Larus fuscus and *Larus argentatus*: Pellet and Bolus Analysis Guide

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Table of Contents

Key: * indicates rare, ^ indicates items found most often in boluses or stomachs.
LA indicates item is part of the *Larus Argentatus* (Herring Gull, Zilvermeeuw) diet.
LF indicates item is part of the *Larus Fuscus* (Lesser Black-backed Gull, Kleine Mantelmeeuw) diet.
Underlined words are in Dutch (NL). Dutch and scientific names are found only in the table of contents.

b. Greater Pipefish, Grote Zeenaald, *Sygnathus acus* (LA and LF)

5. Garfish, Geep, *Belone belone* (LF)

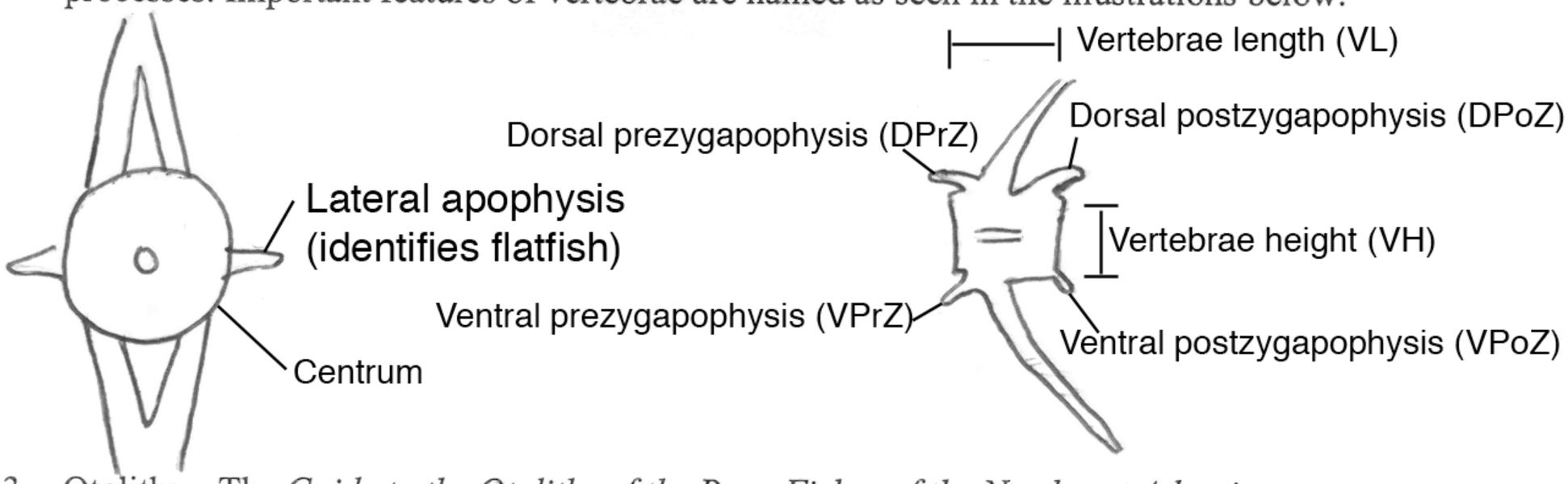
Freshwater Fish

1. Perch, Baars, *Perca fluviatilis* (LA)
2. Roach, Blankvoorn, *Rutilus rutilus* (LA)

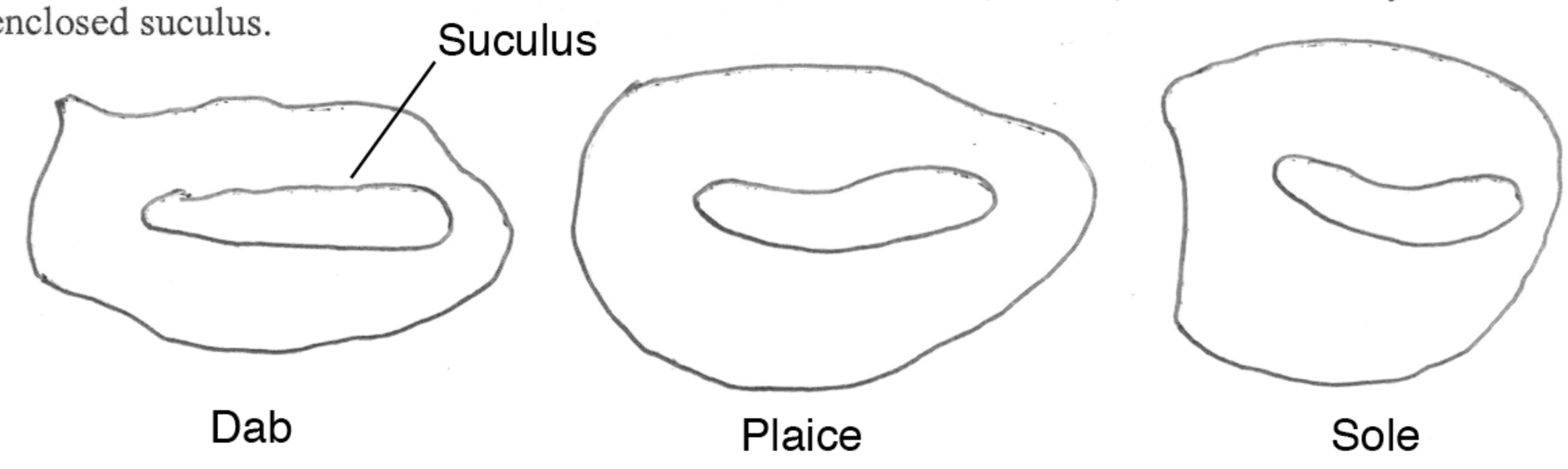
Notes on Using this Guide

1. Jaws – In a given fish, there are many jaw bones and bones that appear to have teeth or teeth sockets. Of these, the premaxillae are the most useful bones for identification purposes. In flatfish, (fam. Soleidae and Pleuronectidae) the right and left premaxillae are structurally different. The left premaxillae are larger, and more often found in samples, but intact right premaxillae are also useful. It is important to note that there are other bones, such as the dentary (lower jaws), that have teeth, and look very different from the premaxillae. These are not regularly used to identify fish because they are similar between many species. If a bone with teeth or teeth sockets is found in a sample, and does not seem to match other bones in the sample, it is worthwhile to search an entire sample skeleton and see if that bone is present somewhere else in the fish's jaw. It is also important to take into consideration that there is sometimes unexpected doubling in rows of teeth. Dab is one species in which this possible doubling has been observed. When in doubt about a toothed bone, it is best to make an educated guess, and then consult the *ICES Guide to the Identification of North Sea Fish Using Premaxillae and Vertebrae* and read the text, or search through an entire sample skeleton.

2. Flatfish Vertebrae – The vertebrae of flatfish can be identified by the presence of lateral processes. Important features of vertebrae are named as seen in the illustrations below.

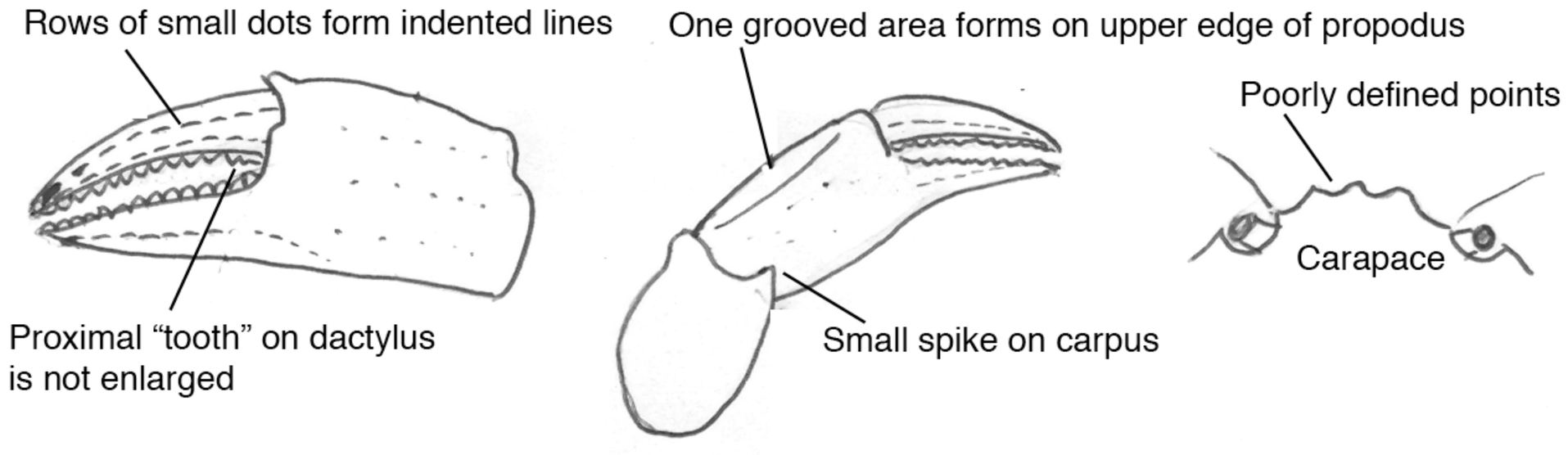


3. Otoliths – The *Guide to the Otoliths of the Bony Fishes of the Northeast Atlantic* seems to show the otoliths of adult fish only. Smaller otoliths, presumably from juvenile fish of the same species, often have wavy and uneven edges not illustrated in the guide. However, once this is taken into account, the book is useful, especially in showing where the suculus (interior channel) is in the otolith, and in showing side views. There is a lot of variation within a given species in the patterns on the edges of otoliths, especially in flatfish. Interior features, such as the positioning of the suculus, seem to be reliable and useful for identification. Flatfish otoliths tend to be rounded (circular), with an entirely enclosed suculus.

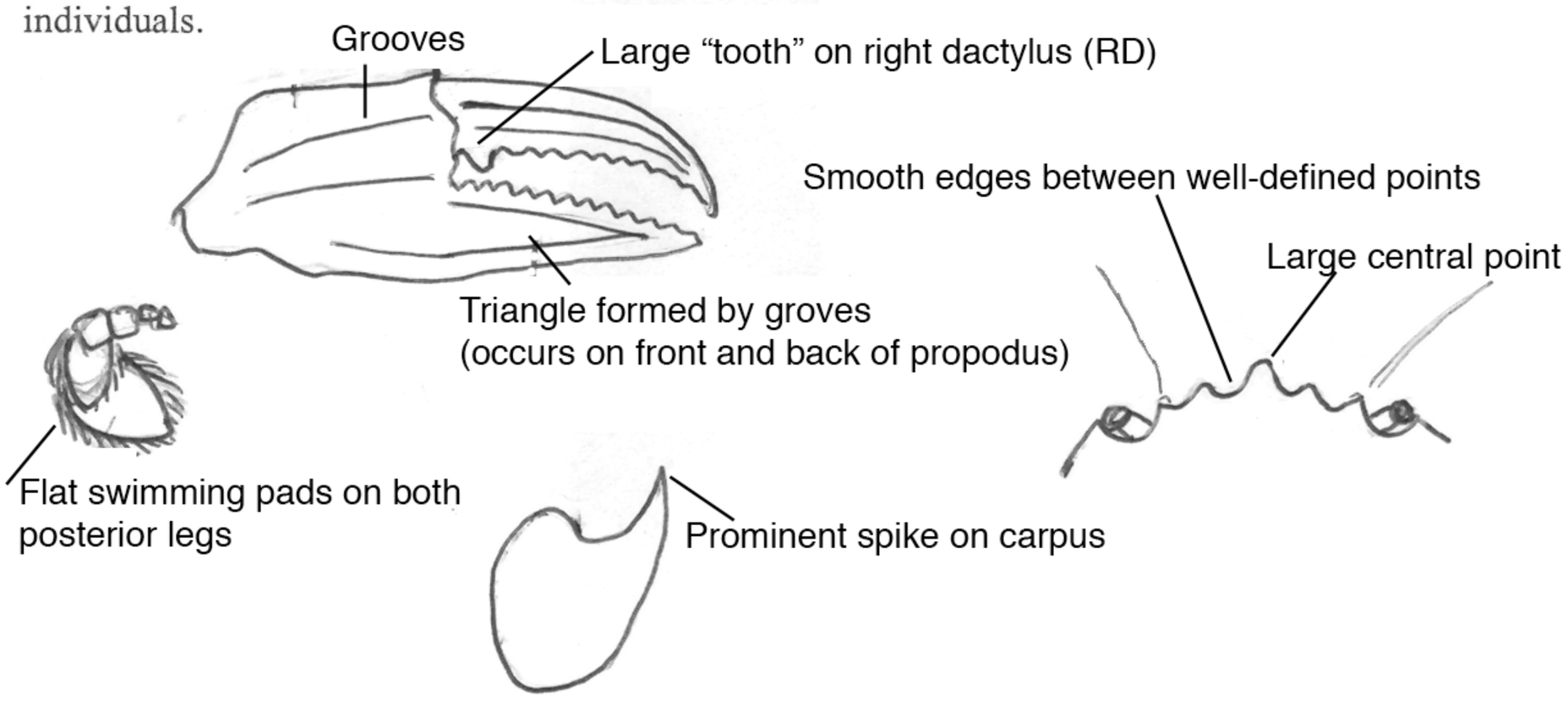


Crabs

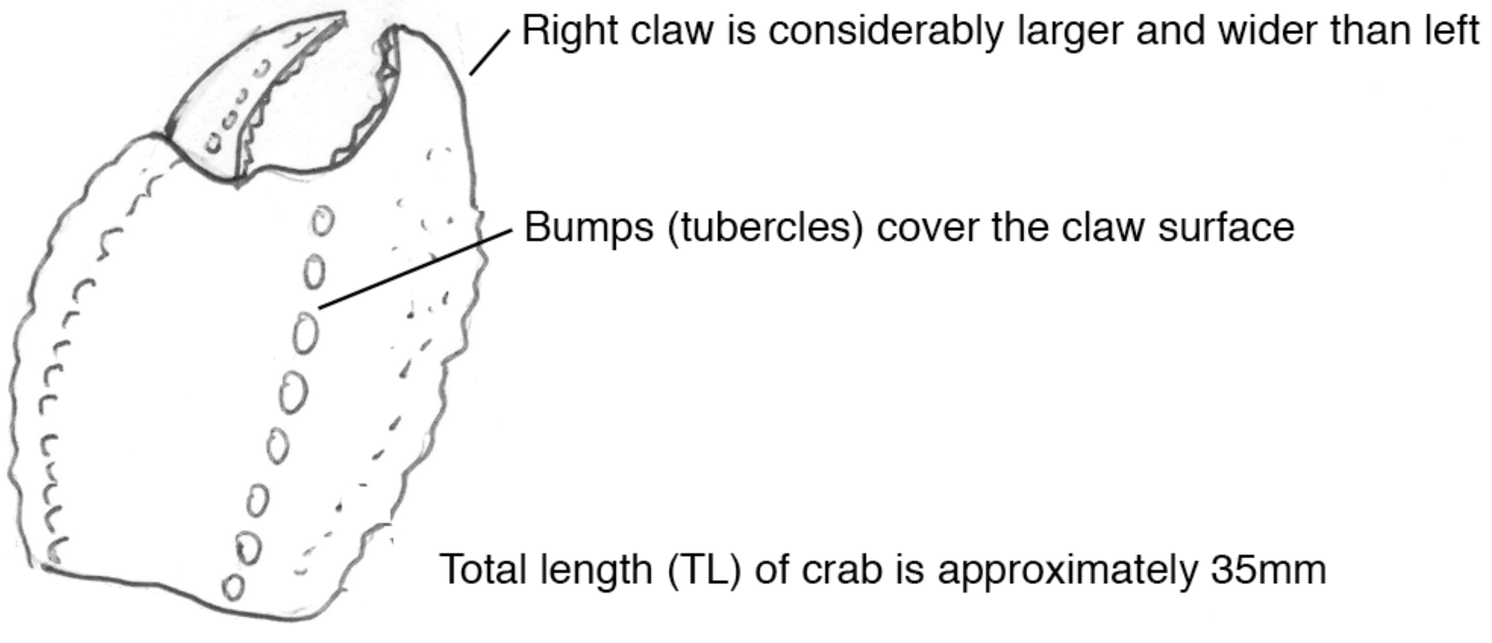
1. Common Crab – Carapace has five relatively indistinct, poorly defined points between the eyes, with many smaller points between those. The claws are indented with lines composed of many small dimples or dots, rather than the prominent grooves on swimming crab claws. There are no swimming pads.



