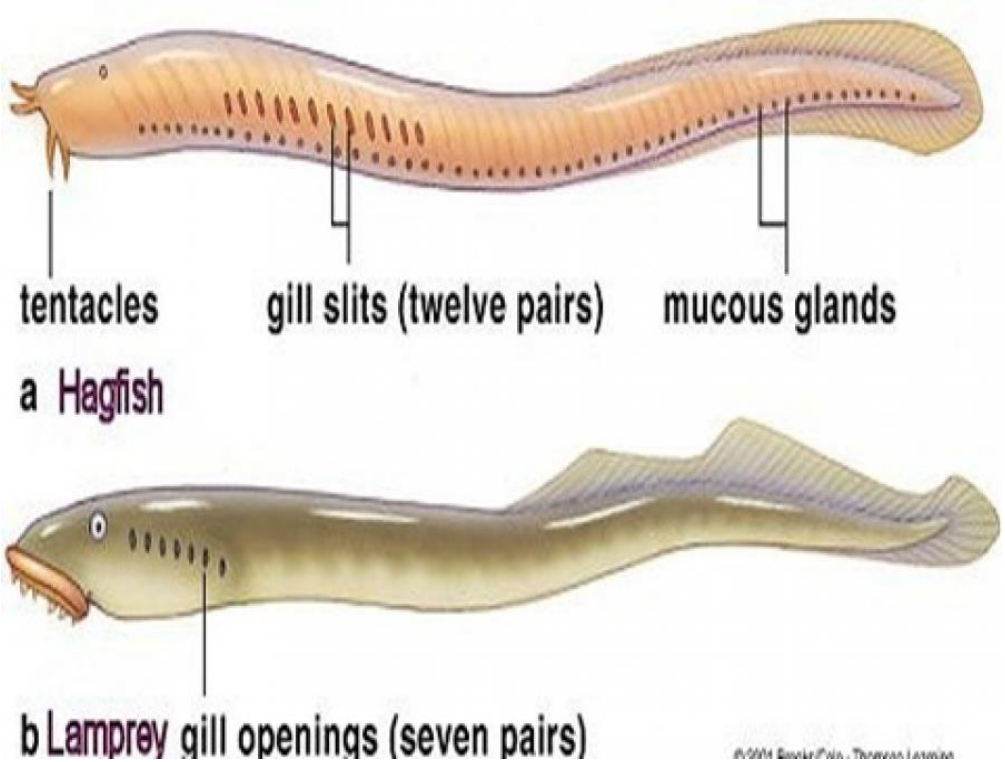
- Traditional fish classification divides them into 2 **superclasses** & several **subclasses** – some with extinct forms:

# Unit 1: Fish &..: Fish systematics

- **Superclass Agnatha** (jawless fishes)
  - **Class Myxini** (hagfishes)…
  - **Class Cephalaspidomorphi** (lampreys)…
  - **Class Ostracodrmi** (armoured jawless fishes, extinct)

- **Superclass Gnathostomata** (Jawed fishes)
  - **Class Placodermi** (armoured fishes - extinct)
  - **Class Acanthodii** (spiny sharks - extinct)
  - **Class Chondrichthyes** (cartilaginous fishes)
  - **Class Osteichthyes** (bony fishes)

