Field Methods of Fish Biology 2014

Exercise 1: Basic Anatomy and Finding and Measuring Characters

*Labs modified from Caillet et al. 1986 and Eric Schultz's Biology of Fishes lab

**Materials: Field notebook and pencil**

## INTRODUCTION:

Fish can be divided into two major groups: Agnathostomata or jawless fishes, and Gnathostomata, or jawed fishes. The agnathans are considered ancestral to jawed fishes, and consist of the lampreys (Order Petromyzontiformes) and the hagfish (Order Myxiniformes). The latter group is separated out from the vertebrates, and placed into its own subphylum, Myxini.

The jawed fishes are divided into two extant classes, the Chondrichthyes, or cartilaginous fishes, which consist of sharks, skates, rays and chimeras, and the Osteichthyes, or bony fish, which consists of the vast majority of extinct and extant fish.

**Orientation Terminology:**

**Anterior**: towards the head

**Posterior**: towards the tail

**Ventral**: towards the belly

**Dorsal**: towards the back – towards the dorsal fin

**Assignment Part 1: Examine and sketch the preserved Sea Lamprey and a fresh teleost. Label all three drawings with as many of the features highlighted in bold font below, and include scale bars (described below).**

Osteichthyes – the bony fishes

You will examine a teleost fish. Today we will work with one of three local marine species: Scup (a.k.a porgy; *Stenotomus chrysops*: Family Sparidae), Striped Sea Robin (*Prionotus evolans* Family Triglidae) and Bluefish (*Pomatomus saltatrix*; Family Pomatomidae). Pay special attention to the terms in **bold type**. You are responsible for knowing these terms!

Observe the form and external markings of the animal. *Cailliet Fig. 1.8* provides a good overview of the major structures on the typical teleost. The body of the majority of teleosts is elongated and laterally compressed, or fusiform (*Cailliet Fig 1.9a*). *What is the body form of your fish?* See *Cailliet Fig1.9* for a description of other body forms in teleosts.

Bony fishes occupy many kinds of habitats and consume a wide variety of food, so they have evolved a vast array of mouth and snout forms. The typical mouth shape is usually referred to as **terminal** (as you can see in the hypothetical fish in *Cailliet Fig 1.8 and Fig 1.13e*), located directly at the front of the body. Other shapes include an overhanging or inferior mouth; projecting lower jaws or superior mouths, as in barracudas; tubular snouts with the jaws at the tip, as in many small, picker-type feeding reef fishes; and prolonged upper jaws, as in swordfishes (See below, *Cailliet Fig 1.13*).

The entire body, with the exception of a part of the "chest" and the fins, is covered with **scales**, which overlap one another. Examine them carefully on different parts of the body and note their arrangement and difference in size. Your fish is fresh, meaning it is not preserved in alcohol. Thus, you should be able to note the slimy, transparent epidermis, which covers the scales. Note the **lateral line,** which runs the entire length along each side of the body parallel to the back. It is a special sensory organ.

Observe any color bands and their arrangement. Are they bilaterally symmetrical? Note that the color consists of an aggregation of small dots, except where it forms solid masses. These dots are pigment cells; they are just beneath the epidermis. Note the structure of a single dot; it will be seen to consist of a black central kernel – the body of the cell – surrounded by a halo of fine dots that constitute the outlying projections. *Note the color pattern of your particular fish.*

The body of the fish may be divided into three regions: the **head, trunk** and **tail**, the boundary between the last two regions being the **anus**. There is no neck.

**The Head:** The head of teleostean fishes differs from that of land vertebrates in that it contains the organs of respiration and the heart. The head is dorso-ventrally compressed with the **mouth** at its anterior and the **gills** at its posterior end. The opening of the mouth is bounded ventrally by the paired **mandibles** and dorsally by the paired **premaxillae**, above which on each side is the flattened **maxilla.** The large eyes are without lids. A transparent membrane, the conjunctiva**,** passes over the front of the eye and is continuous with the epidermal layer of the

skin. A deep fold is present around the eye, joining it with the skin of the head, and yet permitting it considerable freedom of motion.