2. Swimming Crab- Carapace has distinct, rounded points between the eyes. Claws have deep grooves. The propodus is also deeply grooved, and the grooves form a triangle that allows the swimming crab propodus to be distinguished from that of the common crab. Swimming pads are also unique to this species, and can be useful in counting number of individuals.

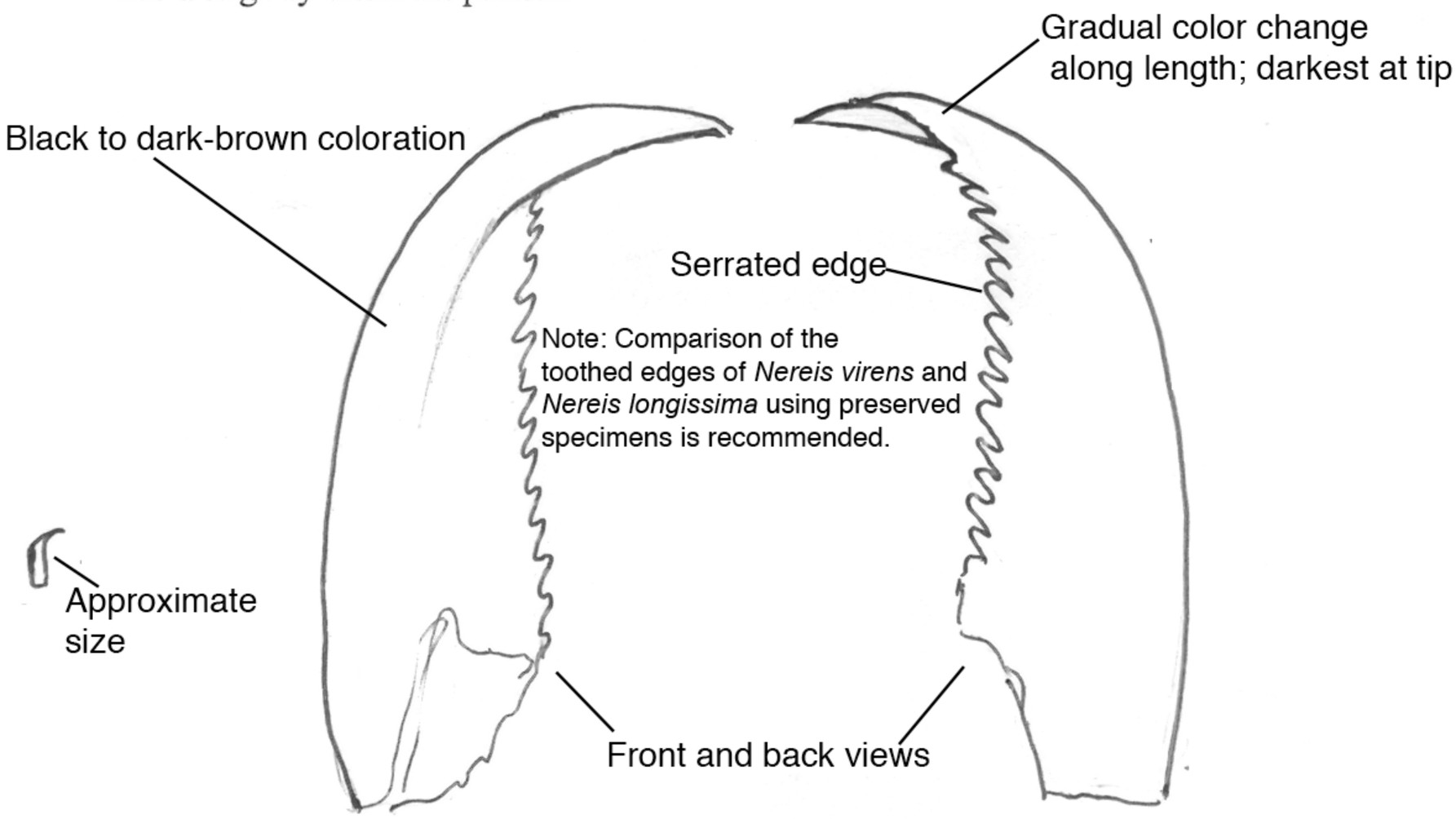


3. Hermit crab- *Pagurus bernhardus*- This is a rare crab to find in pellets, boluses or gull stomachs. The claws are very small, often with brightly colored orange/red stripes, and have circular, rounded bumps.

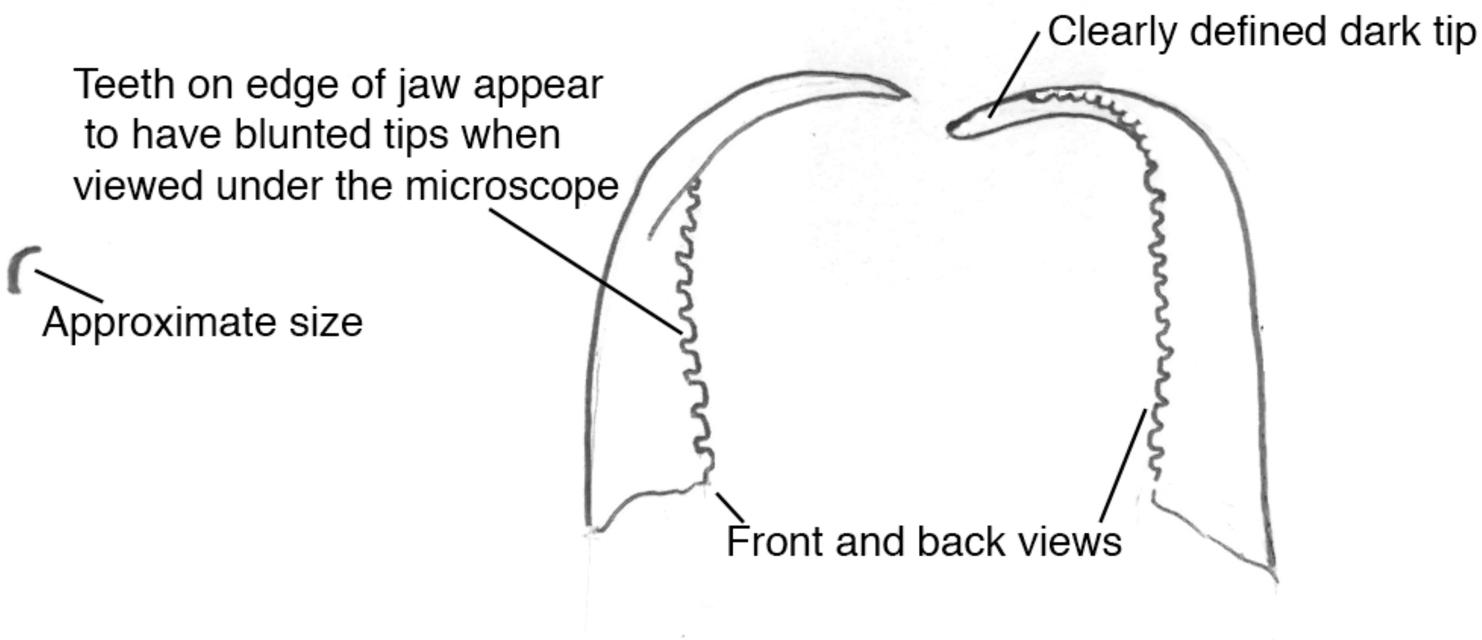


Worms

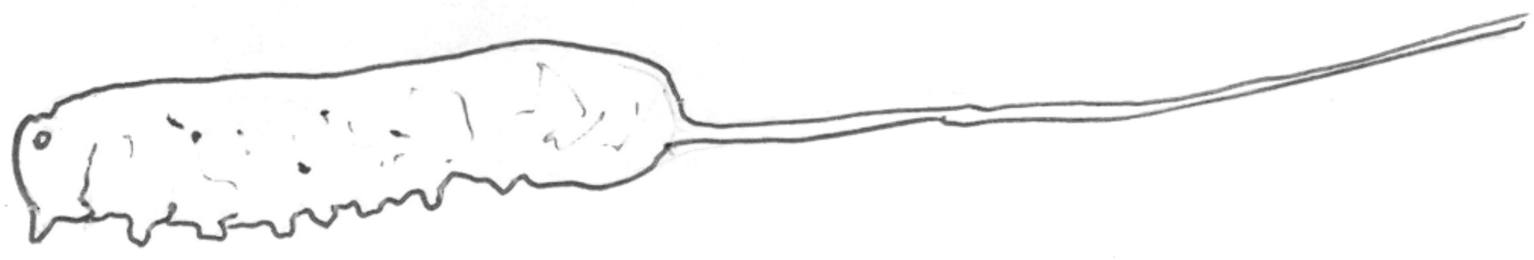
1.*Nereis virens* – The jaws are larger than those of *Nereis longissima*, and the toothed edge has a slightly different pattern.



2. *Nereis longissima*- Jaws are smaller than *Nereis virens*, curved, and feature a darkened tip.



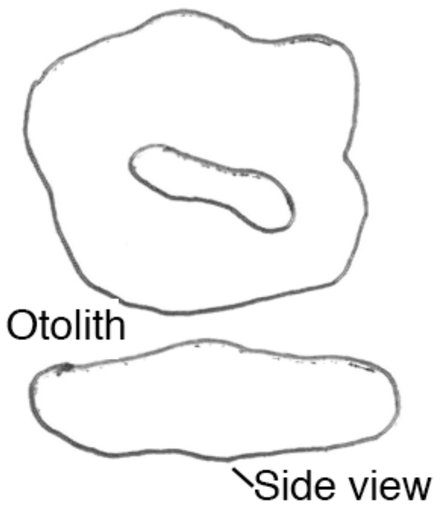
4. Rat-tailed maggots – *Eristalis tenax* -These distinctive maggots, which will become drone flies, have been found in only one bolus (as of 24/7/06). They have eye-spots, an elongated tail, and may be found in clumps of several dozen, loosely connected at the tail ends.

