Identification of Michigan Fishes Using Cleithra

Great Lakes Fishery Commission

Miscellaneous Publication 2010-02

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May 2010

Identification of Michigan Fishes Using Cleithra

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ABOUT THE GUIDE

While working on a cormorant diet study, we were surprised to find that very little published information exists on methods for analyzing the diet of piscivorous animals and even less published information on techniques for identifying the bony structures of fish. The majority of past diet studies have relied on reference collections of bones to aid in the identification of partially digested prey items. Throughout our study, we found that cleithra are the most useful and easily identified bony structures for fish identification and were also the most resistant to digestion in cormorant stomachs. Few publications have explained the usefulness of cleithra as diagnostic bones while providing illustrations of representative species. To date, Hansel et al. (1988) provide the most extensive and useful information on cleithrum identification and morphology, but it is limited to 24 western fish species. We have not yet been able to find any published information on cleithra for species in the Great Lakes region, despite the interest from management agencies.

When we received training for diet analysis and bony structure identification from Mike Bur and Bill Edwards (U.S. Geological Survey (USGS), Lake Erie Biological Station) we were provided with an unpublished cleithrum identification guide (J. Jones, unpublished data). The guide contained more than 30 fish species common to the Great Lakes and proved to be an invaluable tool for cormorant diet analysis. Throughout the project, we built our own reference collection of cleithra and expanded the number of species not previously included in the USGS guide. This publication reflects our current progress and contains approximately 80 species of fish found in Michigan waters. We believe this guide will aid fisheries managers in improved identification and quantification of prey items, as well as enhanced knowledge of feeding habits and food-web interactions of aquatic organisms. We continue to expand our reference collection and expect that this guide may be a precursor to a more complete cleithrum identification guide for fish throughout the Great Lakes region.

This guide begins with a key to cleithra by general shape, which will lead the user to the family or group of families for further identification to species. Lateral views (LV) of cleithra are presented for most species as they are typically diagnostic, but, for some species, mostly within Cyprinidae, a dorsal view (DV) of the cleithrum is also presented to aid in identification. Caution should be used when identifying specimens within a family whose respective members are not all presented in this guide (e.g., the family Ictaluridae). Brown bullhead (*Ameiurus nebulosus*) cleithra are shown in this guide, but yellow bullhead (*Ictalurus natalis*) and black bullhead (*Ameiurus melas*) are not, so care should be taken when samples are collected where the species' ranges overlap. However, one of the benefits of using cleithra for fish identification is that, even if a cleithrum cannot be identified to the species level, it can often be identified to family or genus. Most species' cleithrum shape does not vary, but a few species (e.g., white perch (*Morone americana*), walleye, (*Sander vitreus*), and northern pearl dace (*Margariscus nachtriebi*) do exhibit some variation in cleithrum shape. In white perch and walleye, cleithrum changes appear to occur as fish grow larger, with the primary change being growth of serrations on the dorsoposterior lobe.

When using cleithra as a tool for identifying partially digested fish, it is important to consider that some erosion of the cleithra may have occurred, making them more difficult to identify. Cleithra are typically more robust and resist digestion better than other bony structures but do eventually digest. In cases where cleithra are partially digested, they can typically be identified to family or genus. It is helpful to develop a reference collection of cleithra for side-by-side comparisons, especially when differentiating between similar species. Variations in the color of cleithra shown in this guide are caused by preservatives, size of the specimen, and photo editing, and therefore should not be used as a diagnostic characteristic.

INTRODUCTION

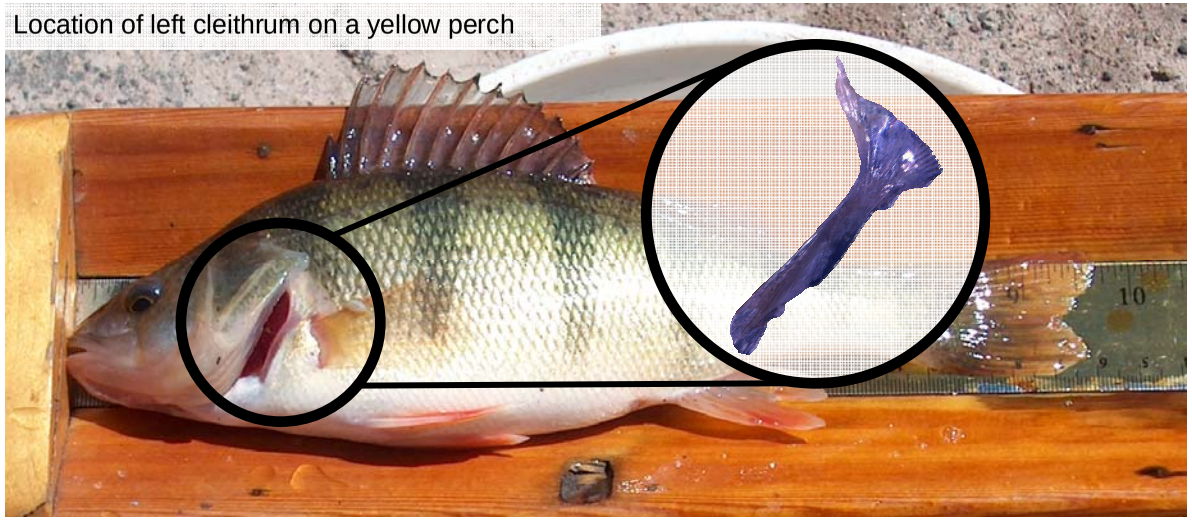
Diet analyses are a tool commonly used by fisheries managers to determine feeding habits and food-web interactions of aquatic organisms. Many different methods have been used to identify and quantify diets of piscivores, but each method has unique advantages and disadvantages. In many studies, only intact fish have been included in diet analyses—probably because of their ease of identification, minimal time requirement, or the lack of need for species-level identification. However, the most accurate diet analyses require identification and quantification of intact prey items as well as prey items that are partially or almost completely digested. There are several characteristic bony structures that can be used to identify partially digested fish, including otoliths, vertebrae, opercles, pharyngeal arches, dentaries, and cleithra. An advantage of using otoliths is that they can be used to identify fish to the species level. However, they are often difficult to find because of their small size, and they tend also to digest quickly and can be dissolved by acidic preservatives such as formalin (McMahon and Tash 1979). In comparison, vertebrae can also be used to identify fish to the species-level (Pikhu and Pikhu 1970), and they resist digestion better than otoliths. However, vertebrae are more difficult to quantify than paired structures such as otoliths and cleithra because each individual vertebra must be identified and accounted for. Opercles, pharyngeal arches, and dentaries have been used also to identify fish and are advantageous because they resist digestion better than less robust bony structures (Hansel et al. 1988). Although these structures can be used to accurately identify fish remains, cleithra may be the easiest and most effective structure.

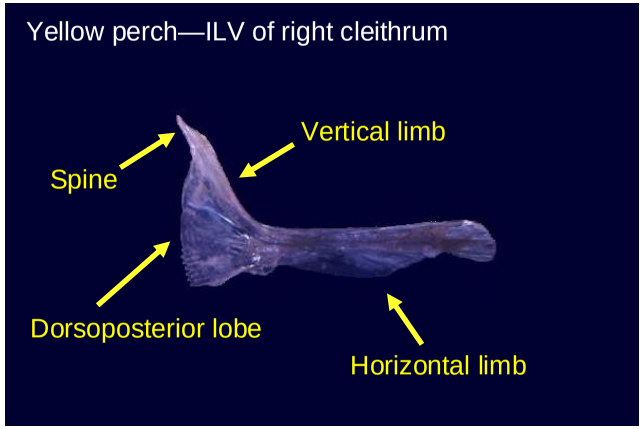
Cleithra are the major bones of the pectoral girdle. They are paired structures with one located on each side of the fish and together form the frame of the body wall directly posterior to the opercular cavity (Scharf et al. 1998). There are many advantages to using cleithra as a diagnostic bony structure. Not only can they be used to identify many fishes to the species level (Hansel et al. 1988; Scharf et al. 1998), but they can also be used to age fish (Harrison and Hadley 1979) and to estimate the original length of partially digested fish (Hansel et al. 1988; Scharf et al. 1998; Bur et al. 1997). Cleithra are also effective structures for diet analysis because they resist digestion better than many other diagnostic bones, which makes it possible to accurately quantify the number of prey items in a predator’s stomach.