# Unit 1: Fish &.: traits major groups of fishes



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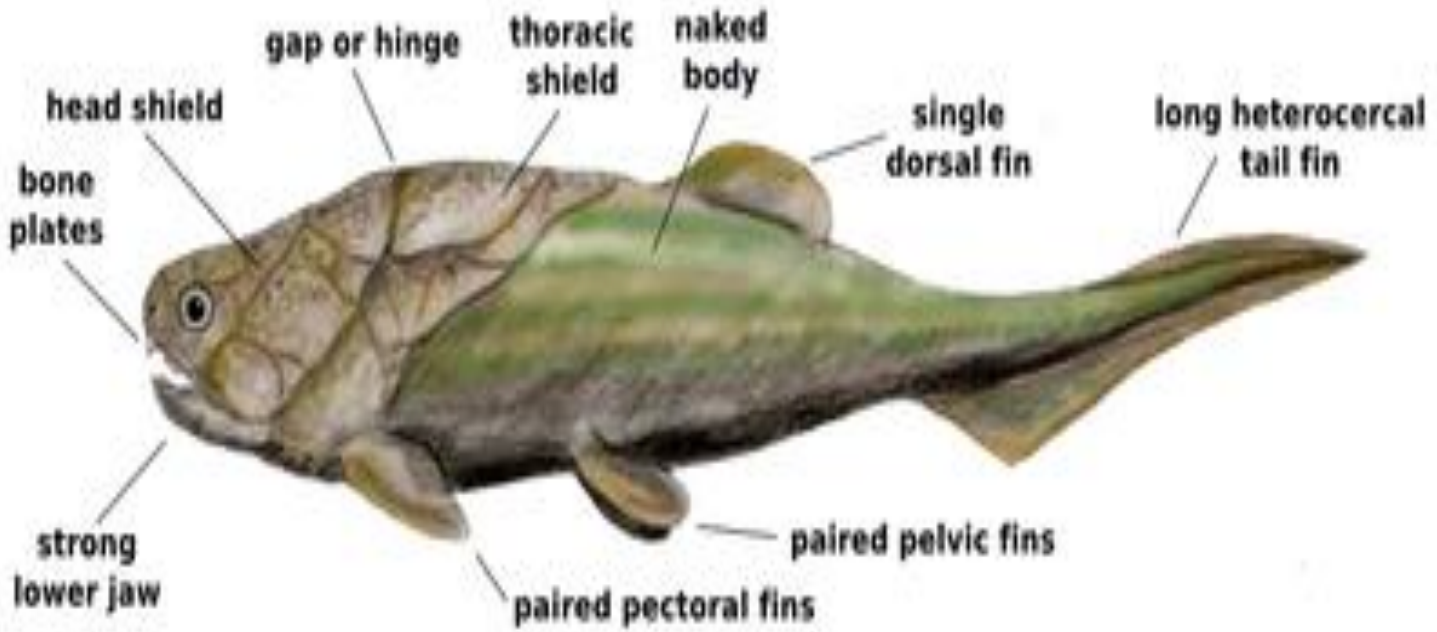

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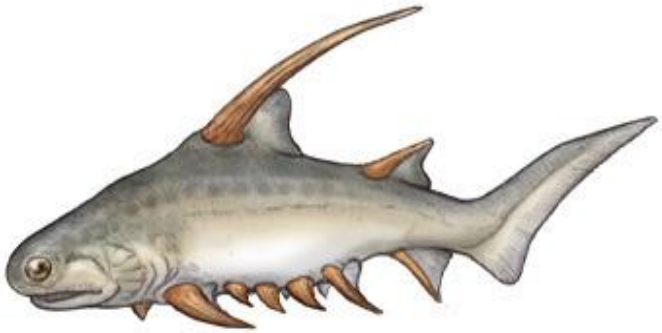
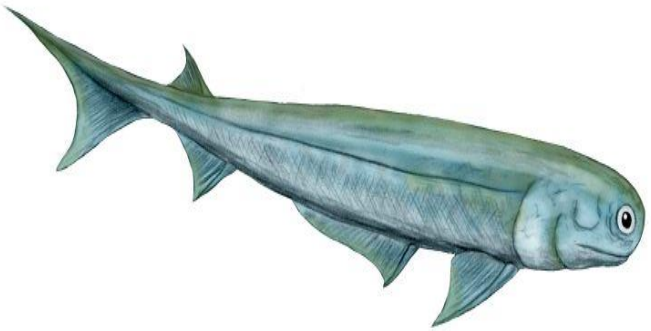




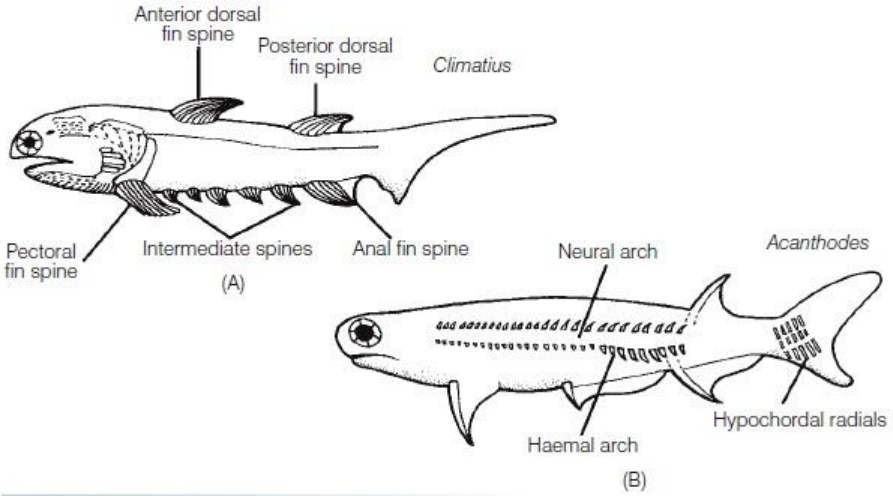



**Figure 11.9**
Acanthodians. (A) *Climatius*, a primitive acanthodian with multiple gill covers and multiple, unembedded spines. (B) The more advanced *Acanthodes*, with fewer, thinner, more deeply embedded spines, a single gill cover, and a more symmetrical caudal fin. After Moy-Thomas and Miles (1971).