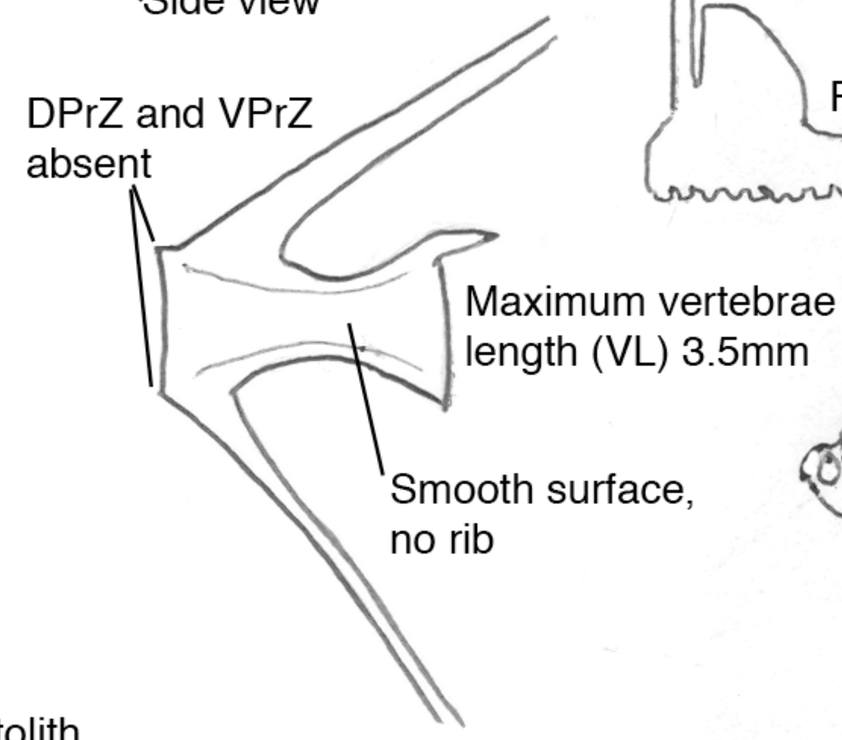


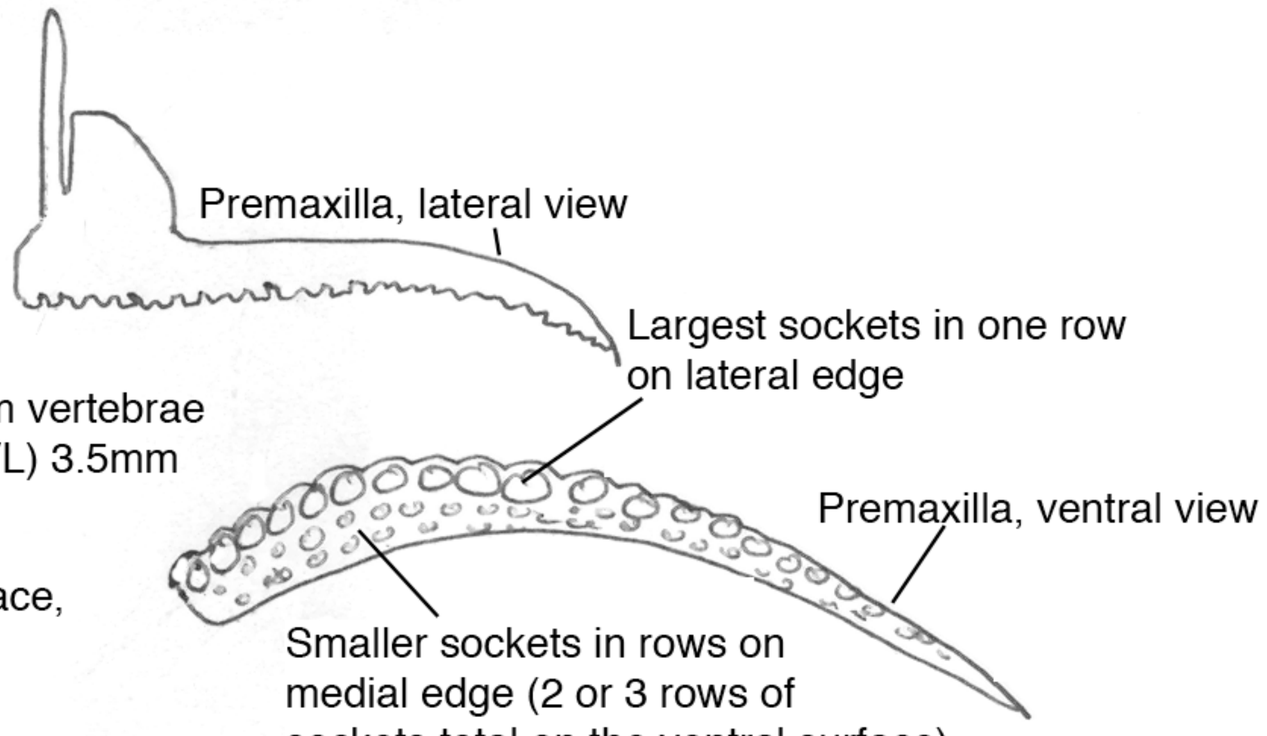
Discarded Fish

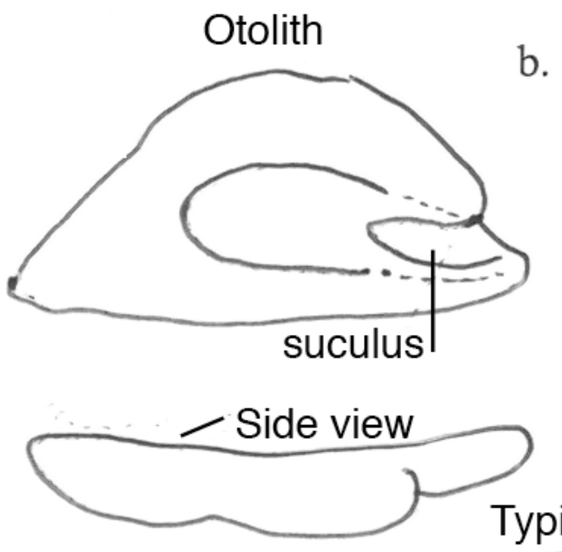
1. Distinctive discards

a. *Sand Goby-The **vertebrae**, according to the *ICES Guide,* cannot be confused with vertebrae of any other fish species. They have very long, emphasized waists, lack ribs, dorsal and ventral prezygapophyses, and smooth lateral surfaces. They are also very small, with a maximum length of 3.5mm (according to the *ICES Guide*). The **premaxillae** can easily be distinguished from those of flatfish by the presence of 2 to 3 rows of teeth sockets (Dab, Flounder, and Plaice usually have a single row, and Soles have many rows). The sockets on the outer edge (the outside of the curve when looking at the jaw from above) are noticeably larger than the interior rows.

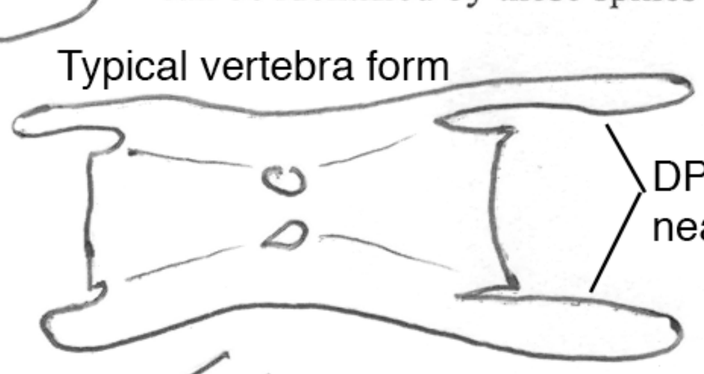


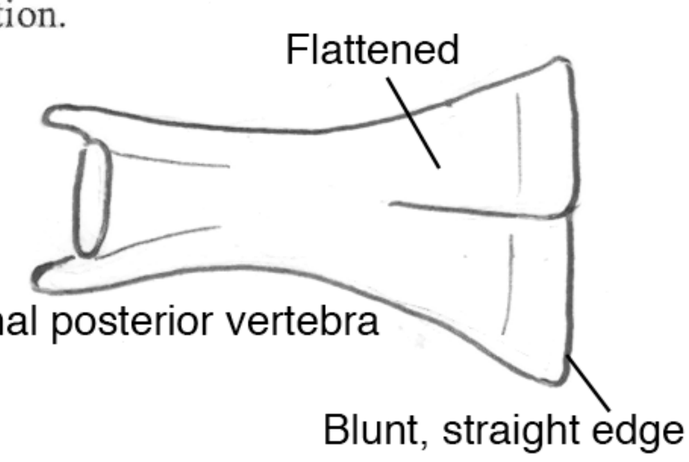


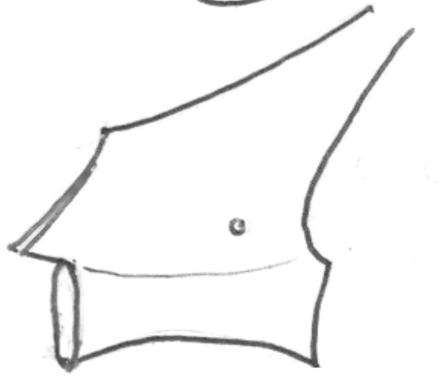


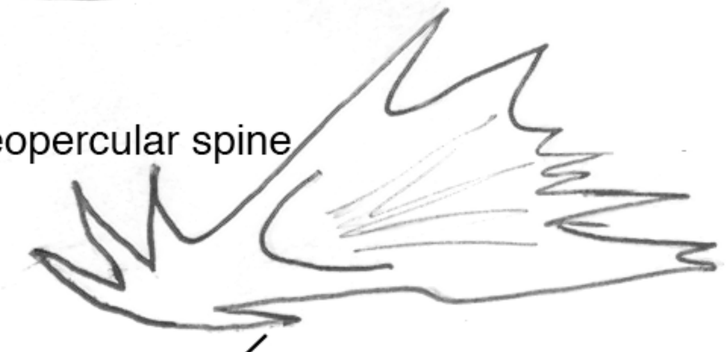


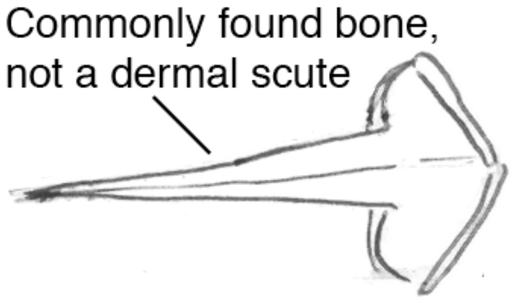
b. Dragonet (LF)- The **vertebrae** are long rectangles. The vertebrae length (VL) is 2 to 3 times vertebrae height (VH). They are flat, which becomes obvious when looking down the anterior axis. There are no ribs on the centrum, and the long postzygapophyses go straight backward, but often break off in samples. Dragonet samples often contain bones that look suspiciously like odd urohyals, but are actually other pieces of dragonet bones. Also, the **premaxillae** are delicate and may be worn down in samples, giving the appearance of urohyals. **Preopercular spines** are unique to Dragonets. The reticulated dragonet (rare) can be identified by these spines as indicated in the illustration.

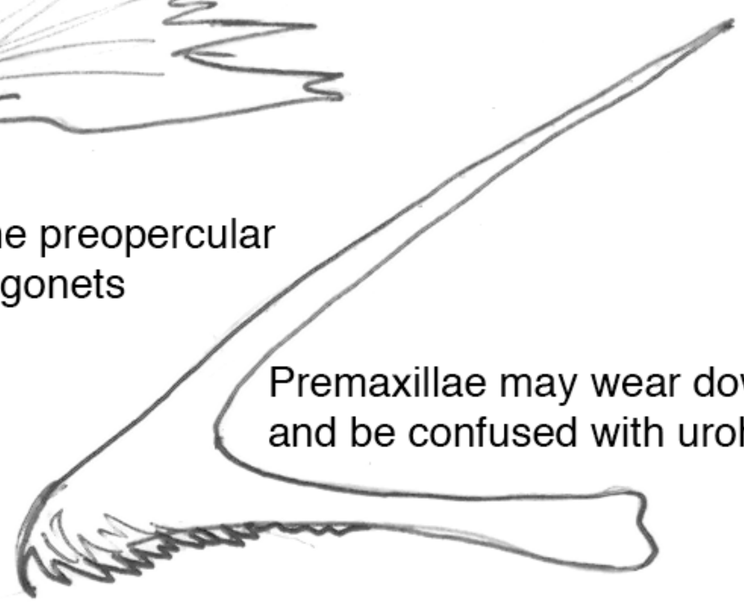






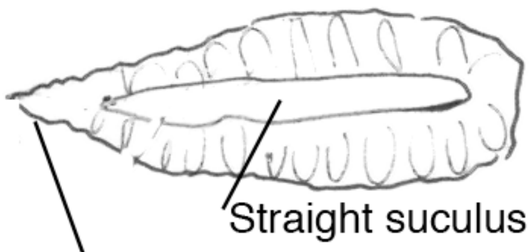


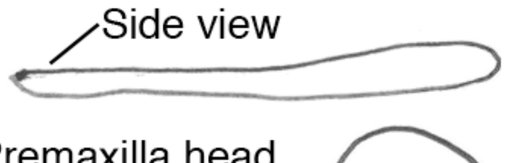


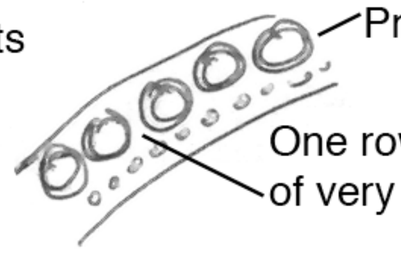


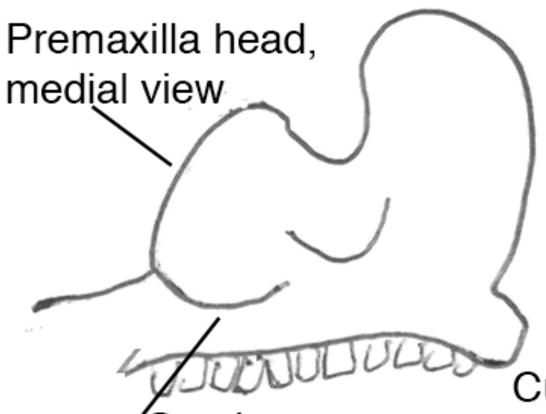
2. fam. Gadidae

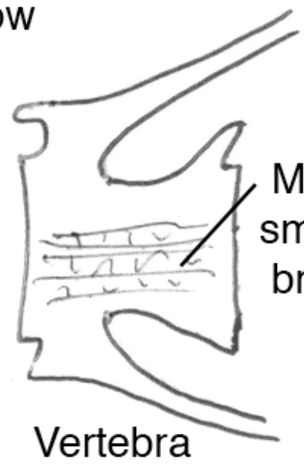
a. Whiting- The **otoliths** are thick, large, often found in samples, opaque and white (compared to the slight translucence of other fish bones and otoliths.) They are also flat, and have a notably straight suculus. The **premaxillae** do not have a visible gap (where indicated) between the ramus and articular process. This is one easy way to distinguish the premaxillae of whiting from bib. Whiting, bib, and cod vertebrae are often difficult to tell apart, especially when slightly worn down.



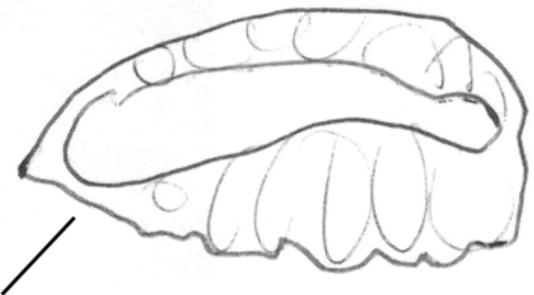


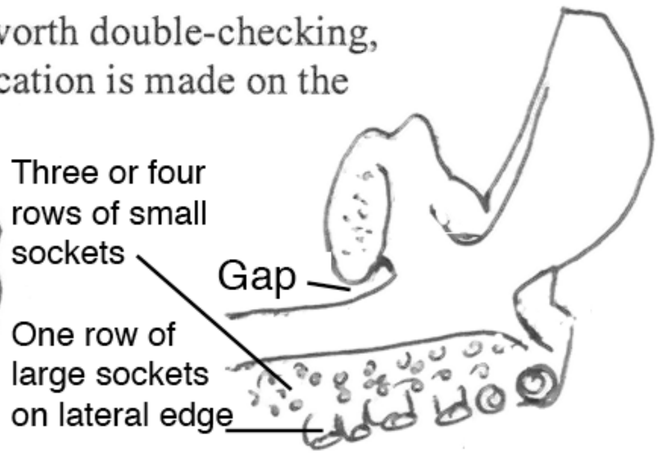




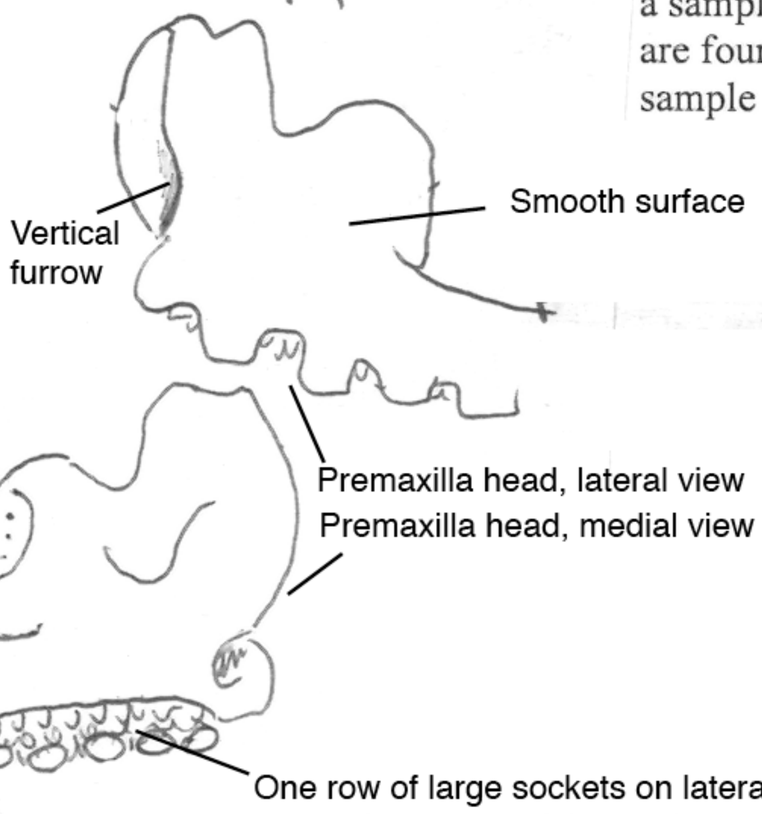


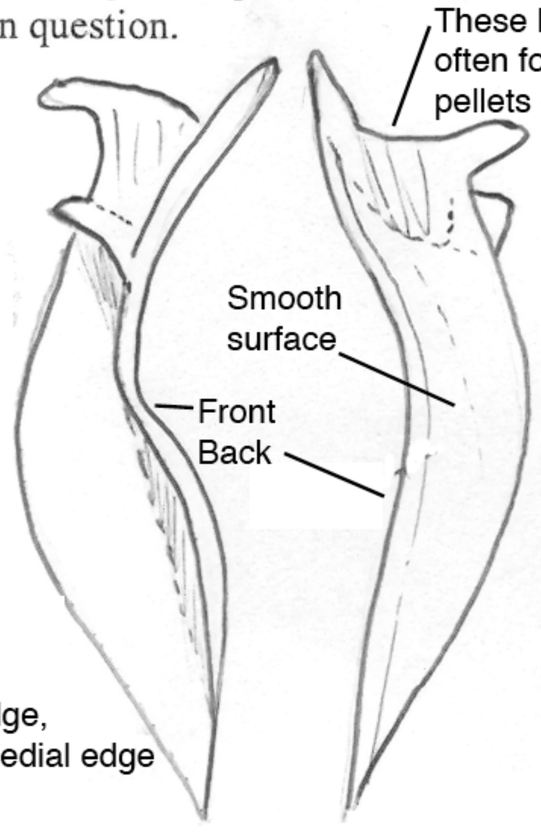
b. *Bib – This is a rare fish, but it is found in samples. It is worth double-checking, that the fish is not actually a whiting, especially if identification is made on the basis of jaws.