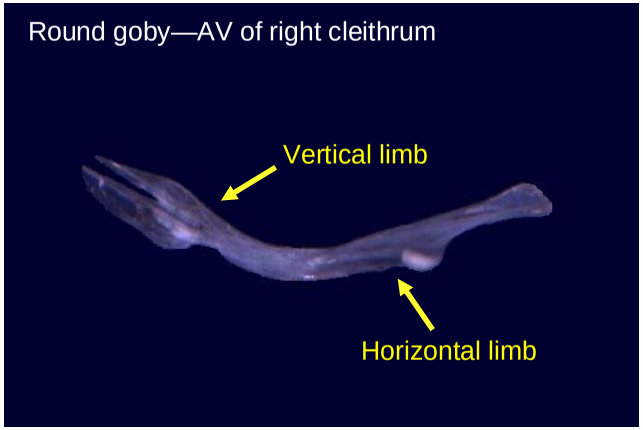
In a recent diet study of double-crested cormorants in Thunder Bay, Michigan, cleithra were used to identify partially digested fish. Of all prey items found in stomachs, 46% percent were identified using cleithra (A. Moerke, Lake Superior State University, unpublished data). In another study of double-crested cormorant diets conducted on Brevoort Lake, Michigan, stomach samples were initially analyzed using only intact prey items. The same samples were then re-analyzed using cleithra to identify partially digested fish. Use of cleithra resulted in finding an additional 16% more prey items, including four additional fish species (A. Moerke, Lake Superior State University, unpublished data). Relying solely on intact prey items for identification would have resulted in underestimates of prey items consumed as well as a larger proportion of unidentified fishes. The results of these studies suggest that using cleithra is a reasonable approach for analyzing gut contents of piscivores. However, identification guides to assist with cleithrum identification did not exist previously, yet are needed to assist managers with identifying fish remains.

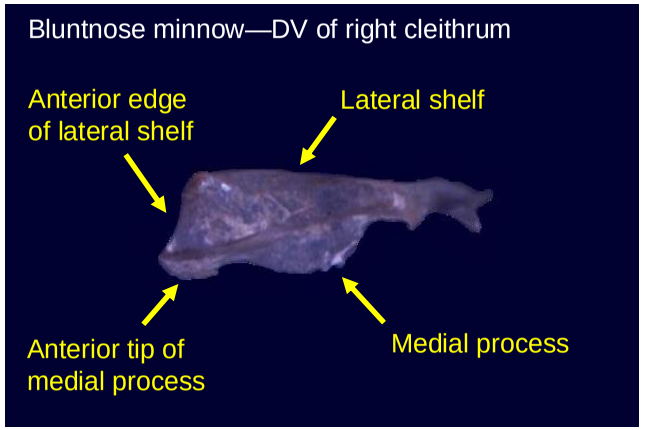
CLEITHRUM MORPHOLOGY

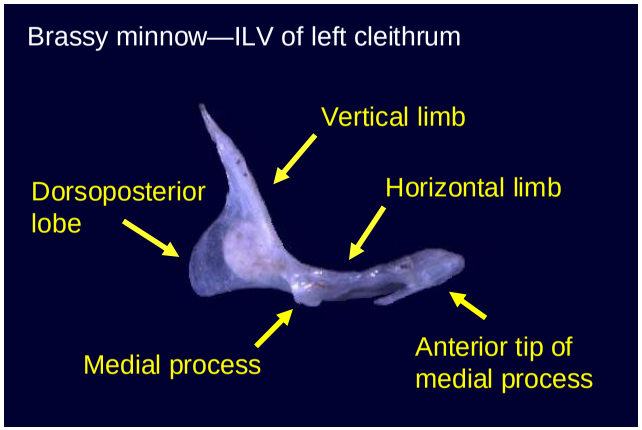
Cleithra are the major bones of the pectoral girdle. They are a paired structure, with one bone located on each side of the fish; together they form the frame of the body wall directly posterior to the opercular cavity (Scharf et al. 1998). Cleithrum morphology is described from four views: inside lateral view (ILV), outside lateral view (OLV), dorsal view (DV), and anterior view (AV). Morphological terminology used in this guide was adapted from Hansel et al. 1988.

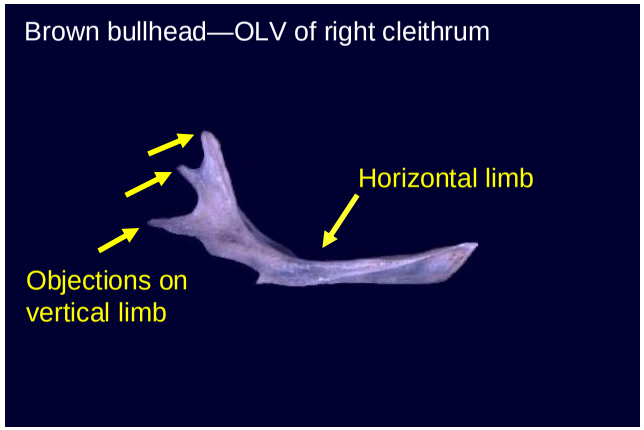


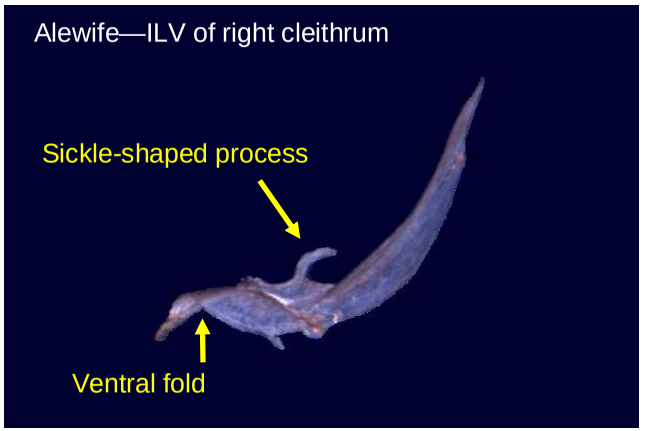






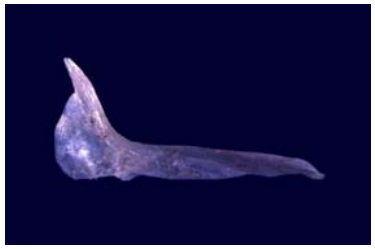






KEY BY GENERAL SHAPE

Select the general cleithrum shape (lateral view) and proceed to the corresponding page(s).



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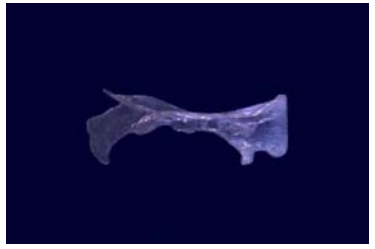
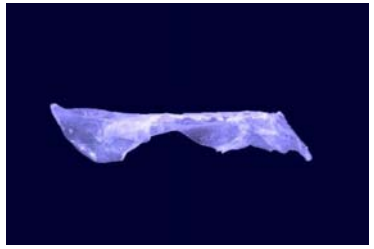
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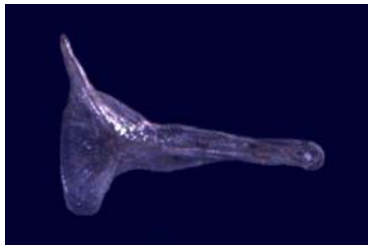

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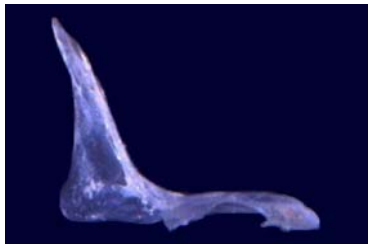
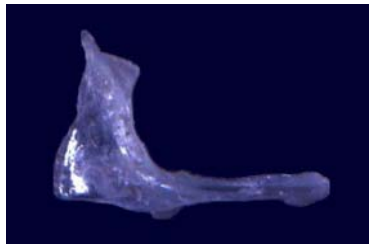
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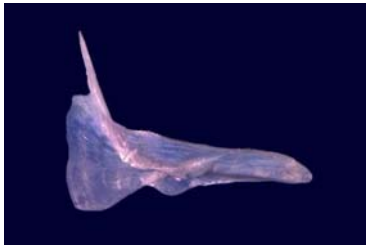
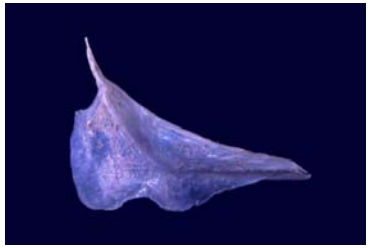
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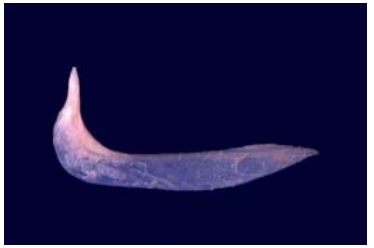