In front of the eyes are two pairs of nostrils; there is, however, but a single pair of nasal capsules, each capsule having two external openings. Note the difference in shape of these two nostrils and the valve that overhangs the anterior one. The nasal capsules do not open posterior to the mouth, and are wholly sensory in function.

At the posterior end of the head is the large **operculum,** or gill cover, and its hinder [posterior] margin, the **gill openings**. Along the posterior and lower border of the operculum is the **branchiostegal membrane,** supported by seven parallel bony rays, the **branchiostegal rays,** which forms a valve guarding the gill opening. Underneath the operculum on each side will be seen the four **gill arches,** which bear the gills, and the clefts between the arches.

Open the left operculum and probe between the gill clefts into the pharynx. Observe carefully the form and position of the gill arches and the double row of **gill filaments** on each; also the gill rakers – the row of spiny projections on the side of each arch which prevent food from passing through the clefts (See *Cailliet Fig 1.16*). In elasmobranchs (sharks, skates and rays) the gill clefts are not covered by an operculum.

**The trunk and caudal region:** These two regions pass gradually into each other; they bear the **appendages.** At the posterior end of the trunk are the **anus** and the **genital** and **urinary pores.** The anus is the largest and most anterior of these three openings; the other two are minute and are situated behind the anus on a small papilla.

**The appendages:** Two kinds of appendages are present – the **paired fins** and the **median fins.** Median fins are unpaired fins located along the median plane of the body (i.e., the dorsal, anal and caudal fins; *see Cailliet Fig 1.8*). The caudal fin can be classified into various types (*Cailliet Fig 1.11*), ranging from naked, without rays on the tip, to forked, indented, and rounded. The shape and structure of the caudal fin is related to its function. Fishes, for example, with narrow **caudal peduncles** (see *Cailliet Fig 1.8*) and forked caudal fins are continuous and fast swimmers, while those with undifferentiated fins are less active. *How would you classify the caudal fin of your fish?* Note carefully which of the dorsal and anal fins have sharp **spiny rays**, and which have simple and branched **soft rays**. You will count them at the end of this lab.

The paired fins are also expansions of the body wall, stiffened by **bony rays**; they are homologous to the appendages of the higher vertebrates. Two pairs are present – an anterior pair, the **pectoral fins,** and a posterior, the **pelvic fins** (see *Cailliet Fig 1.8*)**.** The former are nearly vertical in position and are situated on the side of the trunk just behind the operculum. They are supported by a bony arch known as the **pectoral girdle,** located within the body wall just behind of the gills.

## Sea Lamprey (*Petromyzon marinus*)

Examine the preserved sea lamprey and see *Cailliet Fig 1.2*. This is a jawless fish, believed to be ancestral to both the shark and the teleost. What similarities do you see between the lamprey and your teloest?

## Illustrations

All illustrations must also include scale. This may be presented as a ratio, as magnification, or by the use of a scale bar, depending on the size of the structure being drawn. A **scale bar** is a good way of scaling the fish drawings. To determine the size and scale, do the following: Measure the length of your drawing. Measure the length of your fish. Divide the length of the drawing by the length of the fish. Use this ratio to determine the size of the scale bar.

Example:

If the drawing length is 28.2 cm, and the actual fish length is 37.5 cm, then the ratio of drawing/specimen length is: 28.2/37.5 = 0.752.

Say we want our scale bar to indicate 5.0 cm. Then we should make the bar 5.0 cm * 0.752 = 3.76 cm long, and label it 5.0 cm.

## Finding and Measuring Characters: Morphometrics vs Meristics

Most taxonomy and identification is based on morphological characters. For each character, there is a character state. For example, dorsal fin spines are a **character**. The number of dorsal fin spines typical of a species is a **character state**.