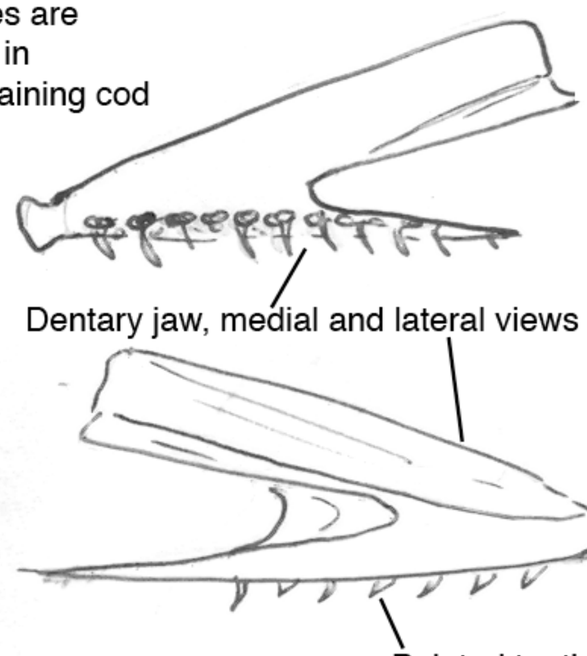


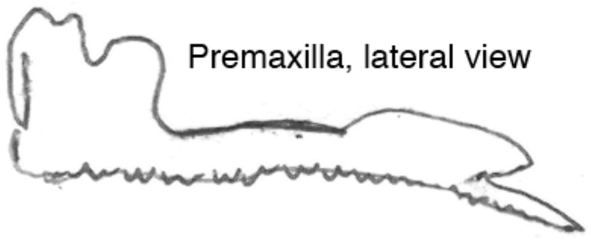


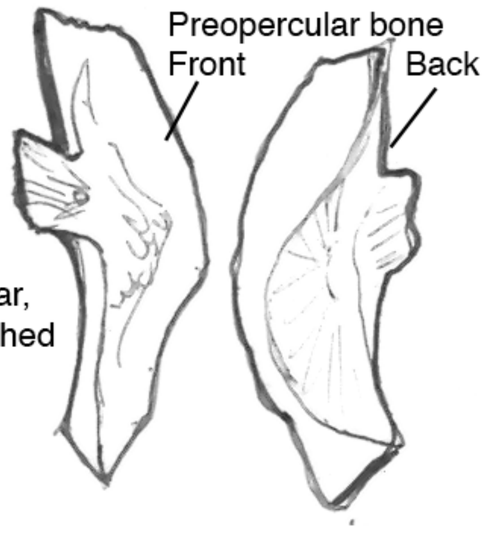
c. Cod – The cod's dentary jaws, not often used for identification purposes, are distinctive in this case, and they may be used to determine the presence of cod in a sample. Many other distinctive and well ossified bones that resist digestion are found, making a complete cod skeleton useful when the presence of cod in a sample is in question.

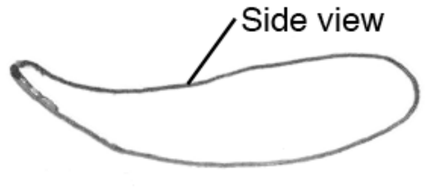


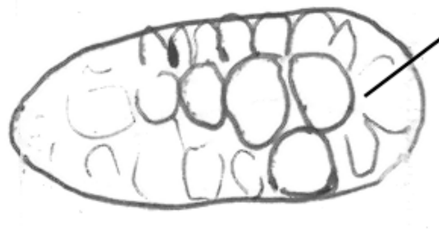










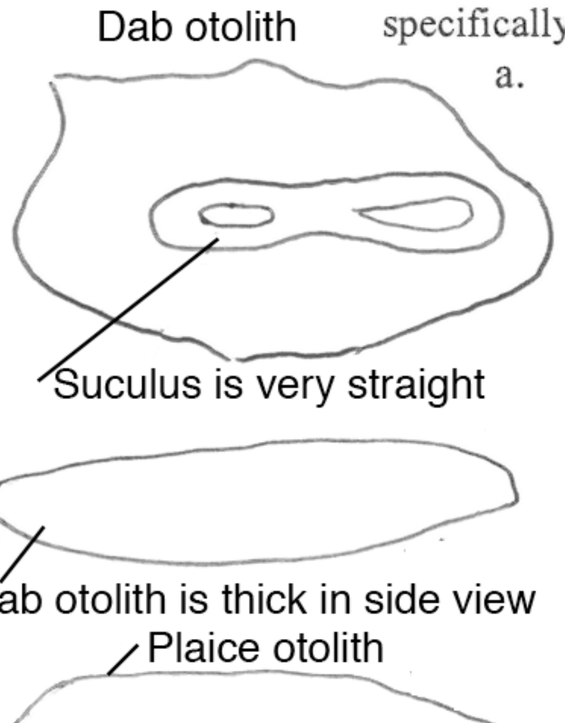


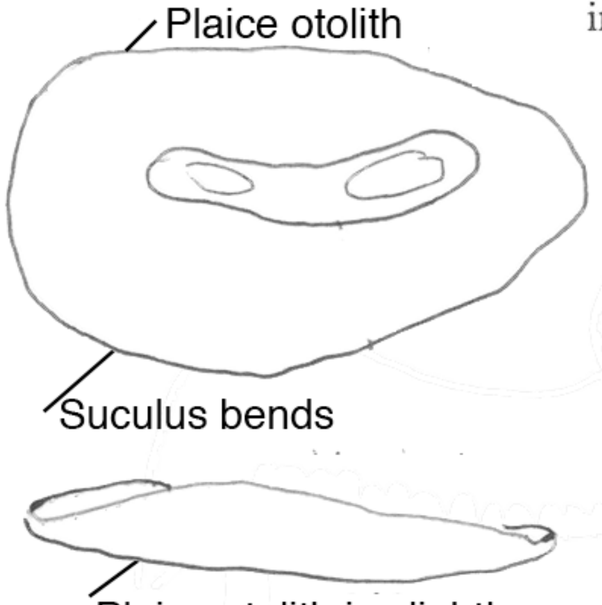
Cod and whiting vertebrae are very similar, but cod vertebrae can often be distinguished by their short centrum. The following equations from the *ICES Guide* are often useful:
Cod VH is 95 to 106% VL
Whiting VW is 80 -95% VL

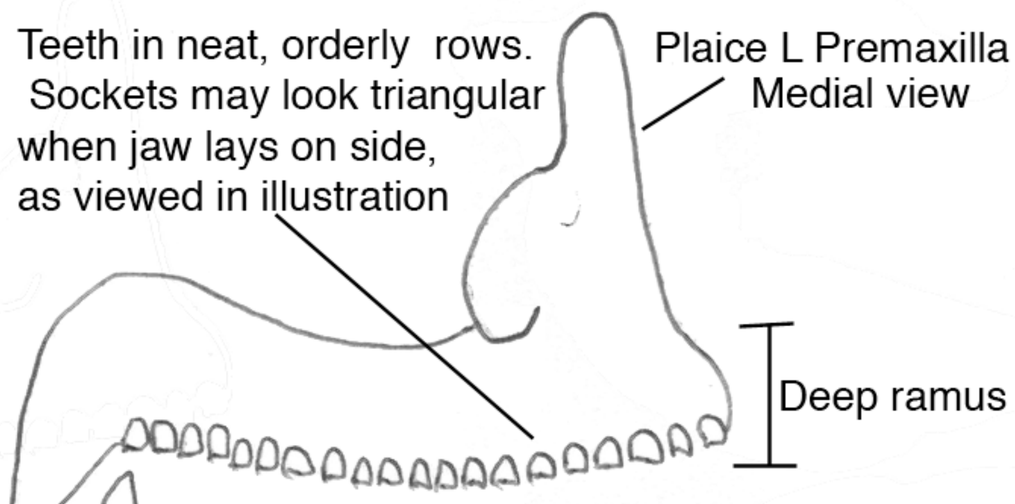
1. Flatfish (fam. Pleuronectidae)

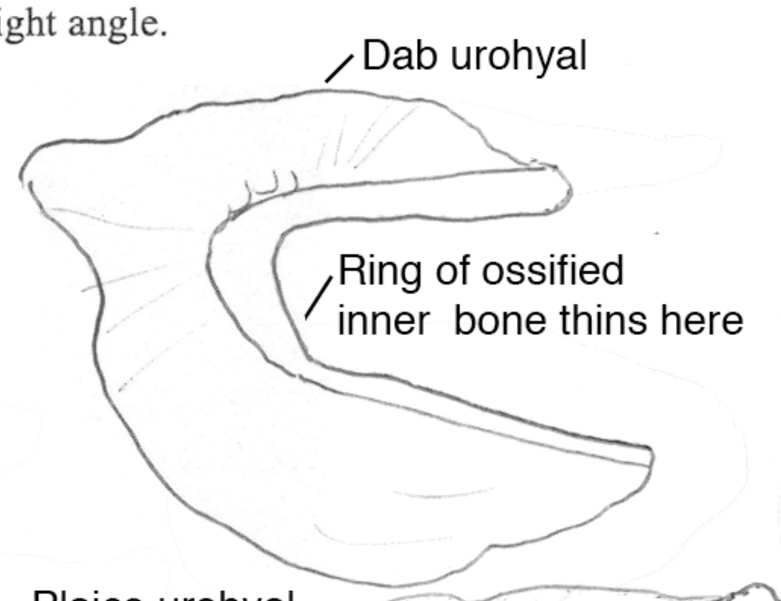
Note – In pellets/boluses from *Larus fuscus* gulls, the choice is often between plaice and dab, because flounder is not a likely option for lesser black-backed gulls. For this reason, differences specifically between dab and plaice are emphasized here.

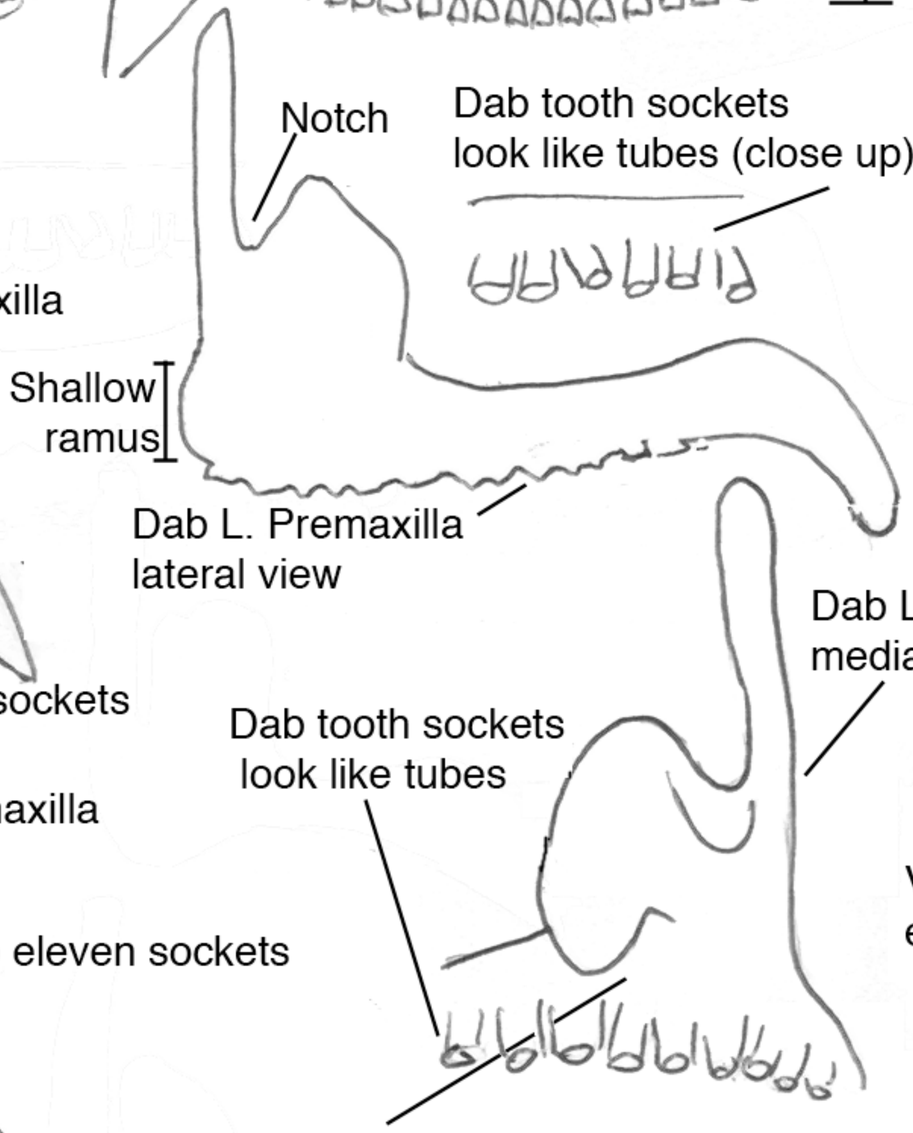
a. Dab vs. Plaice - Dab **vertebrae** have well defined, though short and stubby, ventral prezygapophyses,. These are often extremely small, or absent, on the vertebrae of plaice. The anterior vertebrae of dab are longer than the narrow anterior vertebrae of plaice. The equation given by the *ICES Guide* is dab VL ≥ 79% dab VH for anterior vertebrae, therefore if the VL is < 79% VH, the vertebrae can be assumed to be plaice. Other differences are indicated below. In the **premaxillae**, the teeth sockets in the dab jaw look like tubes, and point in different directions, not neatly ordered in a single straight line. The ramus is deep on plaice and shallow on dab premaxillae (see illustration.) The ascending and articular processes are quite different, but are also prone to fracturing. The **urohyals**, when intact, easily distinguish dab from plaice, but often seem to break at a place that makes them useless in identifying between the two. Dab **otoliths** are thicker, and not curved or shallow compared to plaice, and the suculus is a straight line in the interior of the otolith. In plaice, the suculus bends and makes a slight angle.