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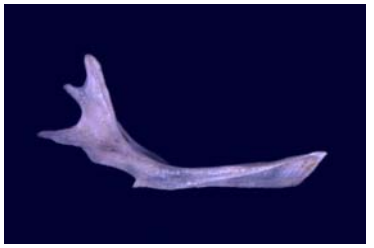
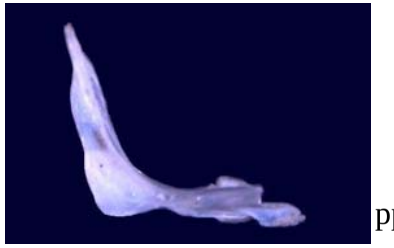
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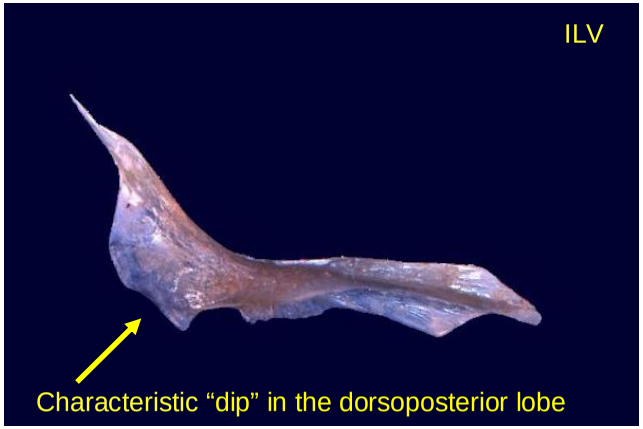
IDENTIFICATION BY FAMILY

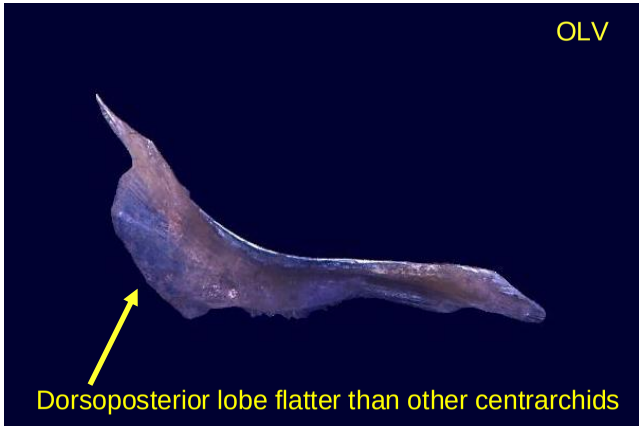
Family Centrarchidae

Cleithra are characterized by longer horizontal limbs than vertical limbs, a well-pronounced dorsoposterior lobe lacking serrations, and a short spine at the apex of the vertical limb. Most centrarchid species in this guide can be easily differentiated with the exception of smallmouth bass and largemouth bass, whose cleithra are very similar in size and shape.

Bluegill (*Lepomis macrochirus*)

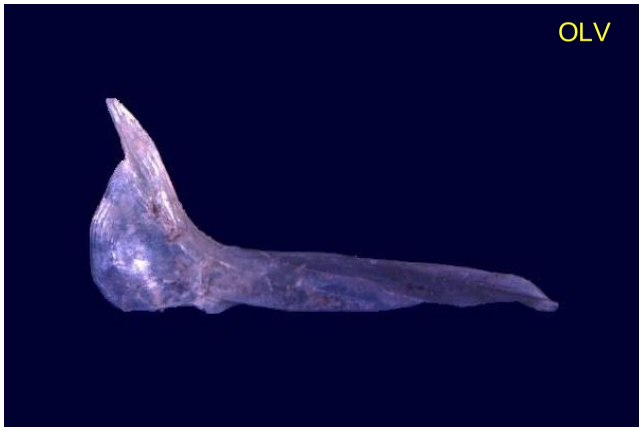


Pumpkinseed (*Lepomis gibbosus*)

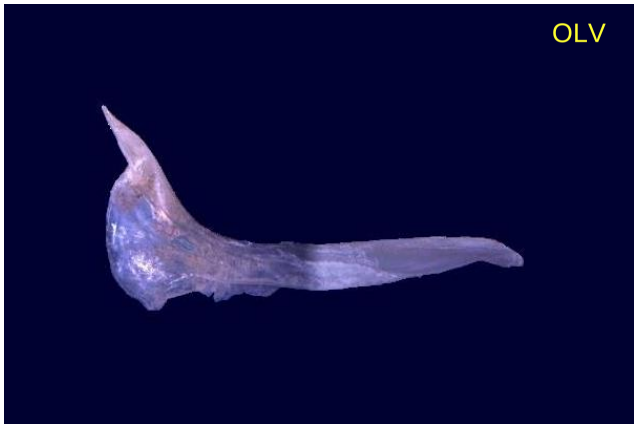


Family Centrarchidae, continued

Smallmouth bass (*Micropterus dolomieu)*

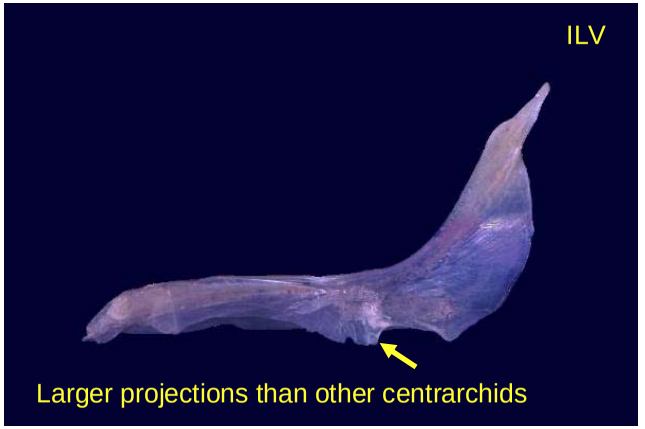


Largemouth bass (*Micropterus salmoides*)

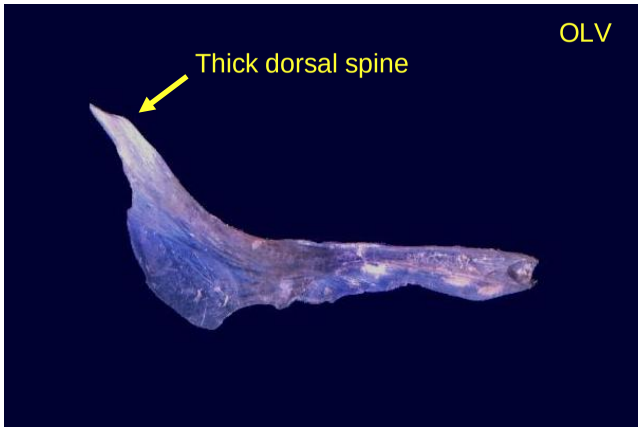


Family Centrarchidae, continued

Rock bass (*Ambloplites rupestris)*



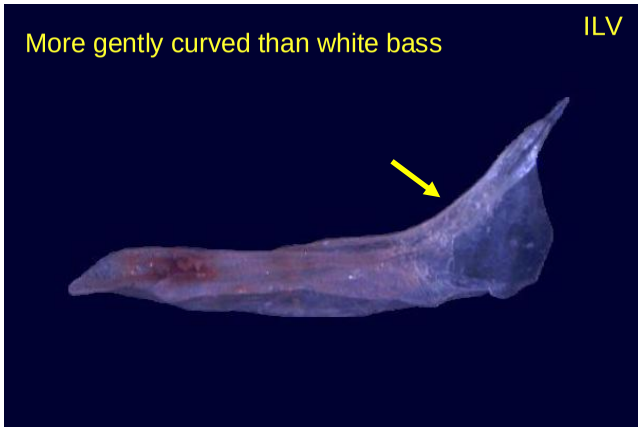
Black crappie (*Pomoxis nigromaculatus*)



Family Moronidae

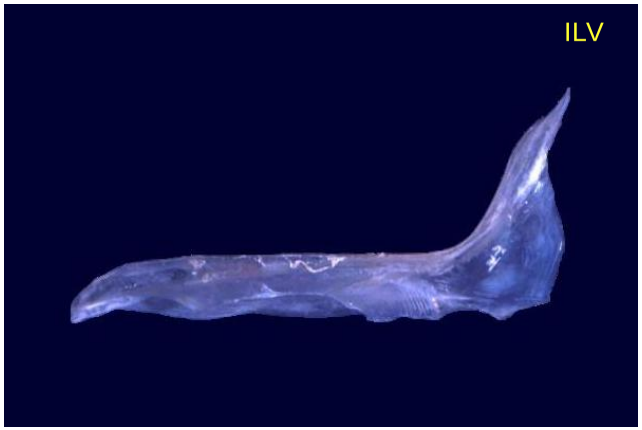
Cleithra are similar to the cleithra of centrarchids. They are characterized by longer horizontal limbs than vertical limbs, a well-pronounced dorsoposterior lobe, and a short spine at the apex of the vertical limb. Examples of cleithra from both small and large white perch are presented in this guide because some of their characteristics appear to change as they grow larger. Larger specimens of white perch cleithra generally have small serrations on a more rounded dorsoposterior lobe, whereas smaller specimens often lack serrations on a less rounded dorsoposterior lobe.