# Unit 1: Fish &..: Fish systematics

- This scheme is the most commonly encountered in non-specialist & general works.

- Many of the groups are *paraphyletic* e.g. Agnathans gave rise to Chondrichthyes to the Acanthodiians, who are the ancestors of Osteichthyes.

- With phylogenetic knowledge, the fishes has been split up into a more detailed scheme.

# Unit 1: Fish &..: Fish systematics

- Fishes account for more than ½ of all living vertebrates.

- There are over 28,000 extant species in 515 families & 62 orders, of which
  - over 26,000 - **bony fishes**,
  - about a 1000 – **cartilaginous**, &
  - about 108 are **jawless fishes**

# Unit 1: Fish &..: Fish systematics

- A 3rd of these species fall in the 9 largest families.

- From largest to smallest, these families are Cyprinidae, Gobiidae, Cichlidae, Characidae, Loricariidae, Balitoridae, Serranidae, Labridae, & Scorpaenidae.

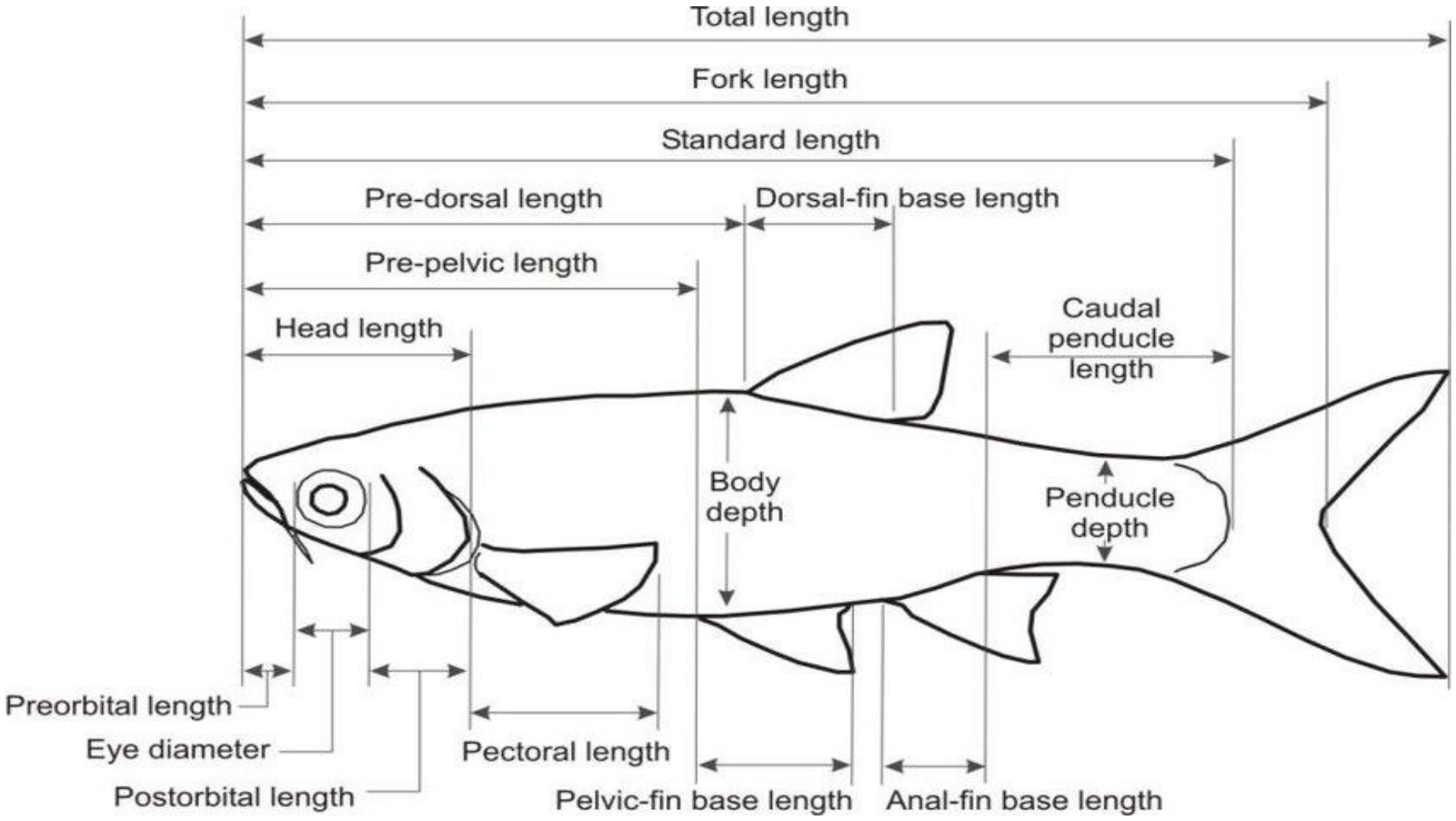
- About 64 families are monotypic, containing only one species.