Usually, identification is based on a combination of **morphometric** and **meristic** characters. Quantification of morphometric character states involves **continuous** data (e.g. snout length, eye diameter). For ease of analysis and comparison, morphometric measures are frequently **standardized to some measure of overall length** (e.g. standard length, fork length, or total length; See *Zale* Fig. 5.1). Meristic character states are **discrete** data. An example might be the number of spines in the first dorsal fin, or the number of rakers on each gill arch. As meristic measures are discrete data, no mathematical manipulation is required to facilitate analysis and comparison

**Assignment Part 2: Using the data sheet provided and *Cailliet Fig 6.2*, perform the indicated meristic counts and morphometric measures on your fish. Express morphometric measurements as a percentage of standard length (mm) See Zale Fig 5.1. When you have completed the counts and measurements, bring your data to the front of the room and enter them into the spreadsheet provided.**

**ASSIGNMENT: finish drawings, counts and measurements due with field notebooks on June 19th**

Literature Cited & Source for Attached Figures

Cailliet,G, M.S. Love and A.W. Ebeling. 1986. *Fishes: a field and laboratory manual on their structure, identification and natural history*. Wadsworth Publishing Company, Belmont, California.

Zale, A. V., D. L. Parrish & T. M. Sutton. 2012. *Fisheries Techniques*. Bethesda, Maryland: American Fisheries Society.

**Data sheet for recording morphometric and meristic characters**

Species_____

MERISTIC COUNTS

1. Dorsal-fin spines_____
2. Dorsal soft rays _____
3. Anal spines _____
4. Total pectoral rays _____

MORPHOMETRIC MEASUREMENTS

Standard length [1] _____
5. Body depth [2] _____
6. Pre-dorsal fin length [3] _____
7. Length of dorsal fin base [4] _____
8. Length of anal fin base [4] _____
9. Height of dorsal fin [5] _____
10. Height of anal fin [5] _____
11. Length of pectoral fin [5] _____
12. Length of pelvic fin [5] _____
13. Head length _____
14. Head width _____
15 Gape width _____

SCORED ATTRIBUTES

13. Position of mouth (inferior, terminal, superior) _____
14. Snout profile (convex, straight, concave) _____
15. Upper-jaw teeth shape (simple pointed, simple blunt, multicuspid)_____

[1] Distance from tip of snout to posterior of caudal peduncle (base of tail fin)
[2] Depth of body (dorsal–ventral) at the point of the anterior insertion of the first dorsal fin
[3] Distance from the tip of the snout to a point perpendicular to the anterior insertion of the first dorsal fin
[4] Distance from the anterior insertion of the fin to the posterior insertion of the fin
[5] Largest distance from the body to the tip of the fin

Figures from Cailliet et al. 1986

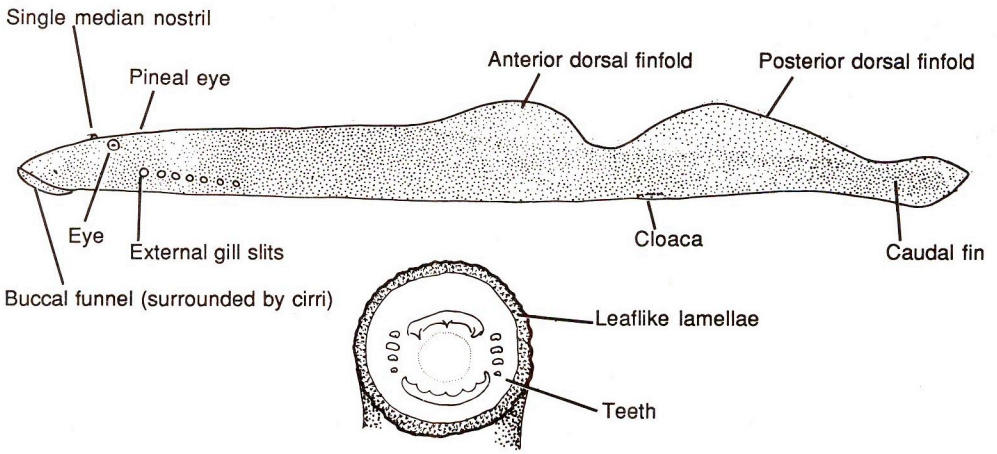


**Figure 1.2** The external anatomy of the Pacific lamprey (*Lampetra tridentata*) with details of the suctorial mouth. (Miller and Lea 1972)

