External Morphology, Osteology, Jaws, Fish Keys

Welcome to the world of fish anatomy! In this lab you will learn about the hard parts of fish both inside and out. You will likely see these structures at some future date and be responsible for identifying them and knowing a bit about their function and purpose. It is important and helpful if you consider each structure in terms of its function and evolutionary history. For example, notice how homologous bones have changed from the Amia skull to a derived teleost skull. Notice how scales transition from no scales in primitive agnathans to sharks (placoid), to gars (ganoid), and on to more derived taxa (ctenoid, cycloid).

Lab Overview

1. External Morphology (body form, fins, lateral line, mouth position, etc.)
2. Examination of the fish skeleton (skull, axial skeleton)
3. Jaws (autostylic, amphistylic, hyostylic)
4. Types of scales (placoid, ganoid, ctenoid, cycloid) and teeth (shape and location)
4. Introduction to fish keys

Regular superscript numbers below refer to figures in Cailliet et al., bold superscript numbers refer to figures in Helfman et al.

1. External Morphology (Cailliet et al. Ch. 1)

You will need to locate and know the following external features of fishes:

Agnathans (lamprey, hagfish)
gill slits \(^{1.1, 1.2}\)
barbels \(^{1.1}\)
buccal funnel \(^{1.2}\)
pineal eye \(^{1.2}\)

Elasmobranchs (sharks, rays)
spiral \(^{1.4, 1.5}\)
caspers \(^{1.7}\)
rostrum \(^{1.6a, 1.6b}\)
gill slits \(^{1.4, 1.6b}\)

Ampullae of Lorenzini

Teleosts (bony fishes)
lateral line \(^{1.8}\)

All Fish
dorsal fin(s) \(^{1.1, 1.2, 1.4, 1.7, 1.8}\)
pelvic fins \(^{1.4-1.8}\)
pectoral fins \(^{1.4-1.8}\)
anal fin \(^{1.8}\)
caudal fin \(^{1.1, 1.2, 1.4, 1.5, 1.7, 1.8, 1.11}\)
adipose fin \(^{1.12b}\) (only certain taxa)
body form \(^{1.9}\)
nostrils (if present) \(^{1.2, 1.6b, 1.14}\)
mouth position \(^{8.7}\)
2. Skeleton (Cailliet et al. Ch. 3, Helfman et al. Ch. 3)

You will need to locate and know the following bones (look for the starred (***) bones on the *Amia* skull).

**Axial skeleton (skull and vertebral column):**

- **Neurocranium**
  - frontal **3.7**
  - vomer **3.7**
  - parietal **3.7**

- **Vertebræ and ribs**
  - abdominal vertebrae **3.2**
  - caudal vertebrae **3.2**
  - neural spine **3.1, 3.2**
  - hemal spine **3.1, 3.2**
  - pleural **3.1, 3.2**
  - centrum **3.3**

**Opercular series**

- opercle **3.5**
- preopercle **3.5**
- branchiostegal rays **3.6**
- branchial arches **3.6**
- gular plate* (found only on the *Amia* skull)

You will also need to know what the **suspensorium** **3.8** is, but not the individual bones themselves.

**Appendicular skeleton:**

- **Pectoral and Pelvic girdle**
  - cleithrum
  - coracoid
  - scapula
  - post-temporal

- **Caudal Fin**
  - hypurals
  - urostyle
  - epurals

3. Jaws

You will need to know the three jaw suspensions, the associated elements and the order they evolved:

- Autostylic
- Amphistylic
- Hyostylic
Jaw Suspension Insert
The evolution of all jaws, from jawless agnathans to humans, occurred through the same route: the fishes.

Agnathans – the jawless fishes
Pteraspids, Cephalaspids, Anaspids, Mixiniformes (Hagfishes) & Petromyzontiformes (Lampreys).

The agnathans represent the base plan for subsequent body plans and jaw suspensions. Note that the major elements for jaws (palatoquadrate, Meckel’s cartilage, hyomandibular) came from these early gill arches.

Meckel’s cartilage and palatoquadrate make up the mandibular arch (1st gill arch). Behind the mandibular arch lies the hyomandibular arch (2nd gill arch).

Gnathostomes – jawed fishes
It is within the gnathostomes that jaw development occurred as the Meckel’s cartilage, palatoquadrate and hyomandibular became critical jaw elements.

1. Autostylic
Dipnoi (Lungfishes) & Tetrapods; Cladoselache

- hyomandibular elements play no role in bracing the jaws; Meckel’s cartilage fused to chondrocranium.
2. **Amphistylic**  
Only in extinct chondrichthyans: Cetnacanthidae\(^\dagger\)  
Hybodont sharks\(^\dagger\)

- mandibular arch & hyomandibula braced directly against the braincase at two strong articulation points; jaws somewhat protrusible allowing: a) shorter, more powerful jaws b) less-terminal mouth.

3. **Hyostylic**  
Extant Chondrichthyans and Teleosts

- mandibular cartilage is braced against the otic capsule; jaws braced against hyomandibula; jaws fully protrusible allowing: a) increased jaw power b) suction feeding c) inferior mouth.
4. Scales and Teeth

Scales: Look at the demonstration slides in lab as well as Cailliet et al., Figures 1.3 and 1.18. Don't be surprised if, at some point in the future, you are asked to name the types of scales (placoid, ganoid, ctenoid, cycloid) and a representative fish possessing each of the scales. Also be able to identify on a ctenoid scale the focus, ctenii and radii. Know something about the evolutionary progression of these scales (read Helfman et al. pp. 33-35).

Teeth: Teeth are identified by their shape (e.g., canine, molariform) and the bones to which they are attached. Fish have teeth everywhere in their mouths and buccal cavities! Check out page 65 in Cailliet et al. for a list of the bones. Look at the examples of teeth. Think about what the different shapes mean for the capture and consumption of prey.

4. Introduction to Fish Keys

One of the reasons we learn all of these general characteristics of fishes is so we can identify species. Fish identification is typical through the use of a taxonomic key. Taxonomic keys allow us to take a specimen of unknown identity and perform a series of 'tests' for the presence or absence of key identifying characters. Through a process of elimination, the final identity is ascertained. These keys are often referred to as dichotomous because each 'test' is a couplet, typically in the form of:

1a. Dorsal fin rays 10-12 .............................................................. 2
1b. Dorsal fin rays 15-18 .............................................................. 7

If the specimen has 10-12 dorsal fin rays, you proceed to couplet 2, if 15-18 then go to couplet 7.

For today's exercise, read the handout titled Identification of Fishes (taken from The Fishes of Tennessee by David A. Etnier and Wayne C. Starnes) and classify the five fishes at the fish key station. When you're done check your answers with one of the TA's.