# Unit 1: Fish &..: Fish systematics

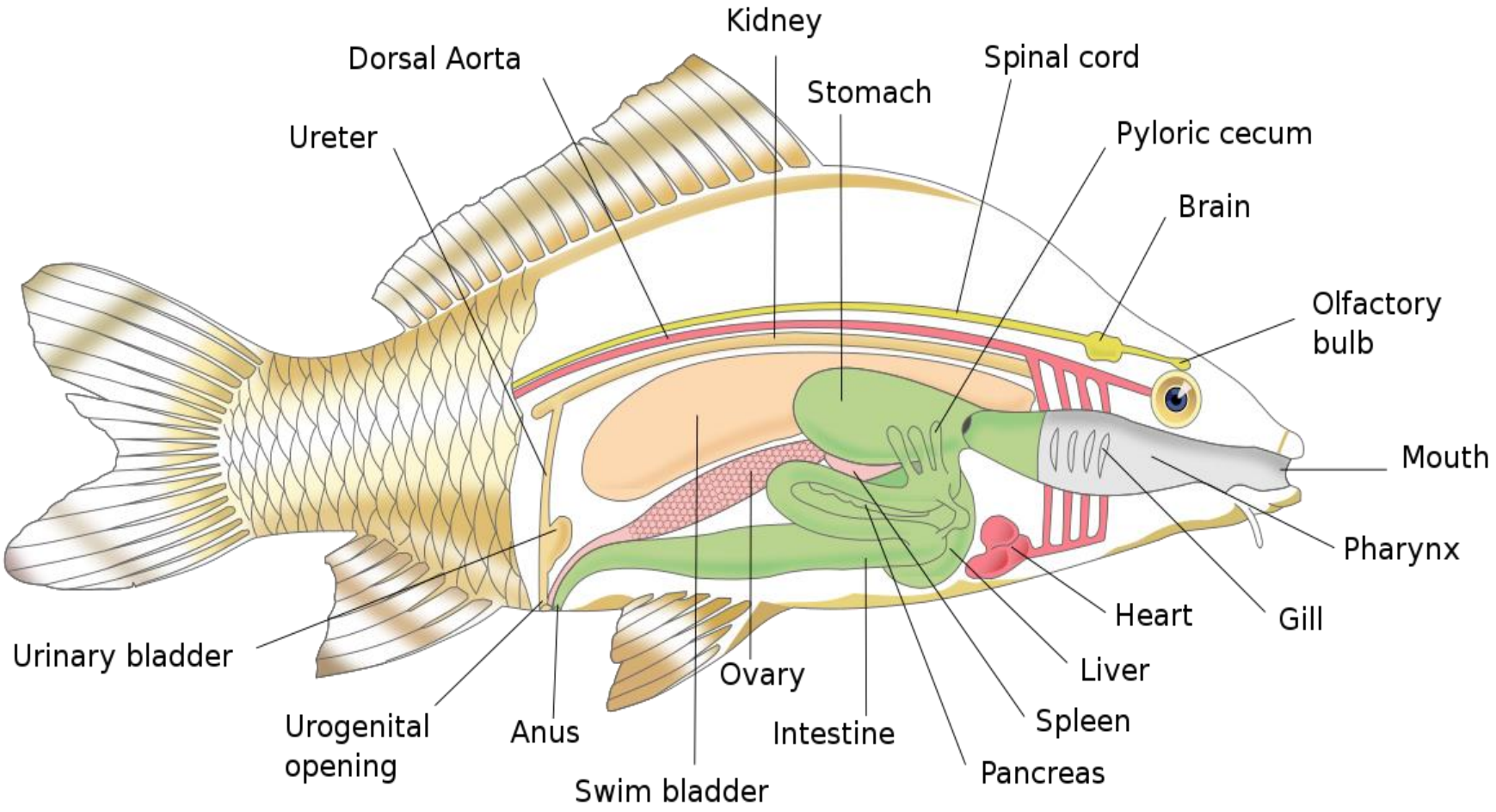
- Taxonomic characters are needed to differentiate taxa & assess their interrelationships.

- To be useful they must show some variation in the taxon under study & can be divided into different categories:
  1. **Meristic..**
  2. Morphometric
  3. Anatomical
  4. Molecular

# Unit 1: Fish &..: Fish systematics



# Unit 1: Fish &..: Fish systematics



# Assignment number one: Reading assignment

**Learn the characteristics of the various classes of fishes.**