White perch *(Morone americana)*



Family Moronidae, continued

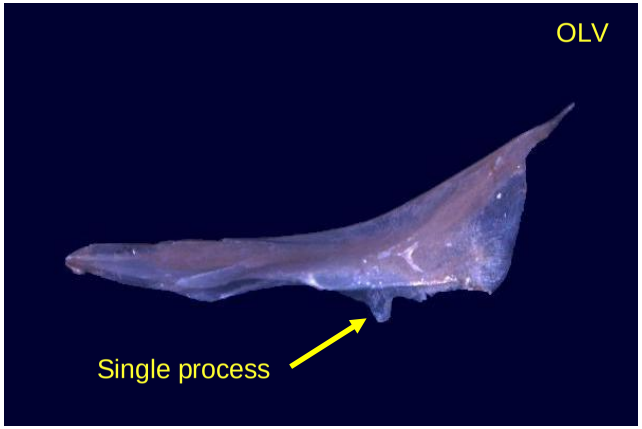
White bass (*Morone chrysops)*



Family Sciaenidae

Freshwater drum cleithra are similar to centrarchid and moronid cleithra. They are characterized by longer horizontal limbs than vertical limbs, a flat dorsoposterior lobe lacking serrations, a short spine at the apex of the vertical limb, and a single process extending from the ventral side of the horizontal limb.

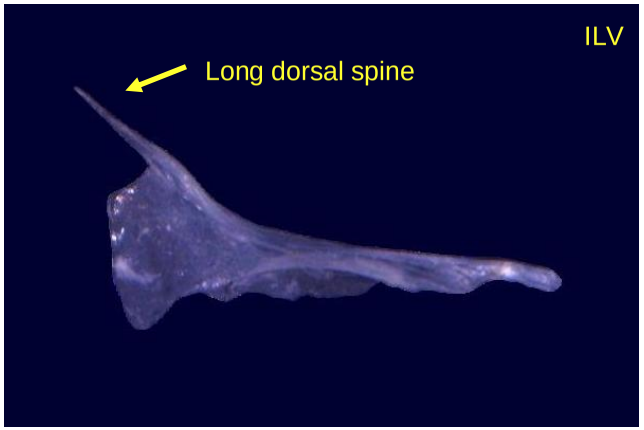
Freshwater drum (*Aplodinotus grunniens*)

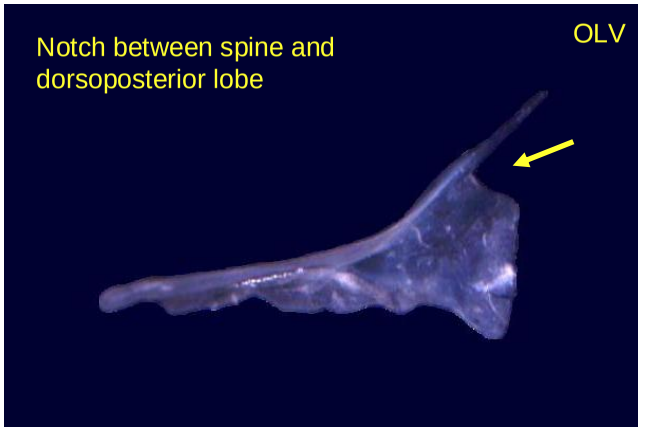


Family Percopsidae

Troutperch cleithra are characterized by longer horizontal limbs than vertical limbs, a long spine at the apex of the vertical limb, and a notch between the spine and dorsoposterior lobe.

Troutperch (*Percopsis omiscomaycus)*

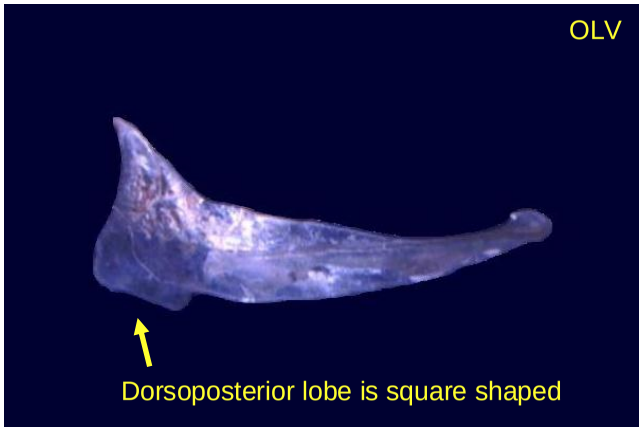


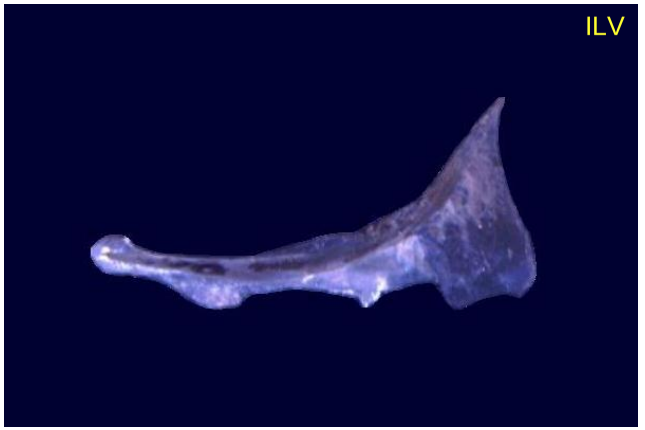


Family Fundulidae

Western banded killifish cleithra are characterized by longer horizontal limbs than vertical limbs and a square-shaped dorsoposterior lobe.

Western banded killifish (*Fundulus diaphanus menona*)

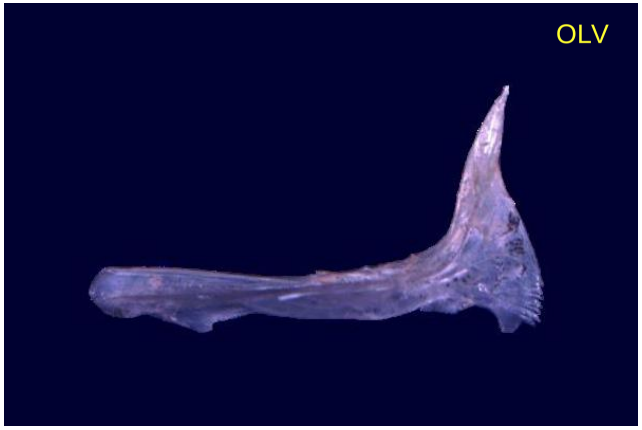




Family Percidae

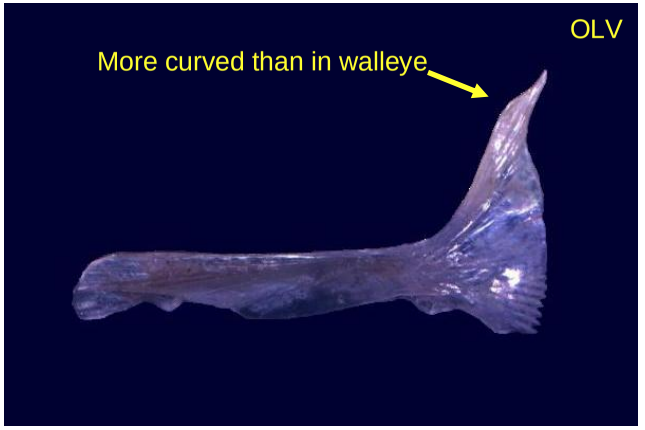
Cleithra can be separated into two groups by general shape—one group represented by yellow perch, walleye, and ruffe, and the other by darters. Yellow perch and walleye cleithra are characterized by longer horizontal limbs than vertical limbs, a well-pronounced dorsoposterior lobe, and a short spine at the apex of the vertical limb. Yellow perch cleithra always have serrations on the dorsoposterior lobe, whereas walleye cleithra may or may not have serrations. Because of their similarities, yellow perch and walleye cleithra are sometimes difficult to differentiate.