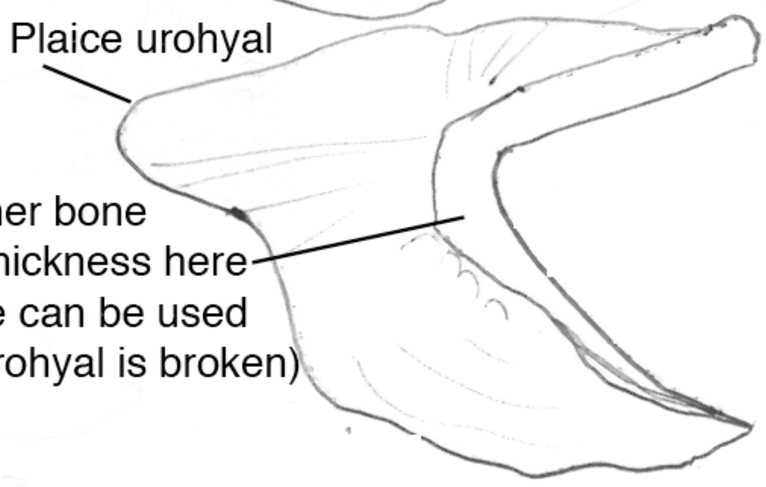


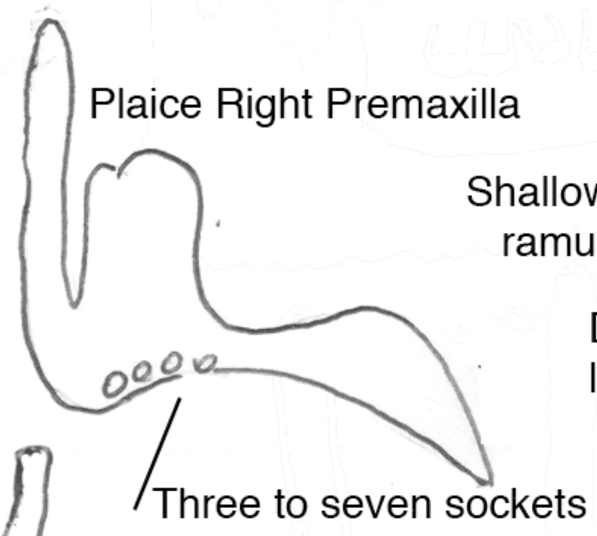


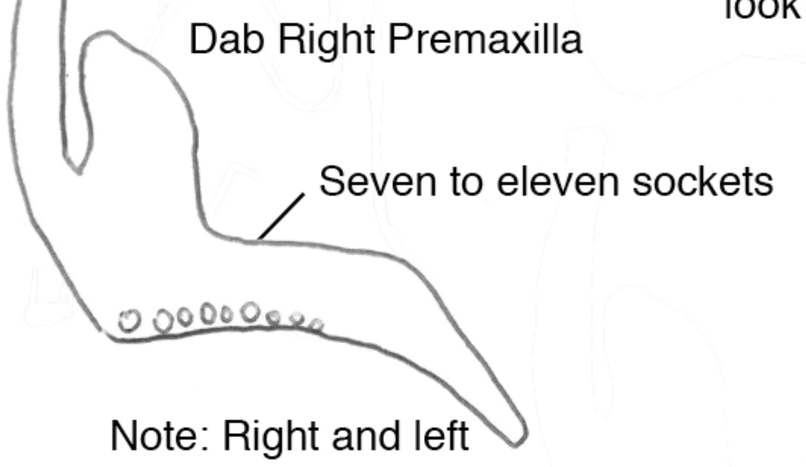






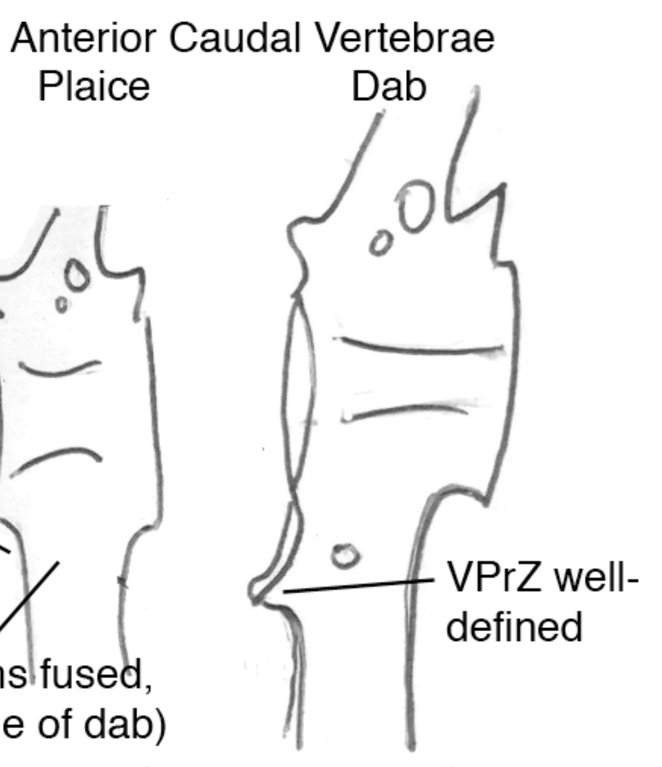






Note: Right and left premaxillae are different in flatfish species.

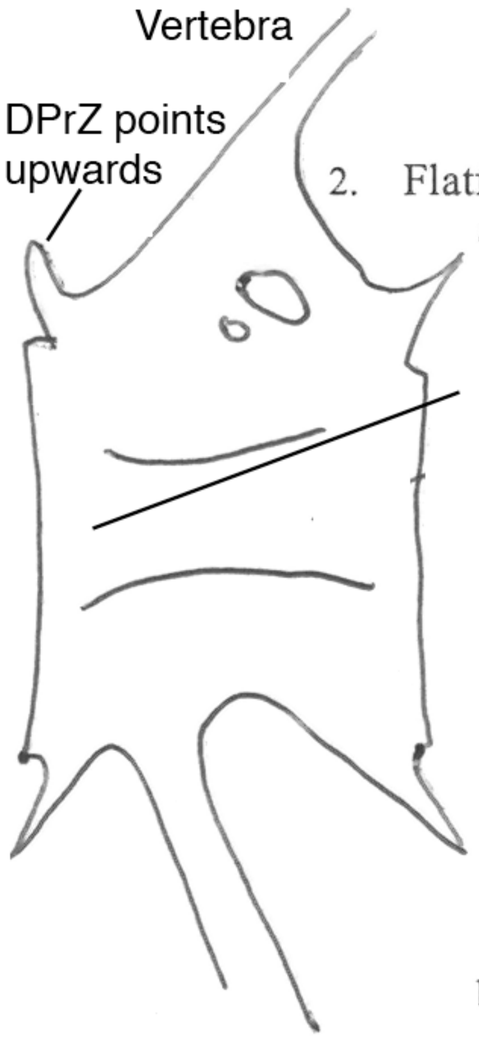
Dab toothed bone with two rows of sockets or teeth. This bone is not used for identification purposes because similar bones are found in other fish species.

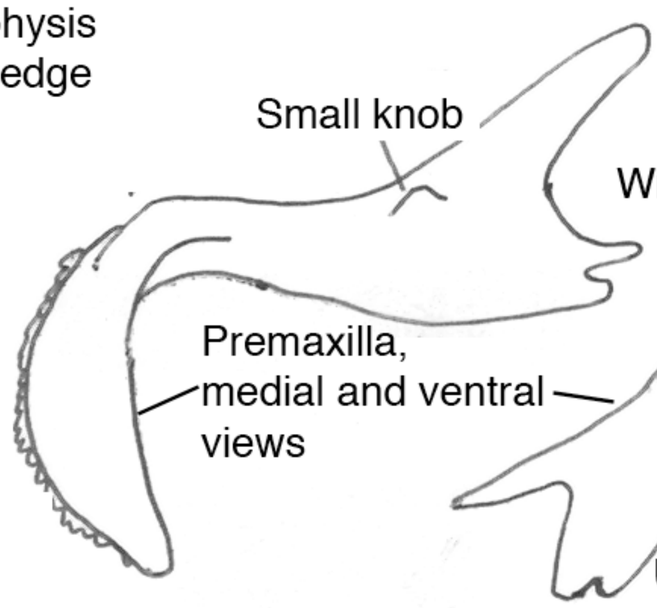


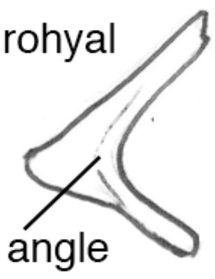
Flounder (*Larus argentatus* only) – Differences from plaice and dab:
L. Premaxilla – Ascending process less fused than plaice or dab. The notch between processes is considerably narrower than the notch found in dab. The ramus is narrow, unlike plaice.
R. Premaxilla- 8-12 teeth sockets, distinguishing from plaice. Dab and flounder r. premaxilla cannot be told apart.
Vertebrae- VPrZ present, unlike plaice. Mid caudals have a narrow based haemal arch, unlike dab.

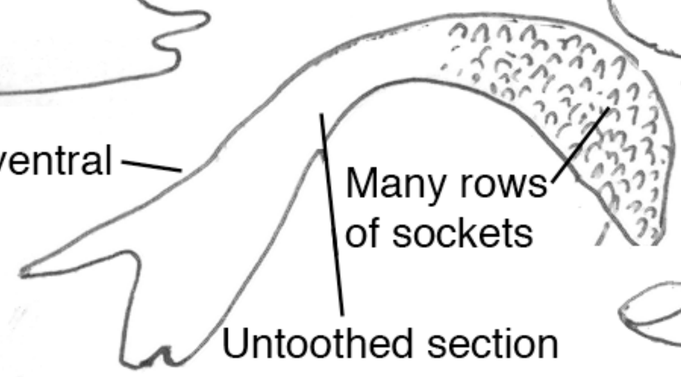
2. Flatfish (fam. Soleidae and Bothidae)

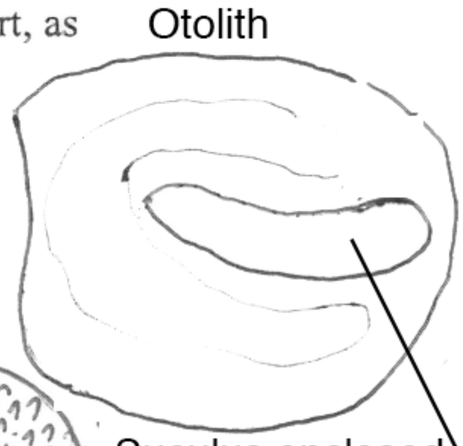
a. Sole- Vertebrae have a dorsal prezygapophysis that goes directly upward, different than solenette. Teeth placement on jaws can also be used to tell these two species apart, as well as size (solenette are smaller.)

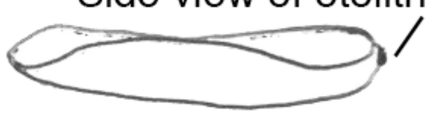




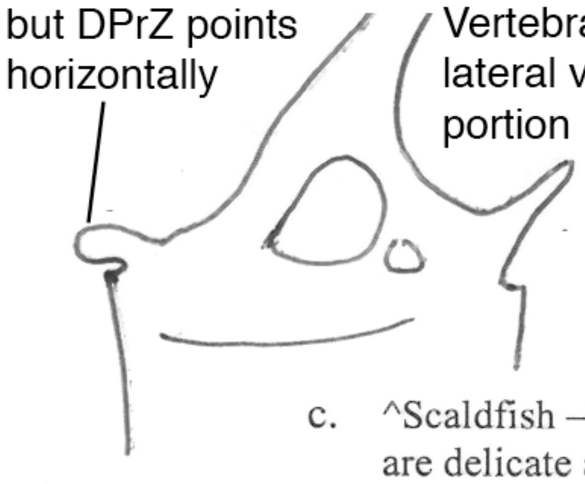


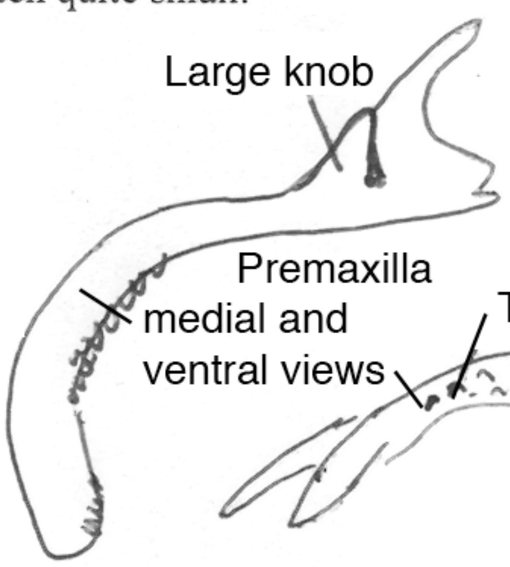


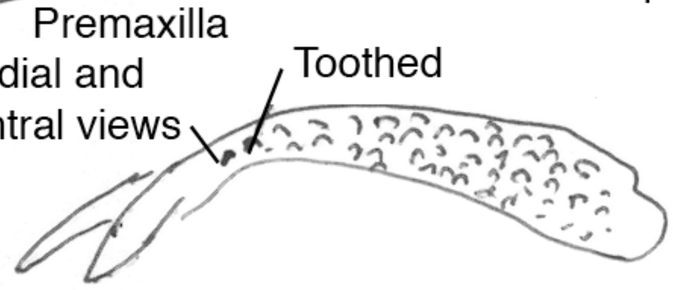




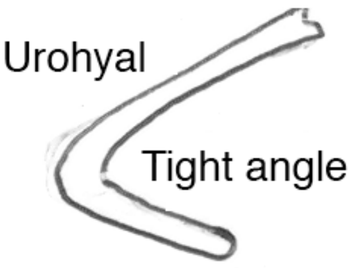
b. Solenette – Vertebrae should not be longer than 3.11mm. They may be confused with scaldfish, which are also often quite small.