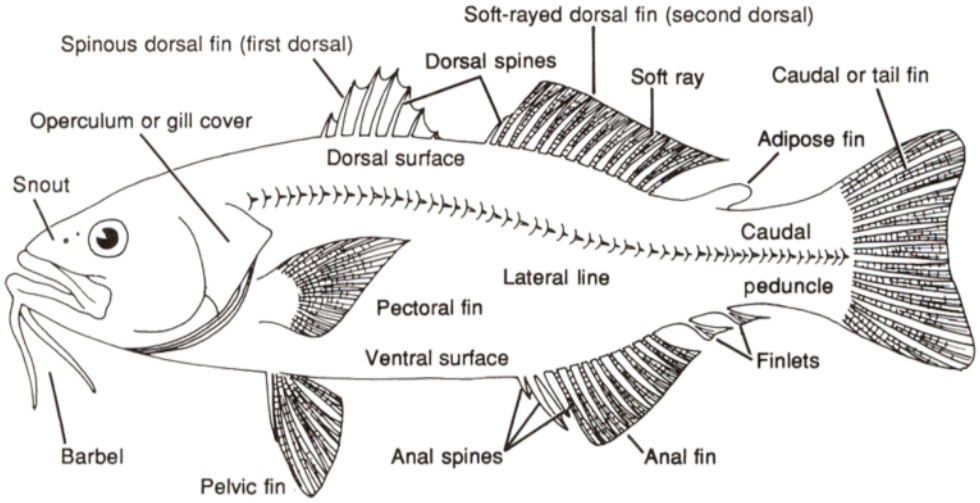


**Figure 1.8** Hypothetical bony fish, a composite to show most of the common external features. (Drawn by Susan E. Smith, from Squire and Smith 1977)