Walleye (*Sander vitreus)*

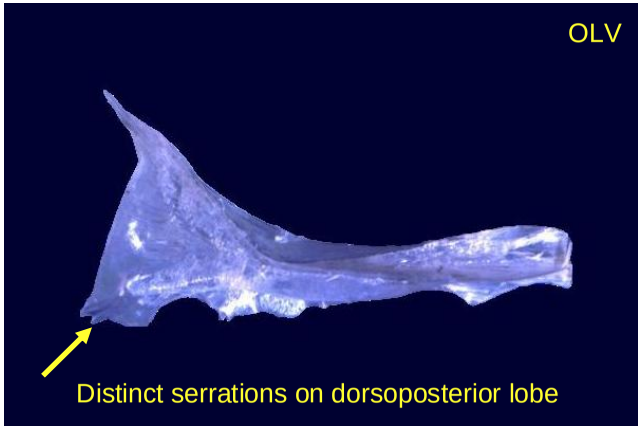


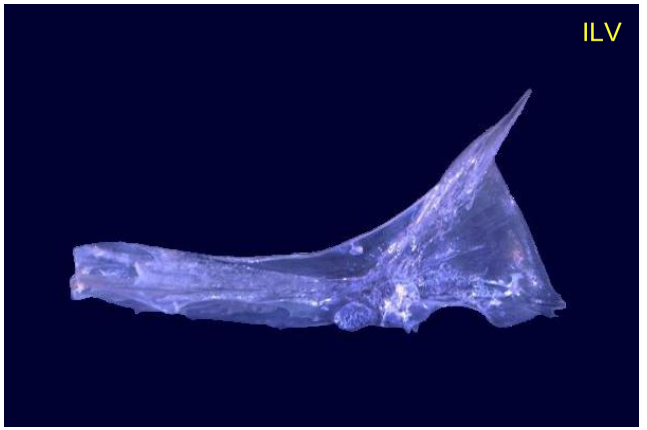
Family Percidae, continued

Yellow perch (*Perca flavescens)*



Ruffe (*Gymnocephalus cernuus*)

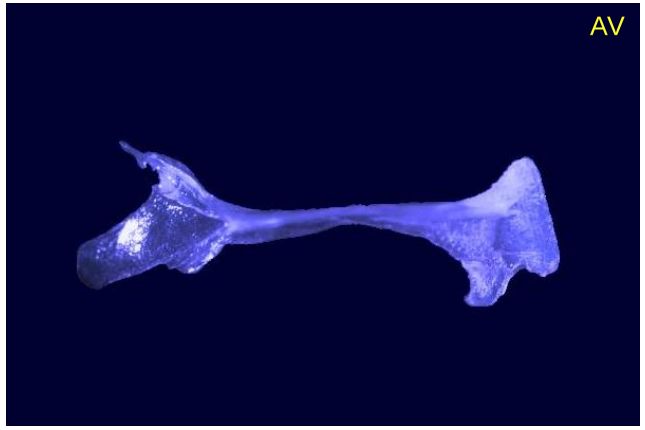


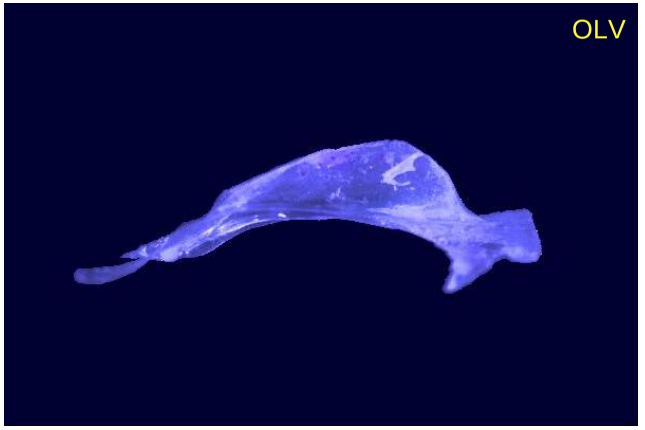


Family Percidae, continued

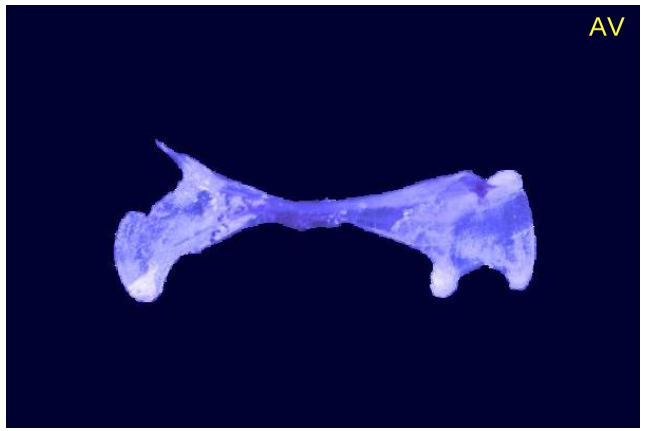
The cleithra of darters are very similar and may not be diagnostic to the species level. However, they can easily be separated from other families. Darter cleithra are characterized by protruding dorsoposterior lobes, a large notch between the dorsoposterior lobe and spine on the apex of the vertical limb, and a “club” on the anterior end of the horizontal limb.

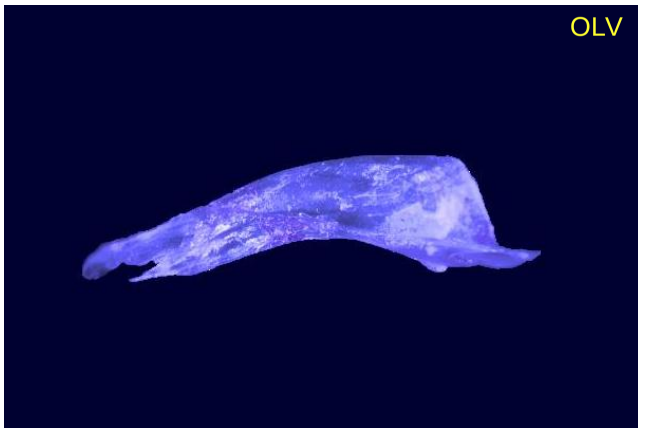
Striped fantail darter (*Etheostoma flabellare lineolatum*)





Blackside darter (*Percina maculata*)

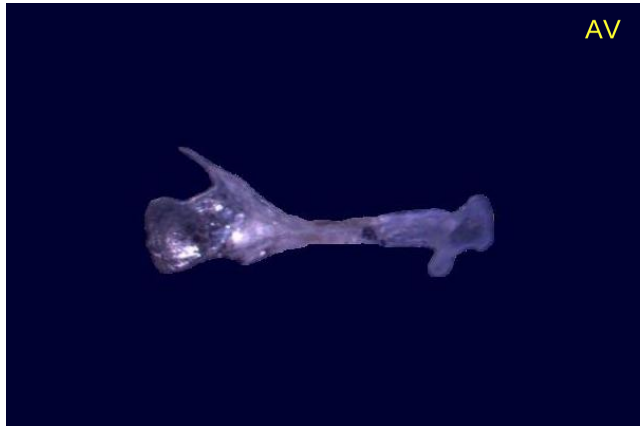


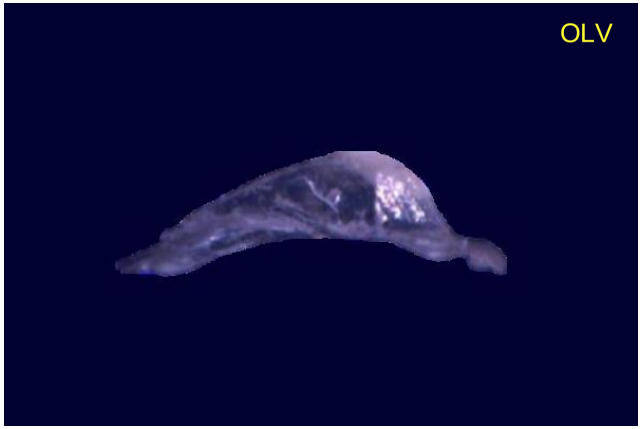


Family Percidae, continued

Johnny darter (*Etheostoma nigrum)*

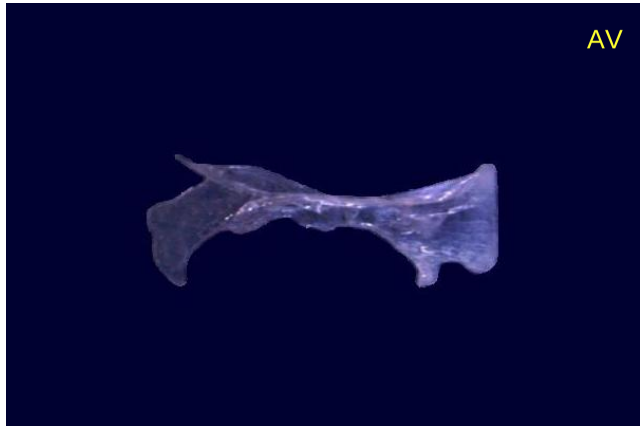
Iowa darter (*Etheostoma exile*)