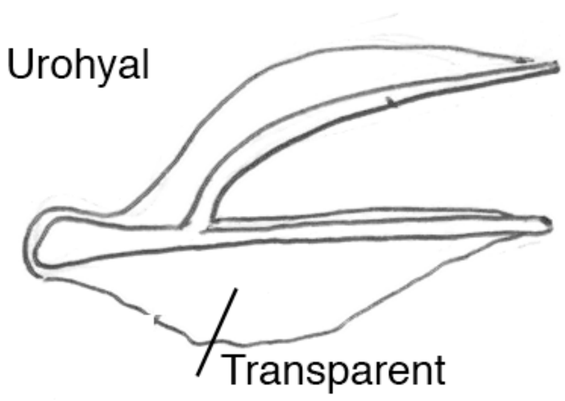


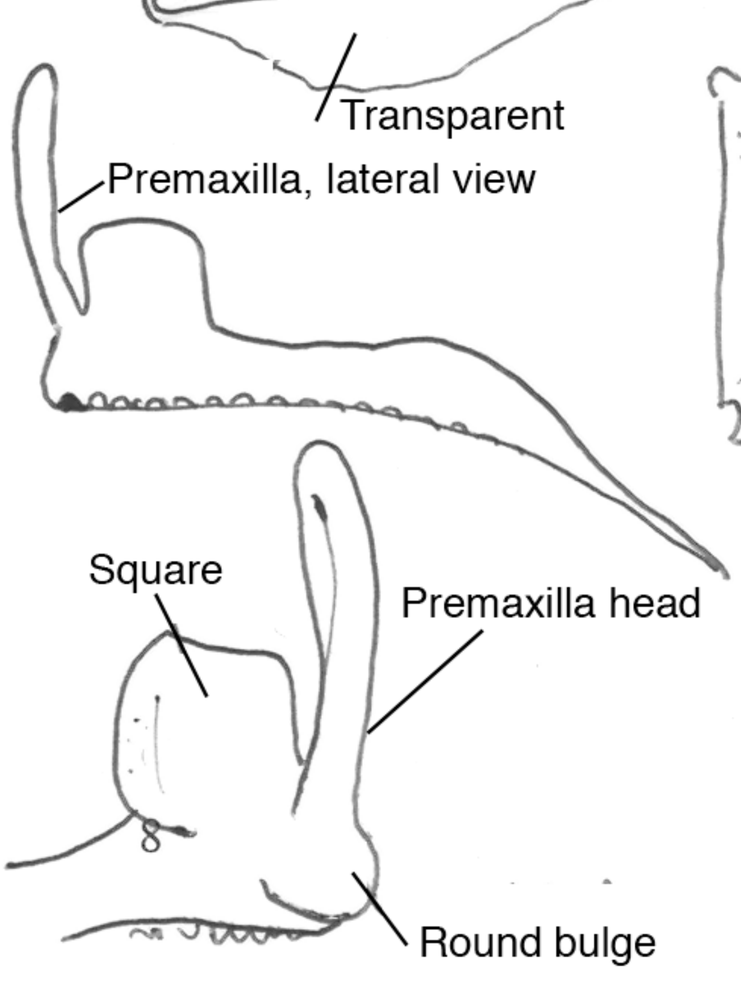


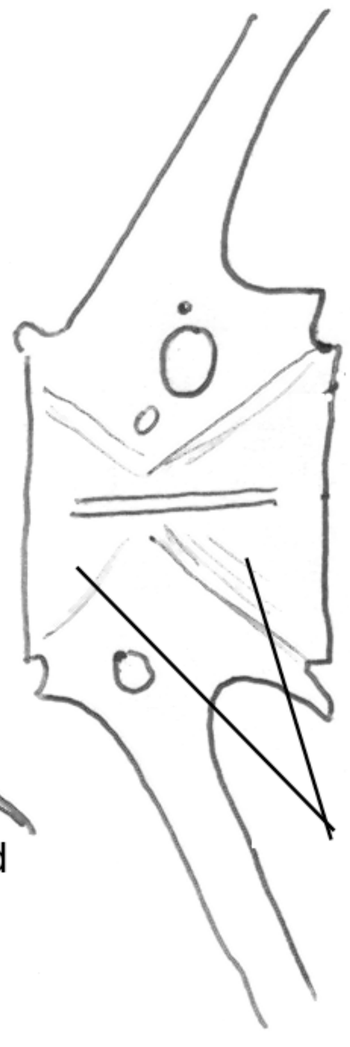
Note: Some vertebrae have two small lateral apophyses per side, most have one (observation conflicts with description in *ICES Guide*



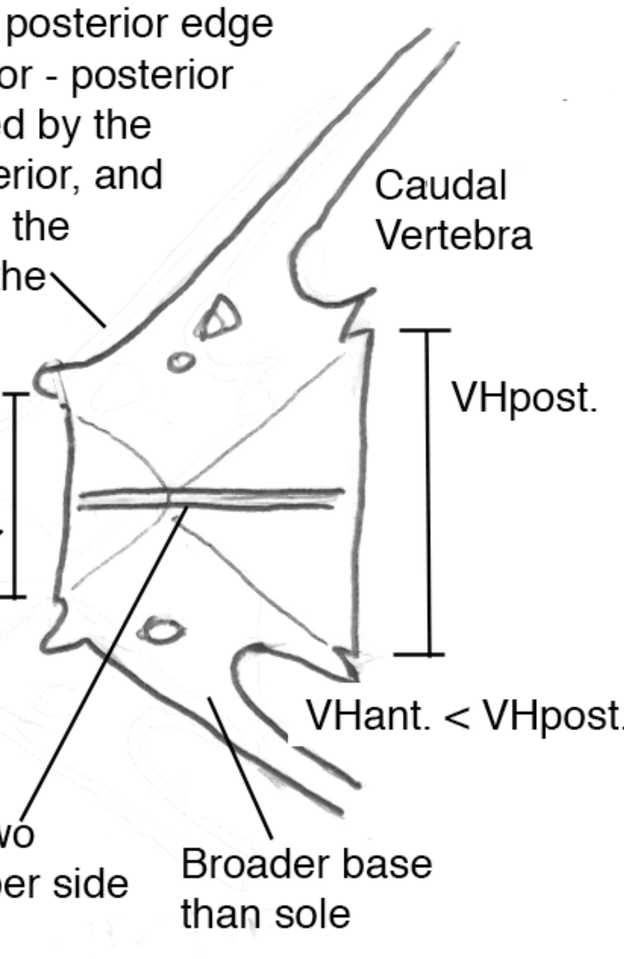
c. ^Scaldfish –These small bones are often found in boluses, but not pellets, because they are delicate and poorly ossified. The urohyal of this species absent from the *ICES Guide*, and was consequently misidentified in many early samples. The urohyal is distinctive, different from the urohyals of soleidae fish, and should be used to identify scaldfish.





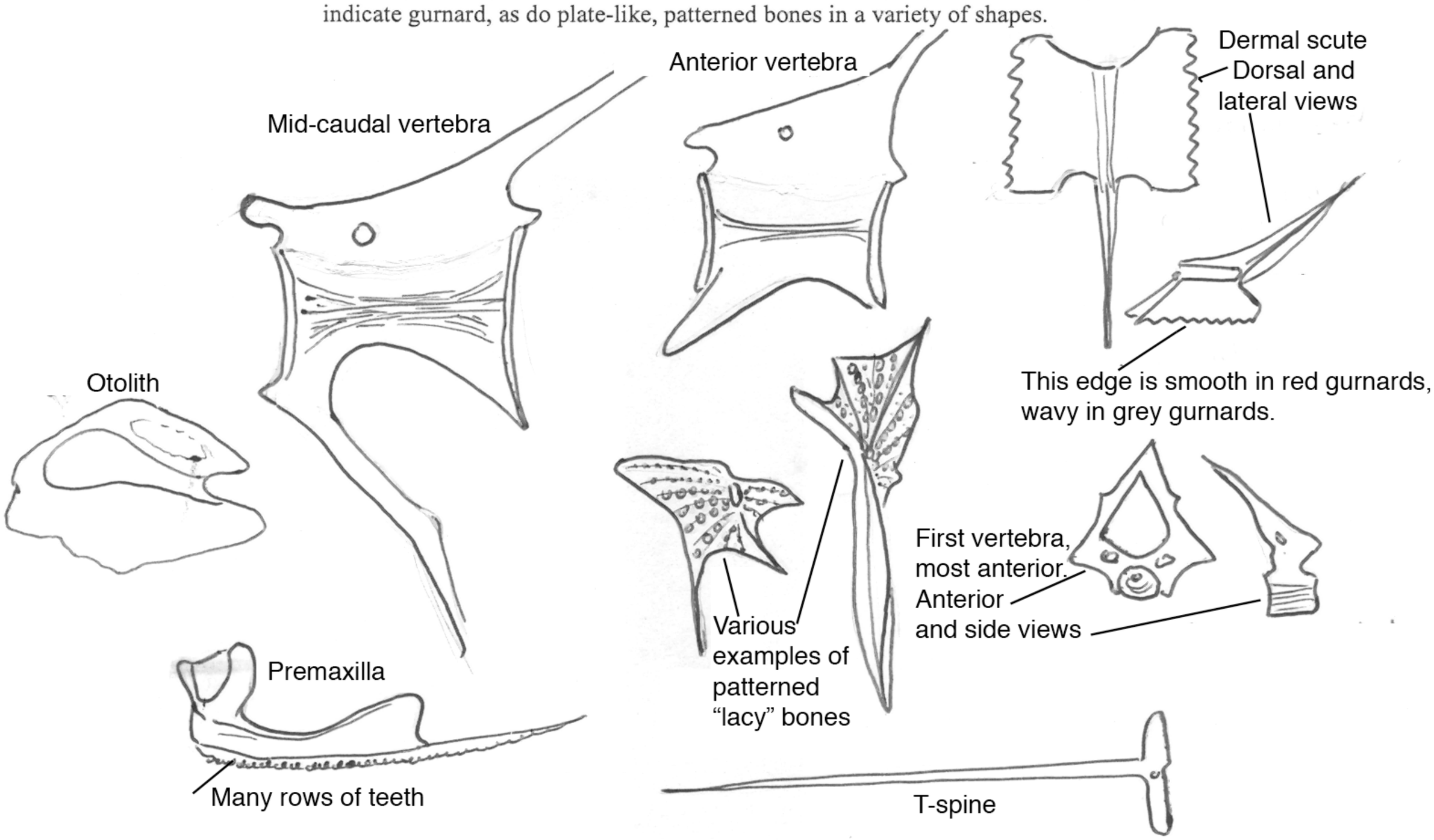


Note: VH anterior edge < VH posterior edge
VW anterior edge < VW posterior edge
When looking down the anterior - posterior axis, the posterior circle formed by the centrum is larger than the anterior, and can therefore be seen behind the anterior circle, as depicted in the illustrations.

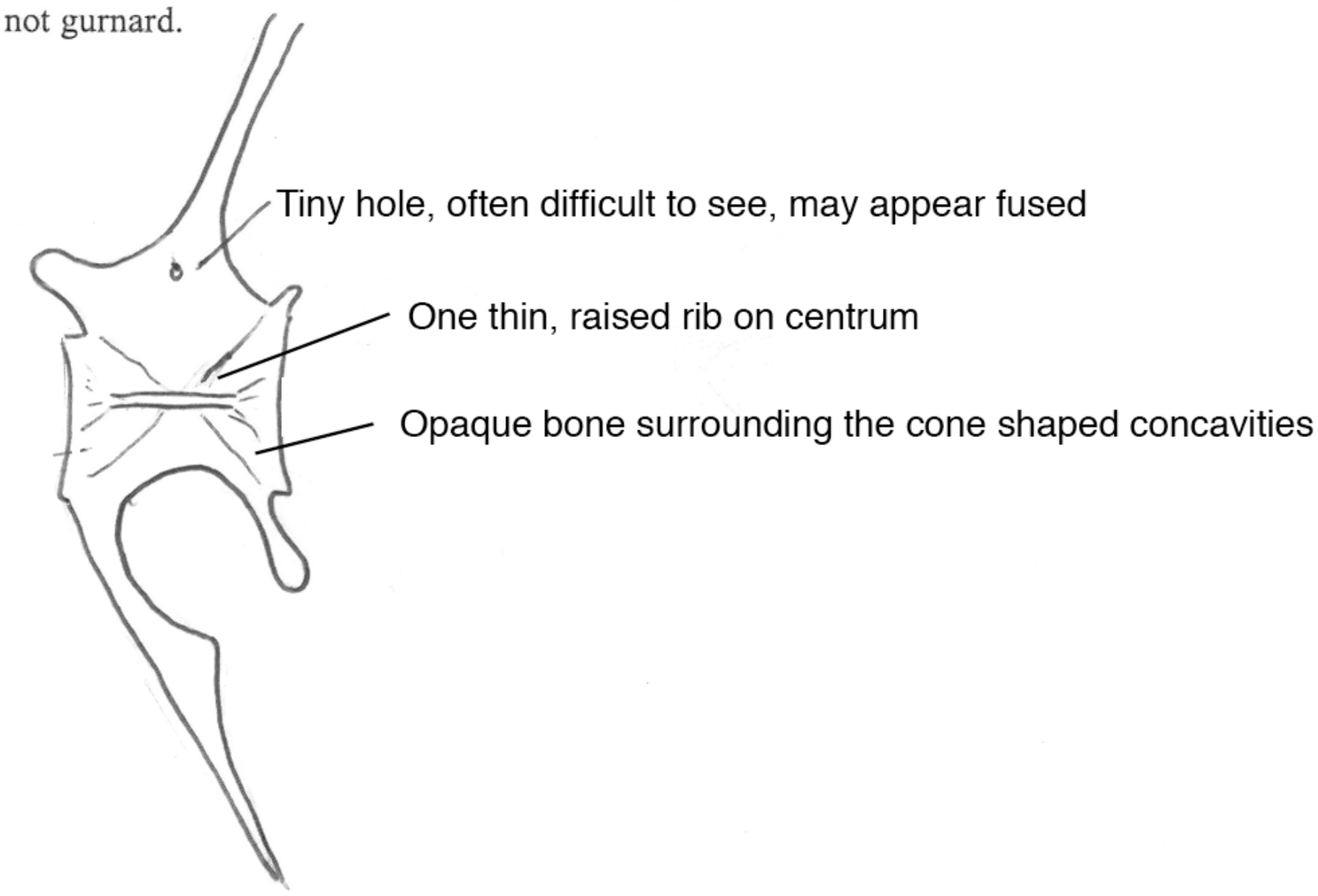


3. Gurnards and Lesser Weaver

a. Grey Gurnard vs Red Gurnard – Grey gurnards are considerably more common in pellet samples. Grey gurnard dermal scutes can be told apart from red gurnard dermal scutes by the wavy edges (red gurnard scutes have flat, smooth edges.) Distinctive T-spines also indicate gurnard, as do plate-like, patterned bones in a variety of shapes.

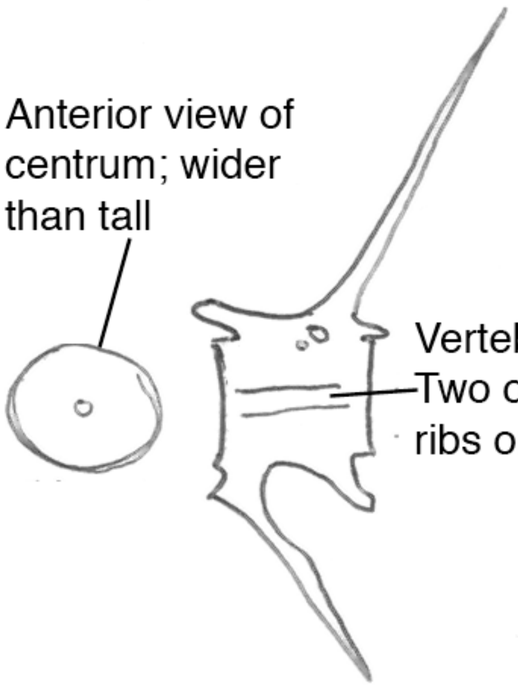


b. *Lesser Weaver- This fish is rarely found in pellets, and vertebrae are very similar to gurnard vertebrae. One should confirm that bones presumed to be lesser weaver are in fact, not gurnard.