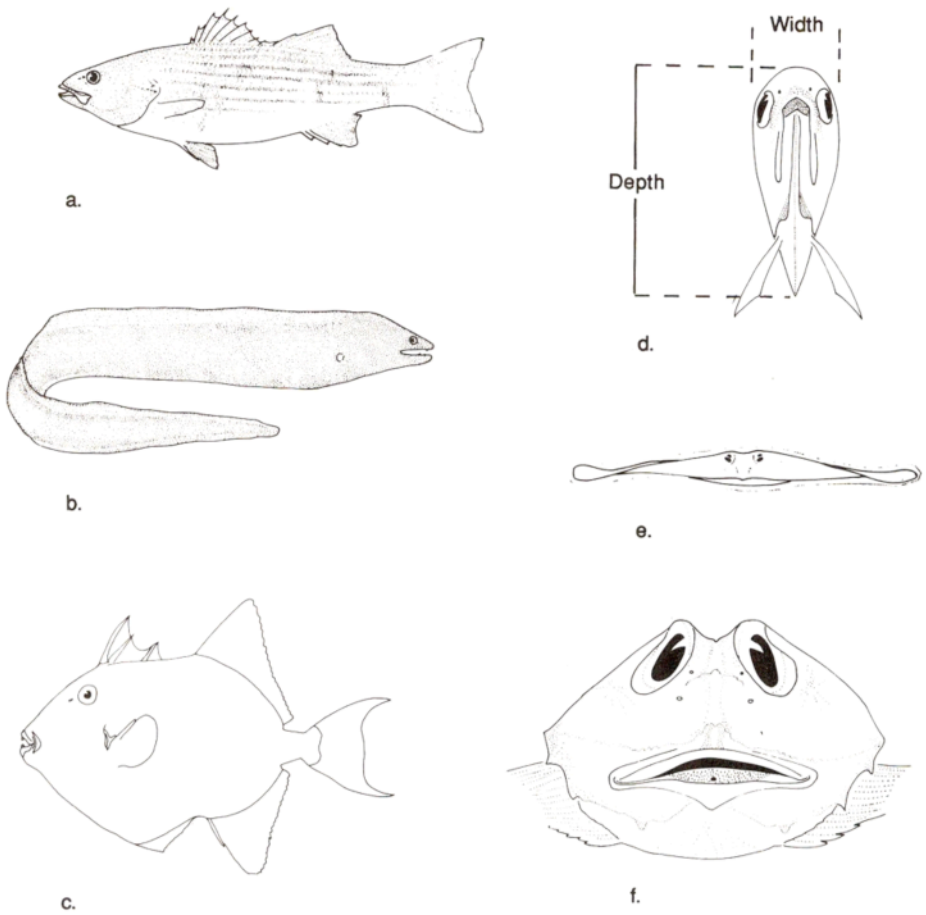


**Figure 1.9** Classification of body forms in fishes: (a) elongate, fusiform, or basslike; (b) anguilliform, eellike, greatly elongated, or attenuated; (c) ovate or truncated; (d) compressed, compressiform, thin, narrow, deep, or perchlike; (e) depressed, depressiform, or flattened; and (f) globiform, subcircular, or hemispherical. (Miller and Lea 1972)

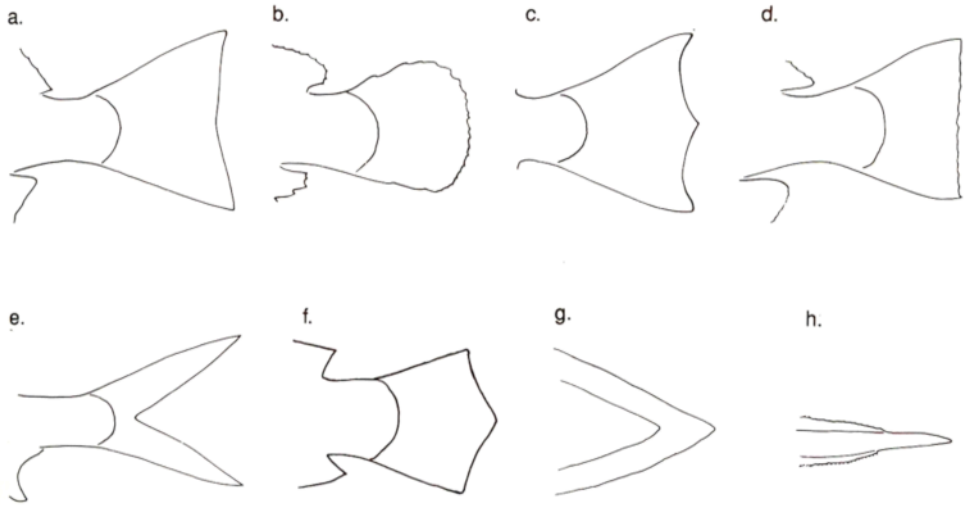


**Figure 1.11** The various shapes of the caudal fins of bony fishes: (a) indented; (b) rounded; (c) double truncate; (d) square, truncate, or straight; (e) forked; (f) pointed with fin present; (g) pointed with fin not differentiated; and (h) naked, without rays on tip. (Miller and Lea 1972)