Family Percidae, continued

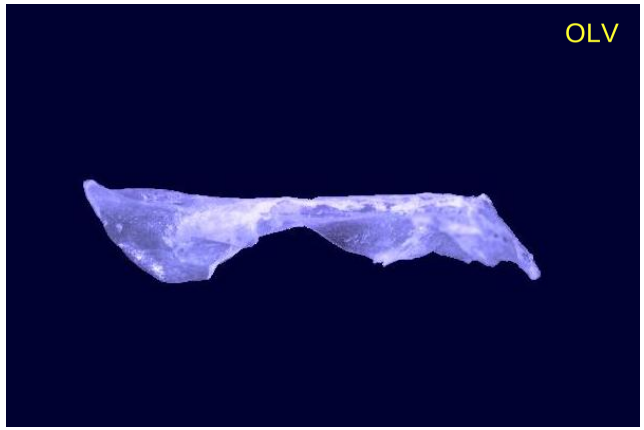
Northern logperch (*Percina caprodes semifasciata*)

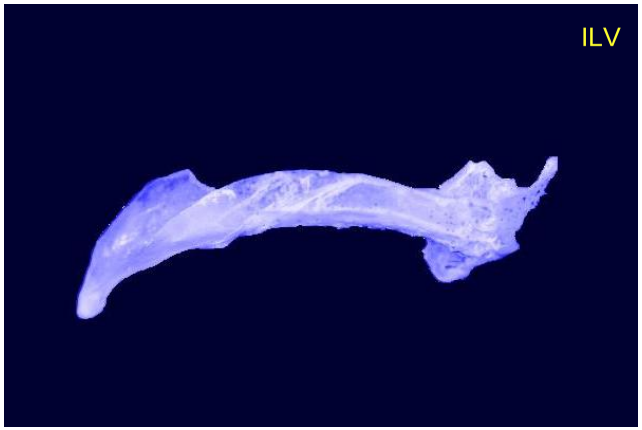


Family Atherinidae

Brook silverside cleithra are easily separated from other families. They are most similar to darter cleithra but lack a spine on the apex of the vertical limb.

Brook silverside (*Labidesthes sicculus*)

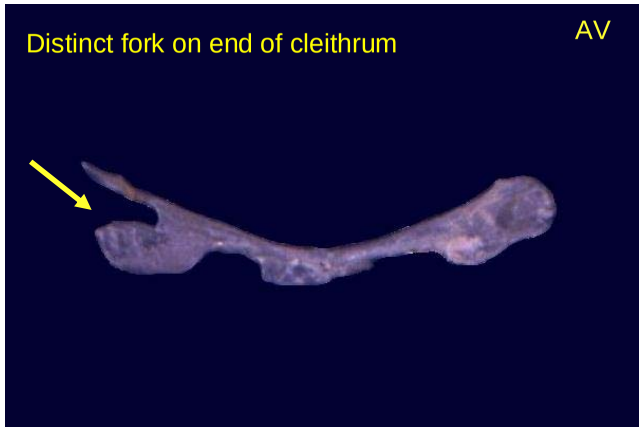


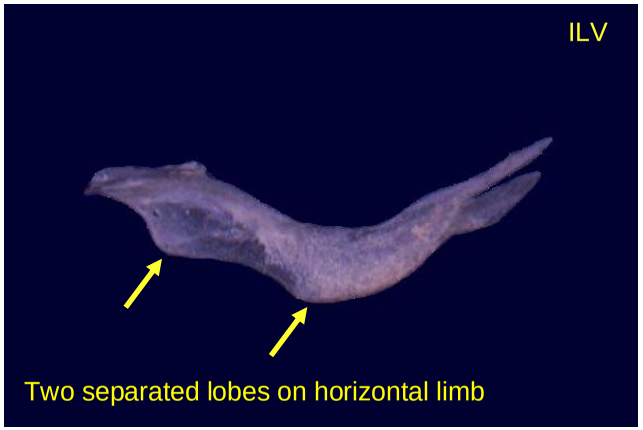


Family Cottidae

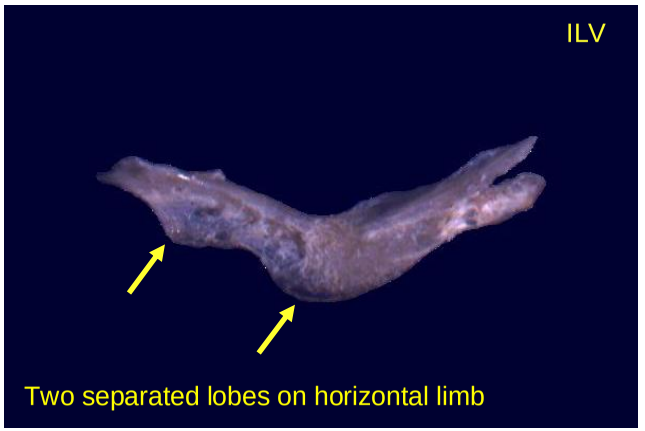
Mottled and slimy sculpin cleithra are difficult to differentiate but are easily separated from other families by the presence of a large fork on the dorsal end and two separated lobes on the ventral side of the horizontal limb. Deepwater sculpin cleithra lack the two separated lobes on the horizontal limb.

Mottled sculpin (*Cottus bairdii)*



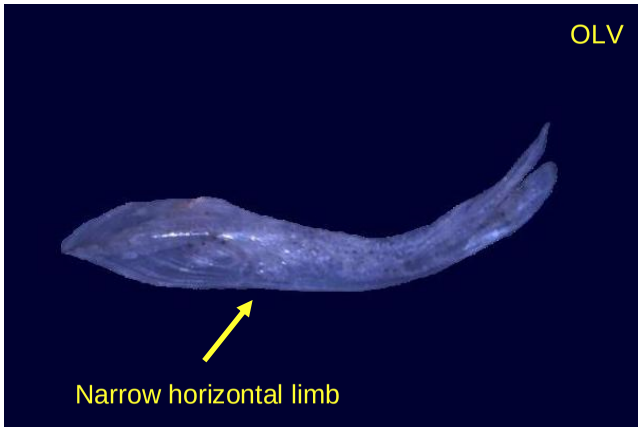


Slimy sculpin (*Cottus cognatus*)



Family Cottidae, continued

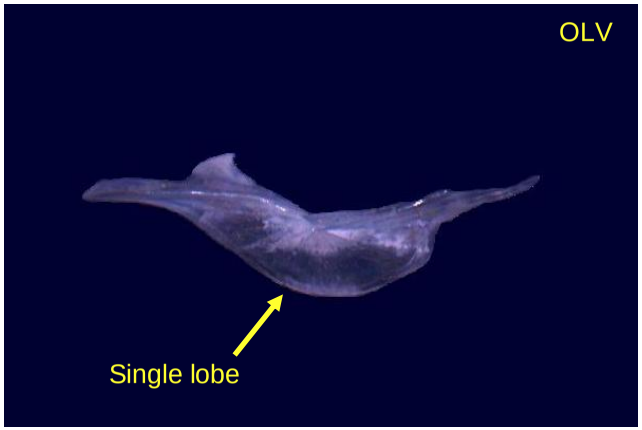
Deepwater sculpin (*Myoxocephalus thompsonii)*



Family Gobiidae

Round goby cleithra are characterized by having a large fork on the dorsal end and a single rounded lobe on the ventral side of the horizontal limb.

Round goby (*Neogobius melanostomus)*

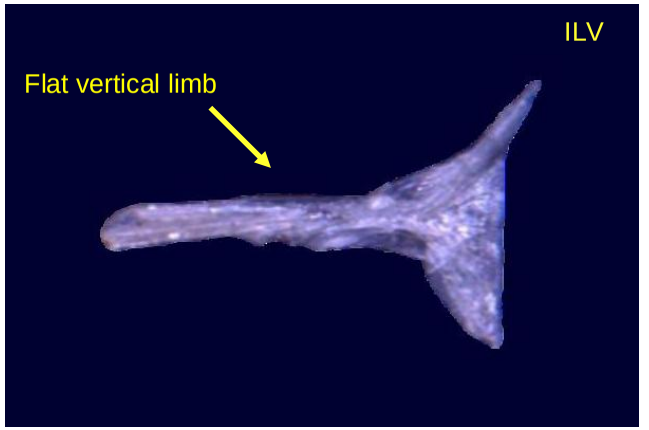


Family Gasterosteidae

Stickleback cleithra are characterized by longer horizontal limbs than vertical limbs; flat or curved dorsoposterior lobes; and narrow, flat horizontal limbs, with the exception of the ninespine stickleback, which has a large process on the ventral side of the horizontal limb.