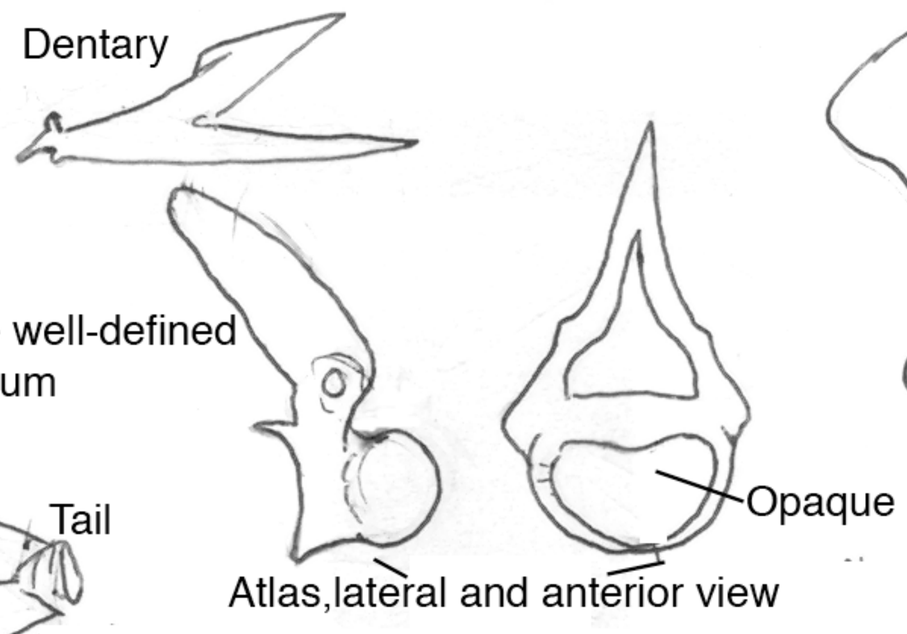


Naturally Obtained Fish

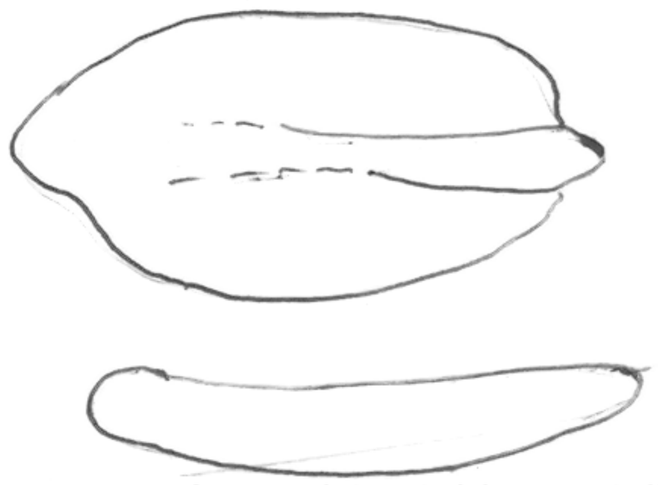
1. fam. Ammodytidae
   a. Sandeels – Greater sandeel **vertebrae** can be up to 3.70 mm long, while other sandeel species vertebrae have a maximum length of 2.95mm. Very large vertebrae that somewhat resemble ammodytidae are likely to be gurnard vertebrae. The **premaxillae** delicate and are unlikely to be found. The **otoliths** resemble sesame seeds.



Note: Vertebrae of different sandeel species are the same in form, and differ only in size (see text)

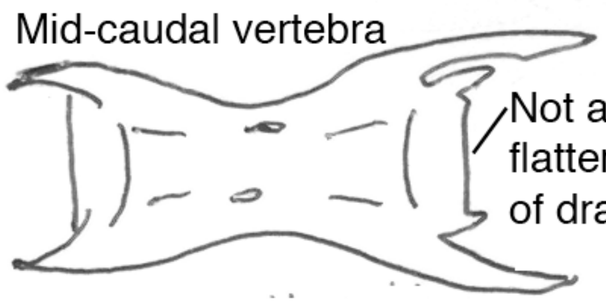


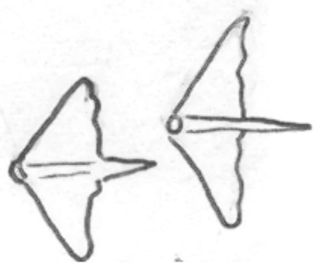
Atlas,lateral and anterior view
The atlas joins the vertebral column with the bones of the skull.



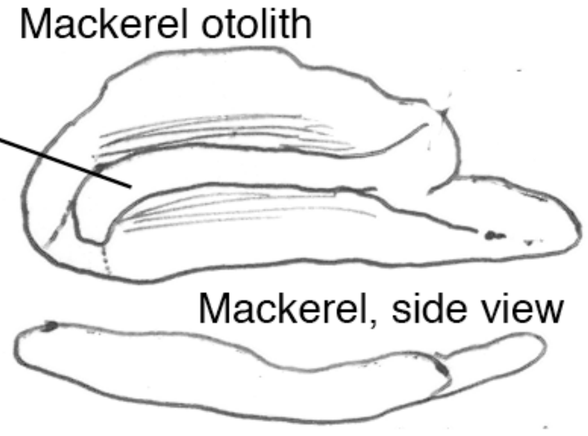
Ammodytes tobianus otolith, two views.
Otoliths of other sandeel species are similar in form,

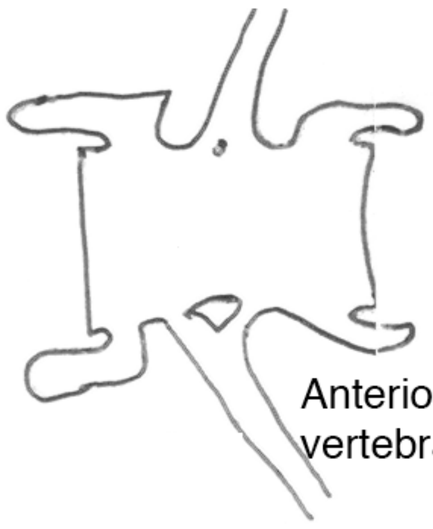
2. Scad vs. Mackerel – Scad and Mackerel vertebrae are very similar with the following differences: scad vertebrae are laterally concave (rounding in to the interior of the vertebrae) while mackerel vertebrae are laterally convex (rounding outwards) and scad vertebrae are smooth and shiny, while mackerel vertebrae have a grainy texture. Scad samples also contain distinctive dermal scutes. Scad premaxillae are delicate, unlikely to be found in samples.



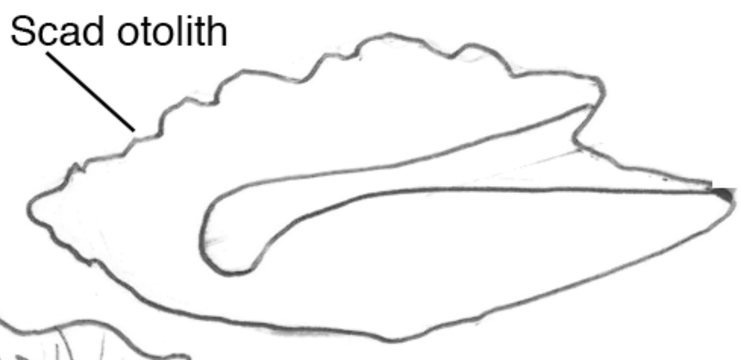


Scad dermal scutes, actual size

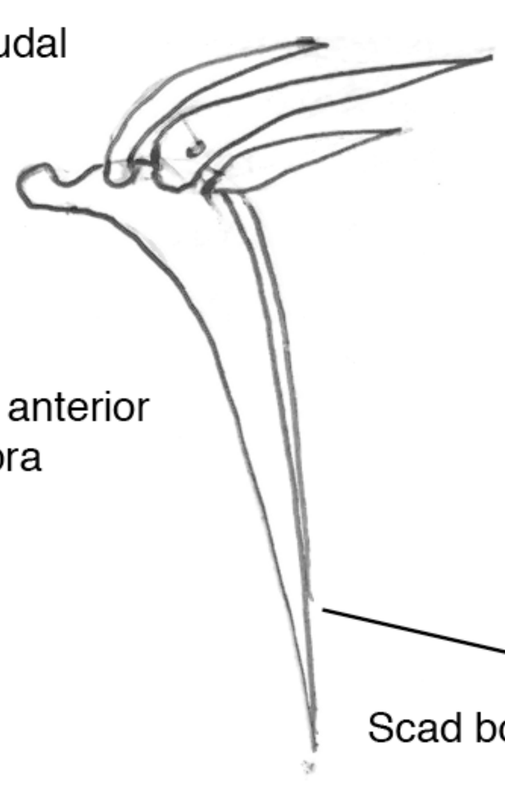


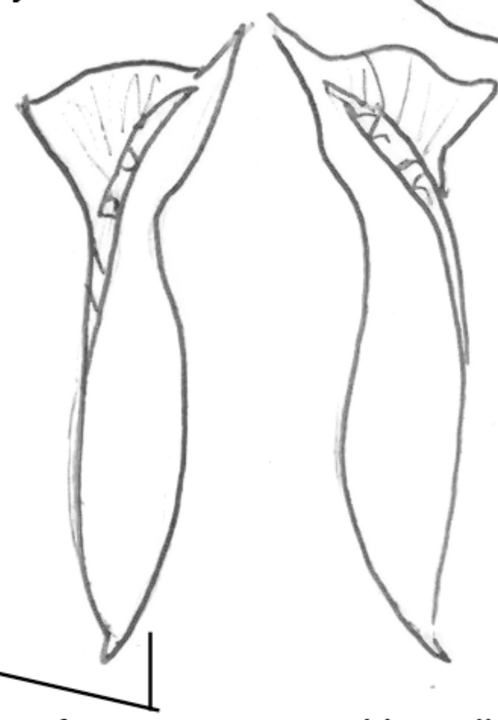


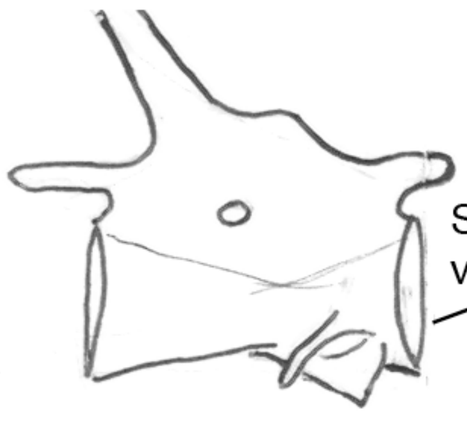
Note: Mackerel and scad vertebra have the same basic form and shape, with a few distinquishing features;
Mackerel: grainy texture, sides laterally convex
Scad: smooth texture, sides laterally concave