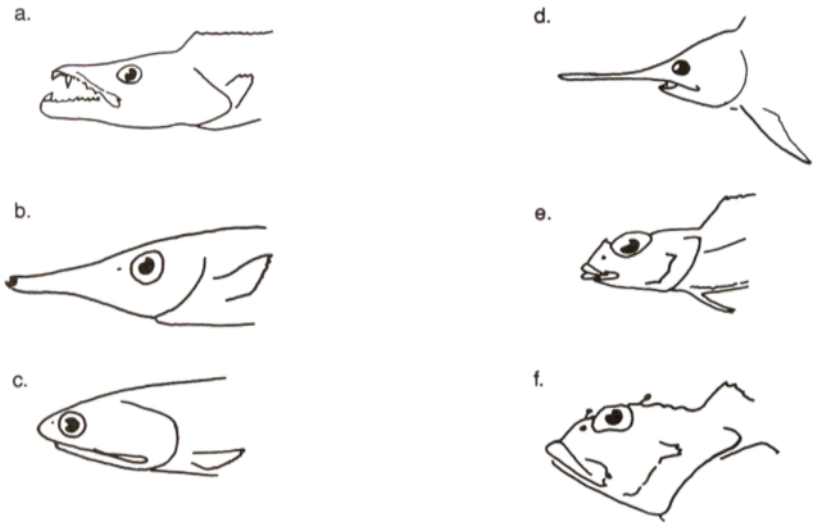


**Figure 1.13** Terminology of the various mouth and snout forms: (a) the lower jaw projecting beyond the upper jaw, as in the Sphyraenidae; (b) a tubular snout with jaws at the tip, as found in the Macrorhamphosidae; (c) a snout that is overhanging or projecting beyond the mouth, so the mouth is termed inferior, as in the Engraulidae; (d) a prolonged upper jaw that forms a swordlike beak, as found in the Istiophoridae; (e) jaws (and lips) that are terminal (i.e., at the end of the body), as in the Cottidae; and (f) an extended upper jaw with the lower lip inferior or included, as found in the Blenniidae. (Miller and Lea 1972)

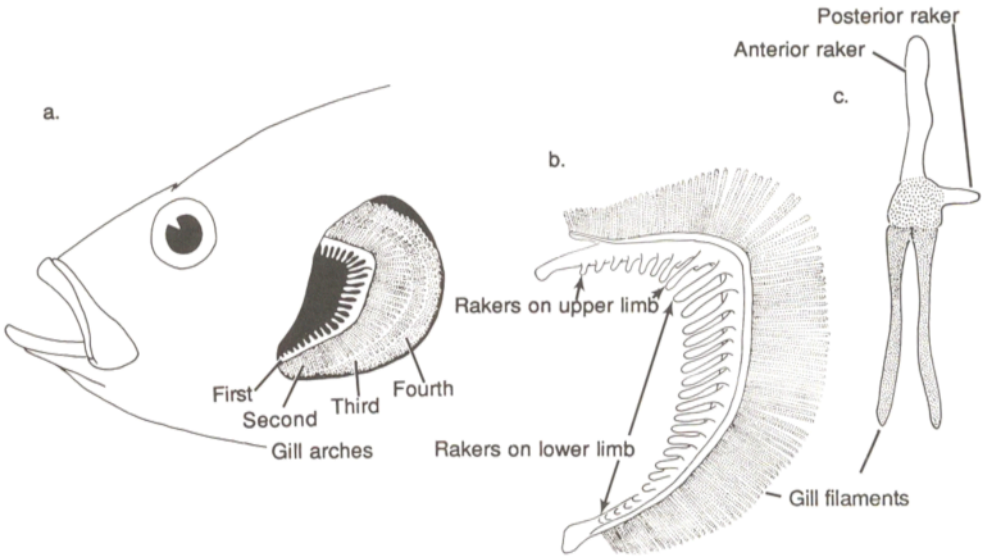


**Figure 1.16** The arrangement and structure of gill rakers and gill arches of a bony fish: (a) the position of gill arches inside the gill cavity of a bony fish with the gill cover or operculum removed; (b) a side view of the first gill arch (a raker in the angle between the upper and lower limbs is counted with the lower rakers); (c) a top view of a cross section of the first gill arch. (Miller and Lea 1972)

Zale Fig. 5.1

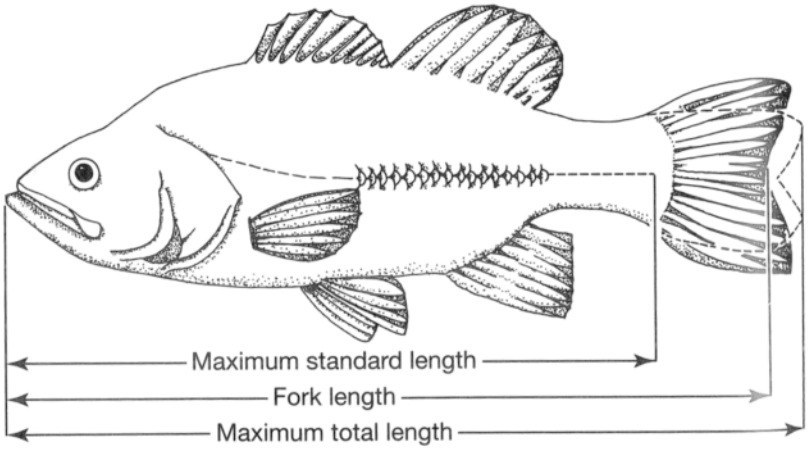


**Figure 5.1** Common measurements of fish length.