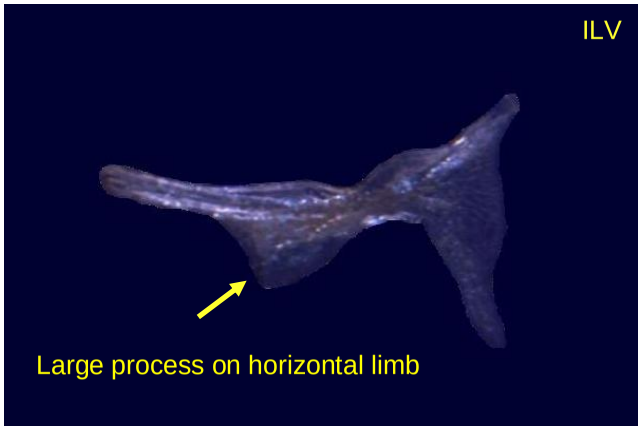
Brook stickleback (*Culaea inconstans*)

Threespine stickleback (*Gasterosteus aculeatus)*



Family Gasterosteidae, continued

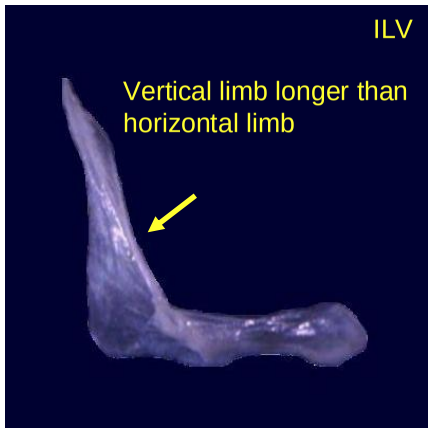
Ninespine stickleback (*Pungitius pungitius)*

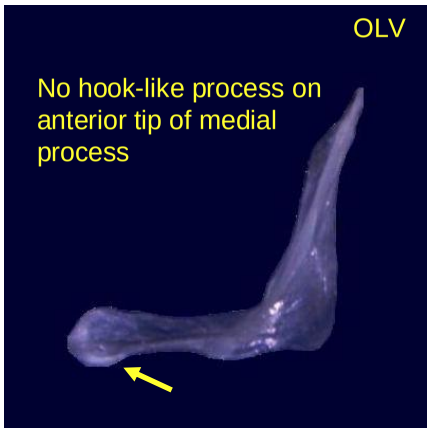


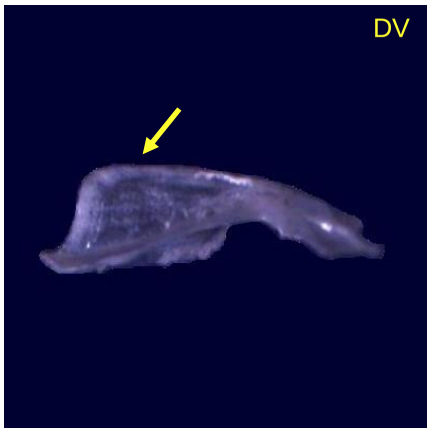
Family Cyprinidae

Cyprinid cleithra are easily distinguished from other families but can be difficult to distinguish within their family. They have vertical and horizontal limbs of varying lengths, varying sizes and shapes of dorsoposterior lobes, and may or may not have a hook-like process on the anterior tip of the medial process. Unlike most other families, cyprinids can also be distinguished by the shape of the lateral shelf (from the dorsal view). In similar species, the shape of the lateral shelf is often the most diagnostic characteristic.