Anterior caudal vertebra



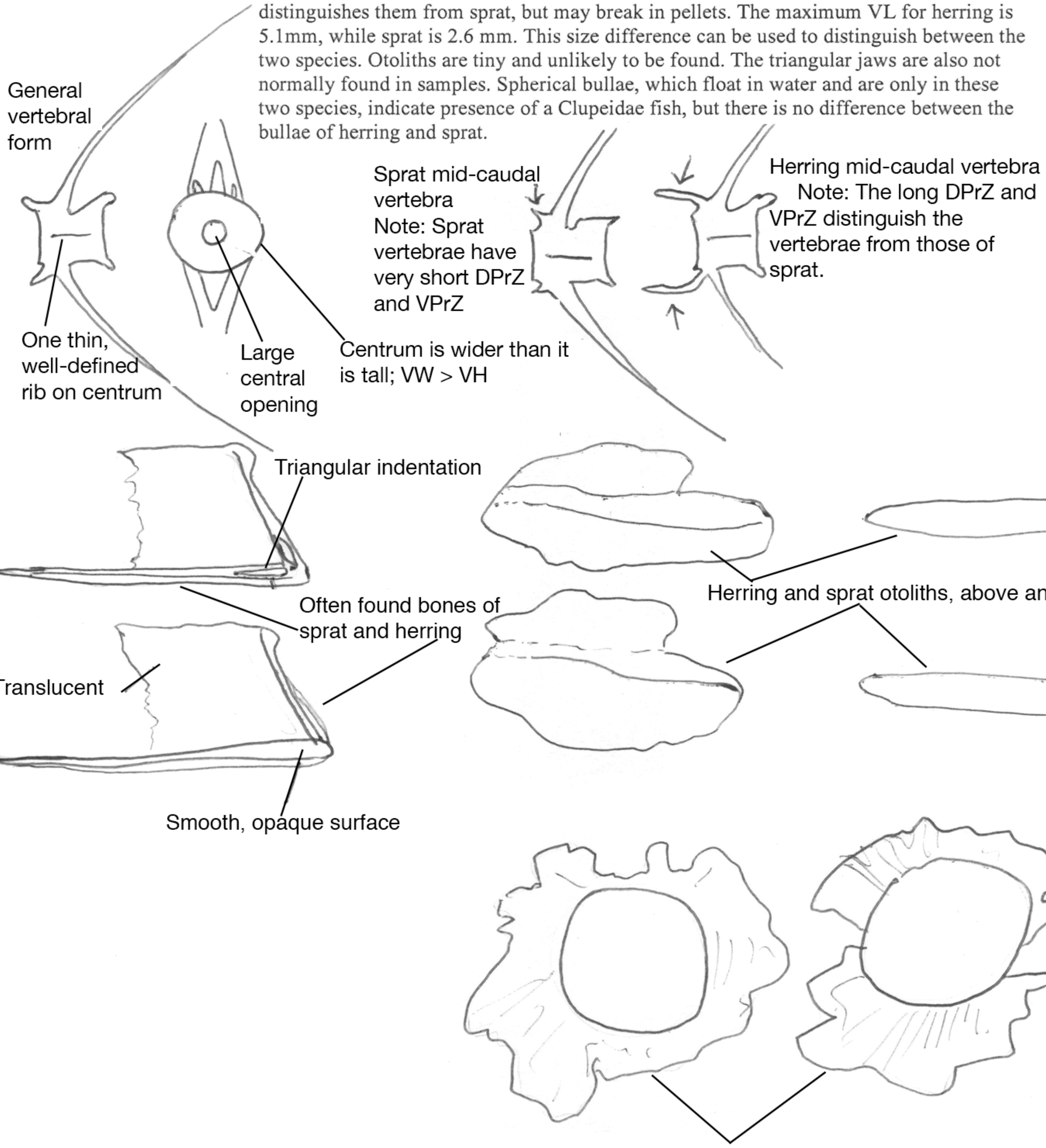




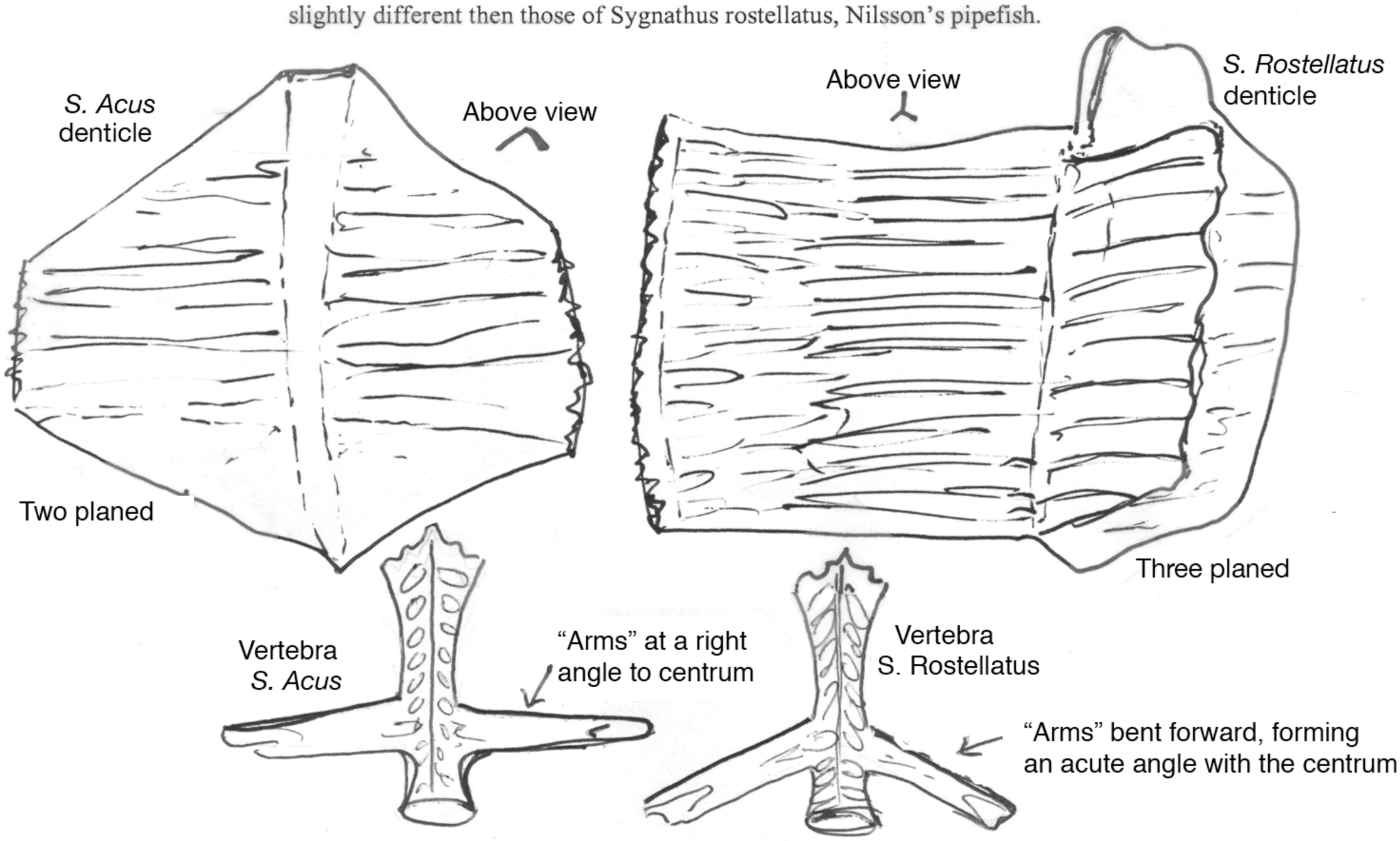
Scad bones often encountered in pellets

3. fam. Clupeidae

a. Herring vs. Sprat – Herring vertebrae often have long prezygapophyses, which distinguishes them from sprat, but may break in pellets. The maximum VL for herring is 5.1mm, while sprat is 2.6 mm. This size difference can be used to distinguish between the two species. Otoliths are tiny and unlikely to be found. The triangular jaws are also not normally found in samples. Spherical bullae, which float in water and are only in these two species, indicate presence of a Clupeidae fish, but there is no difference between the bullae of herring and sprat.



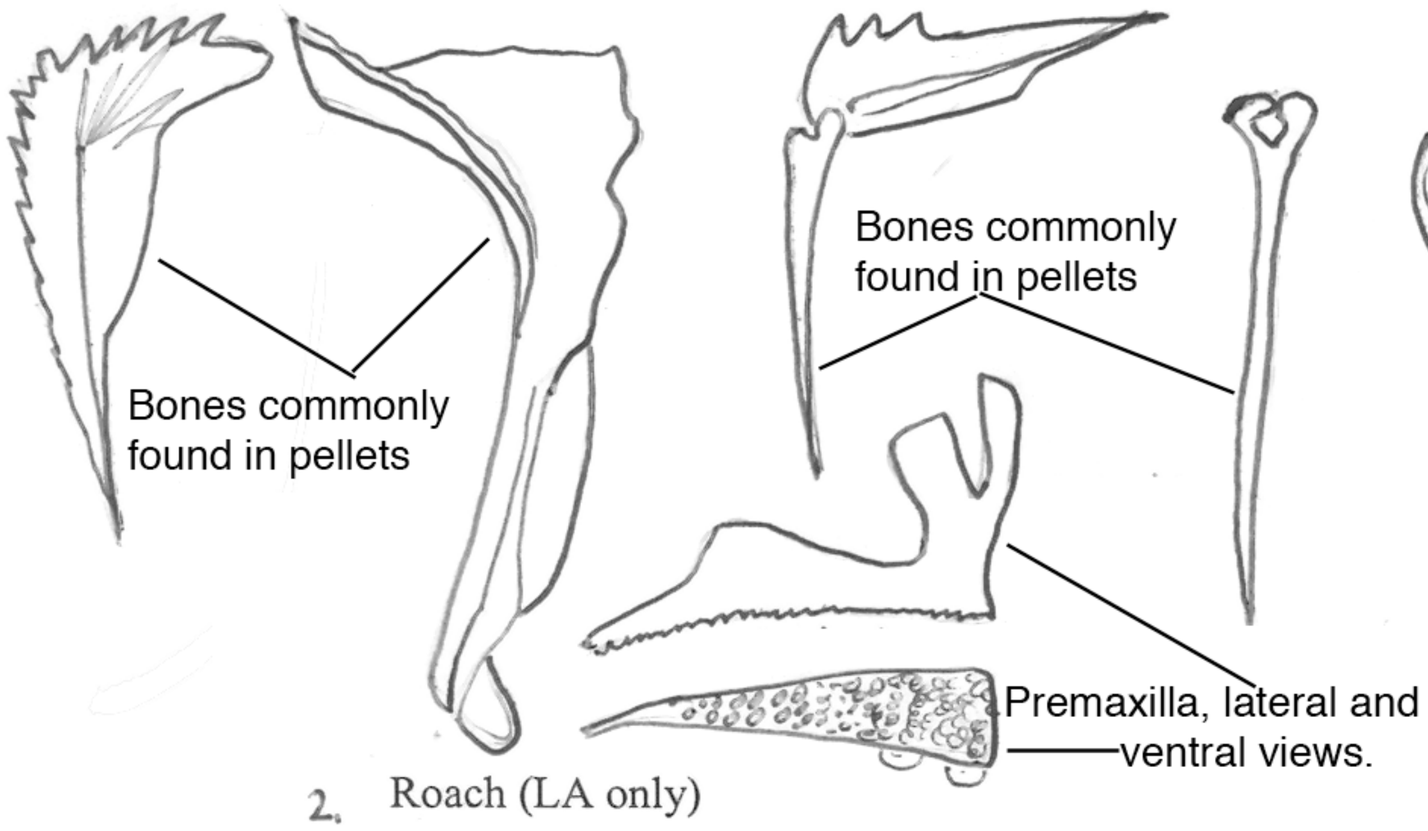
4. **Pipefish**
   a. Sygnathus rostellatus – Three planes on denticle.
   b. Sygnathus acus –Two planes on denticle. These vertebrae are likely to be larger, and are slightly different then those of Sygnathus rostellatus, Nilsson's pipefish.

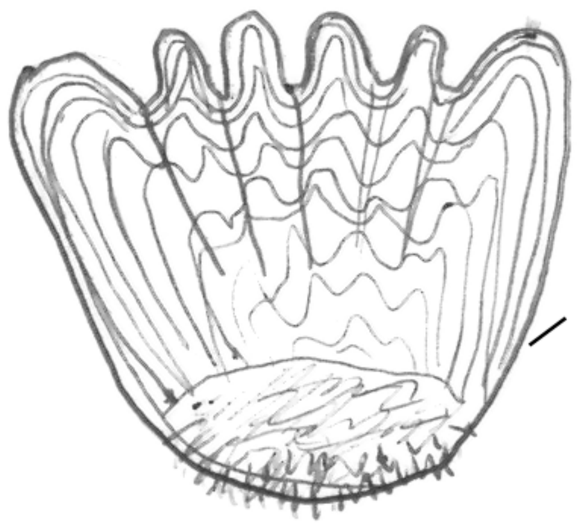


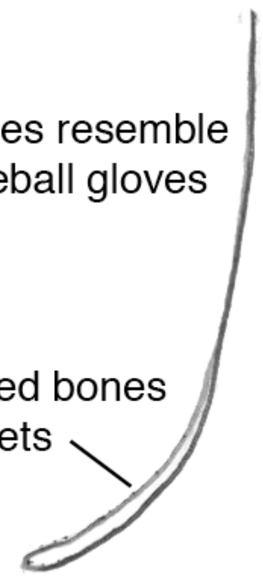
4. **Garfish** – Bones have green coloration. Jaws are elongated and teeth often remain in sockets.

Freshwater Fish – Phyargneal teeth and scales are used to identify between freshwater fish.

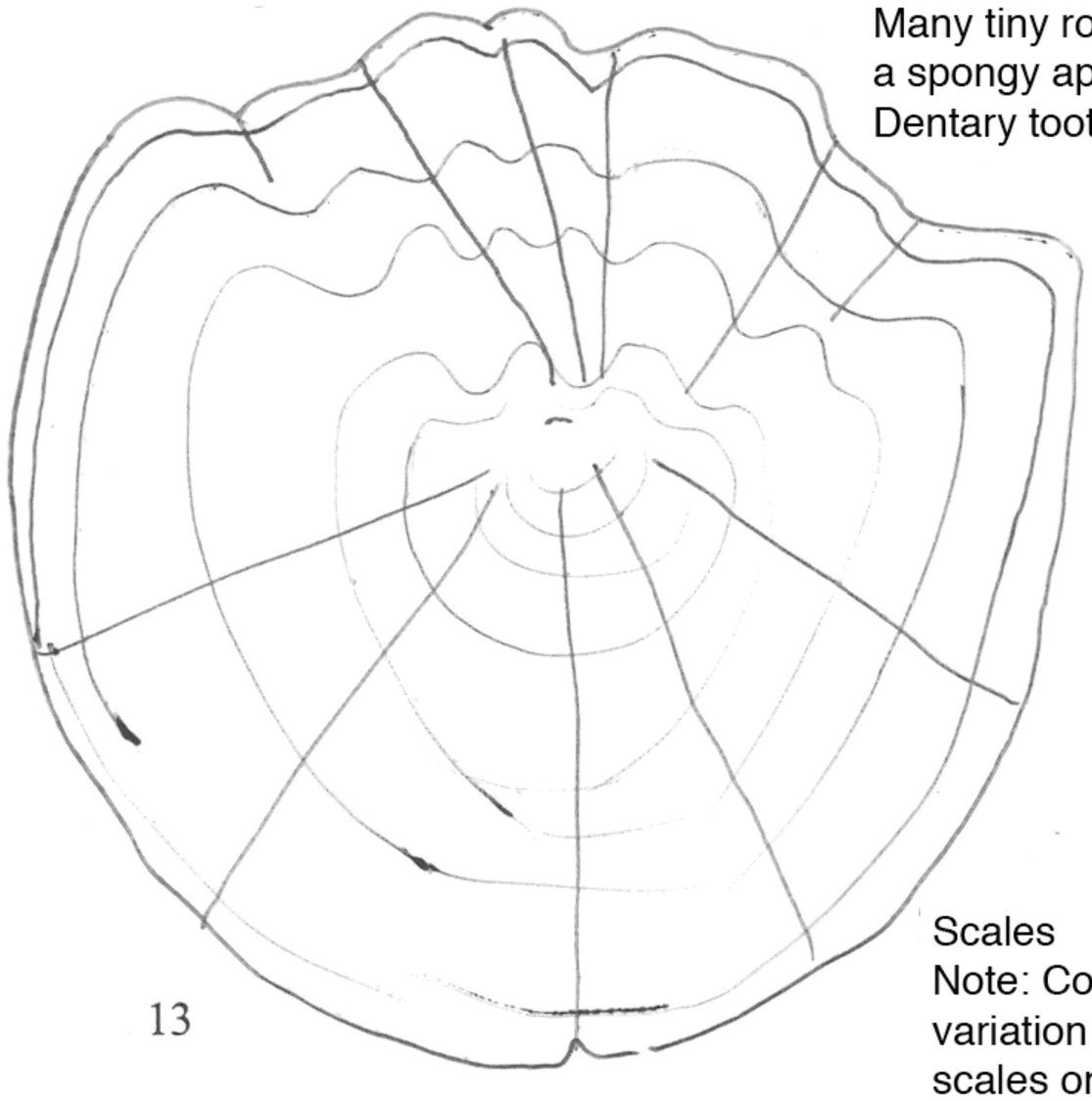
1. Perch (LA only)

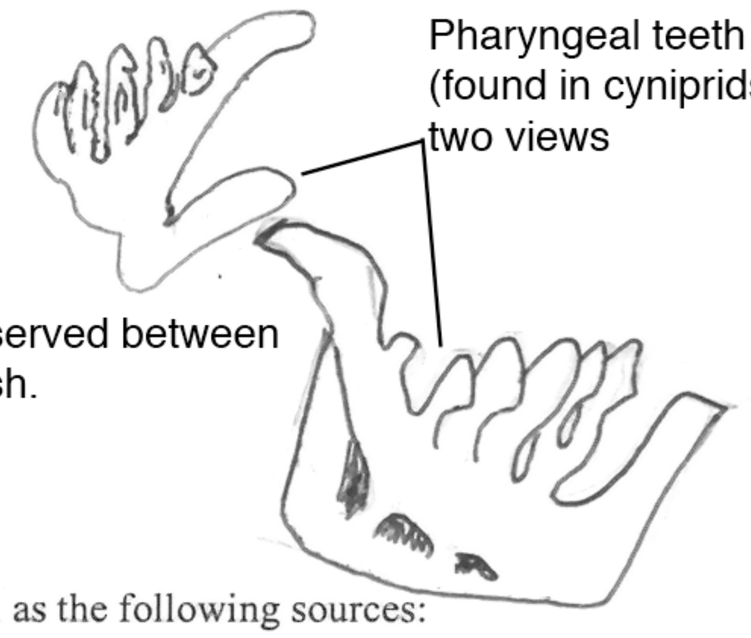






2. Roach (LA only)





Scales
Note: Considerable variation may be observed between scales on a single fish.

This guide uses material from the ID Fish Binder in the Nioz library as well as the following sources:

Harkonen, Tero. *Guide to the Otoliths of the Bony Fishes of the Northeast Atlantic.* Sweden: Danbiu ApS. Biological Consultants, 1986.

Hayward, Peter et al. *Collins Pocket Guide; Sea Shore of Britain and Northern Europe.* London: Harper Collins Publishers, 1996.

Maitland, Peter. *Keys to the Freshwater Fish of Britain and Ireland, with Notes on their Distribution and Ecology.* Scotland: Freshwater Biological Association, Scientific Publication No. 62, 2004.

Watt, J., Pierce, G. J., and Boyle, P. R. *ICES Cooperative Research Report: NO. 220, Guide to the Identification of North Sea Fish Using Premaxillae and Vertebrae.* International Council for the Exploration of the Sea. Printed by Trekroner Offset, Denmark, 1997.

Wheeler, Alwyne. *Key to the Fishes of Northern Europe.* London: Frederick Warne Publishers Ltd., 1978.

Guide created by Vicky Hunt
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