Fathead minnow (*Pimphales promelas)*

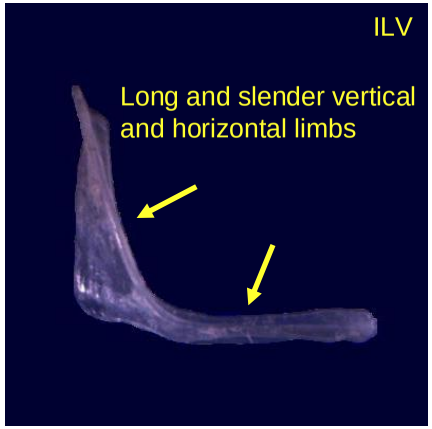


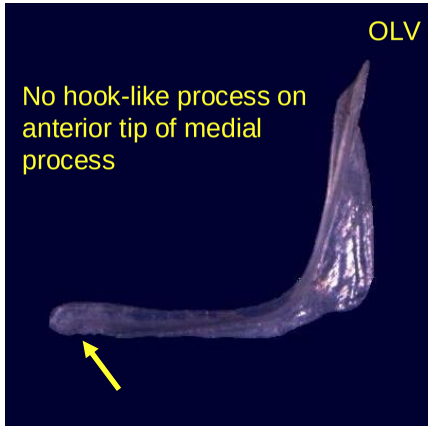


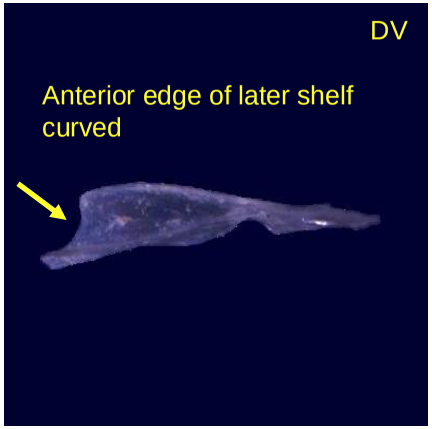


Family Cyprinidae, continued

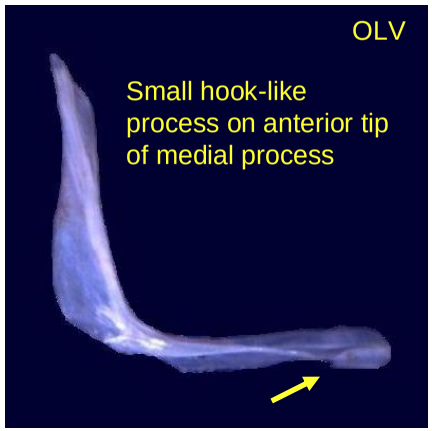
Creek chub (*Semotilus atromaculatus)*

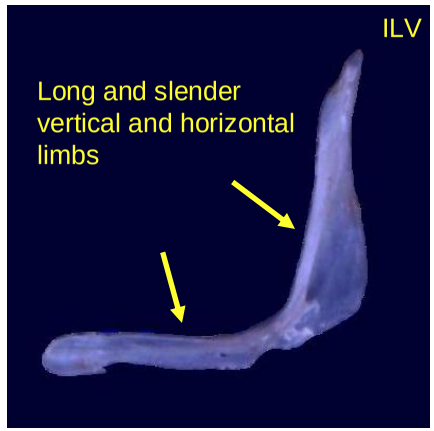


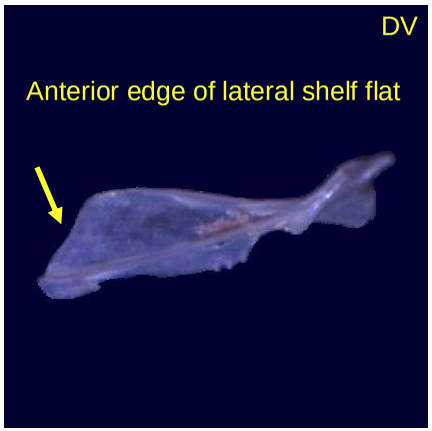




Hornyhead chub (*Nocomis biguttatus)*

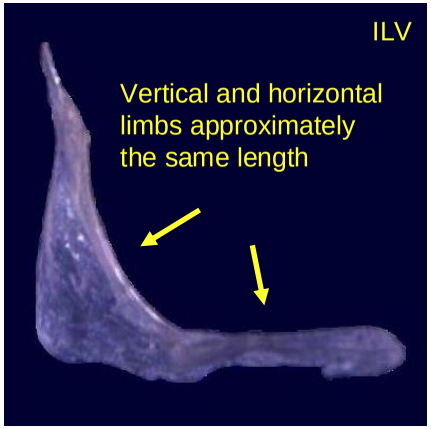


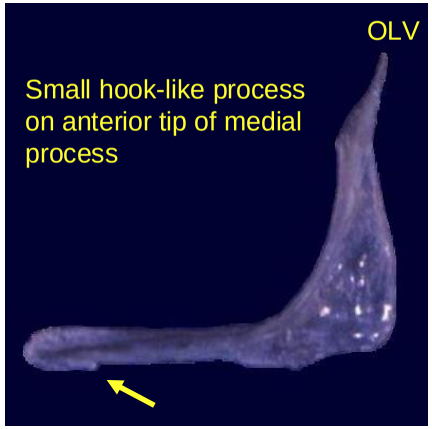


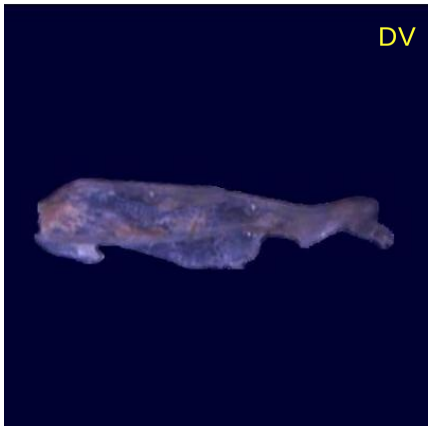


Family Cyprinidae, continued

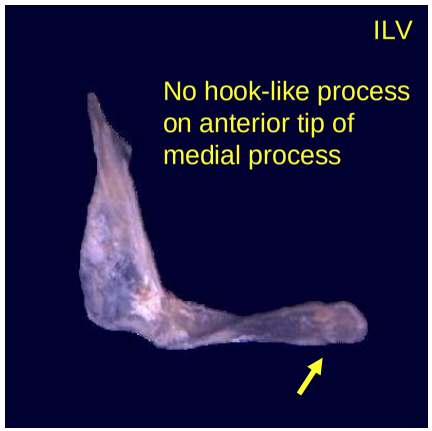
Redside dace (*Clinostomus elongatus)*

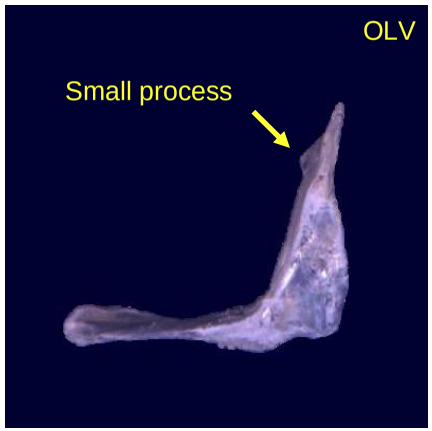


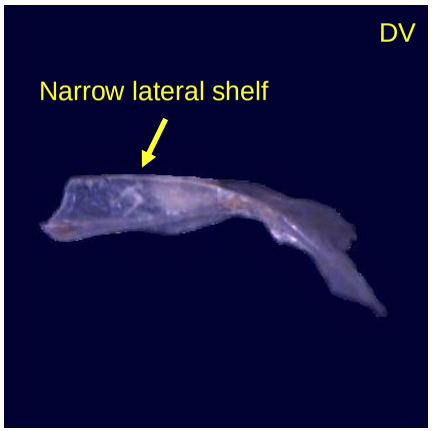




Common shiner (*Luxilus cornutus)*

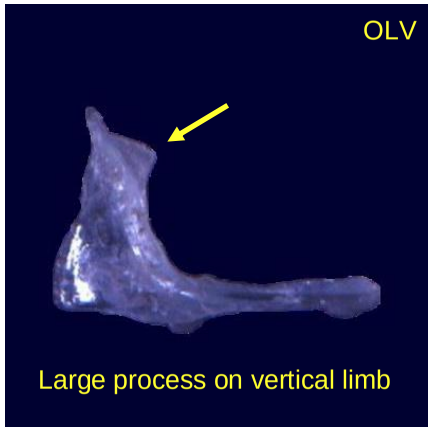


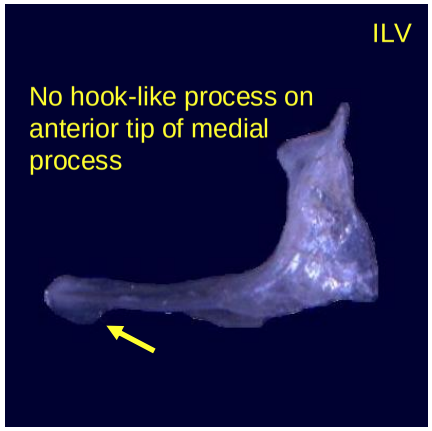


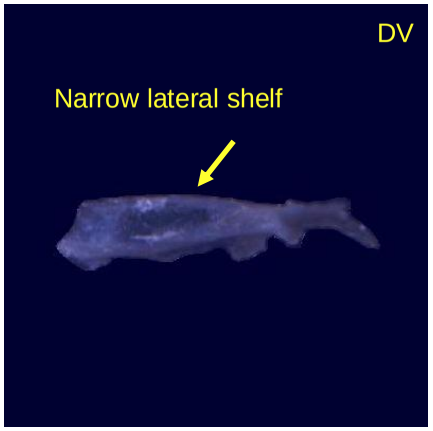


Family Cyprinidae, continued

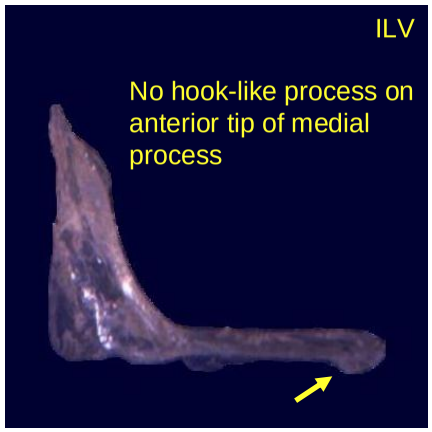
Sand shiner (*Notropis stramineus)*

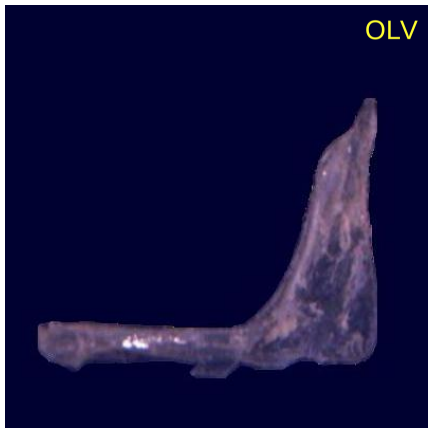


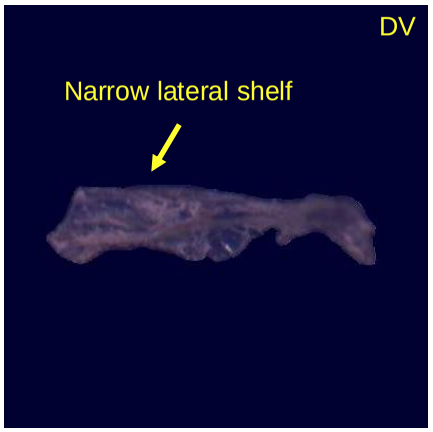




Mimic shiner (*Notropis volucellus)*

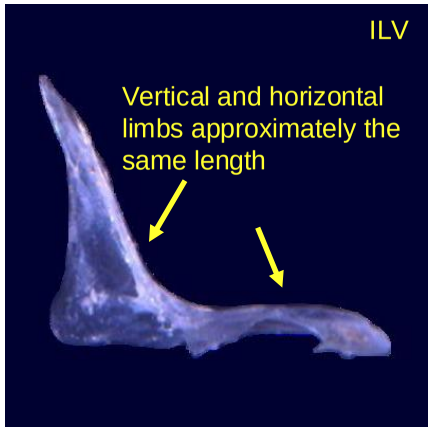


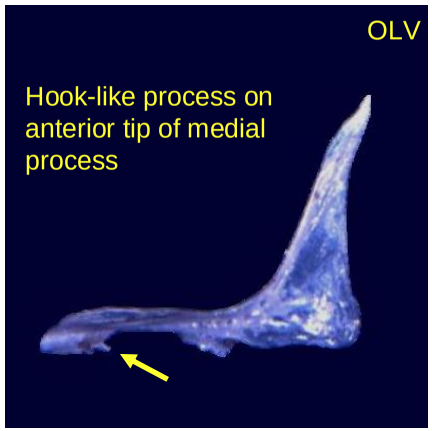


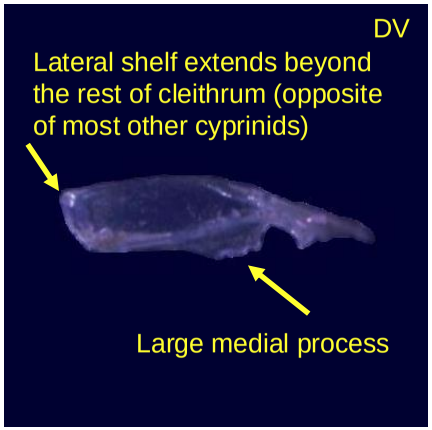


Family Cyprinidae, continued

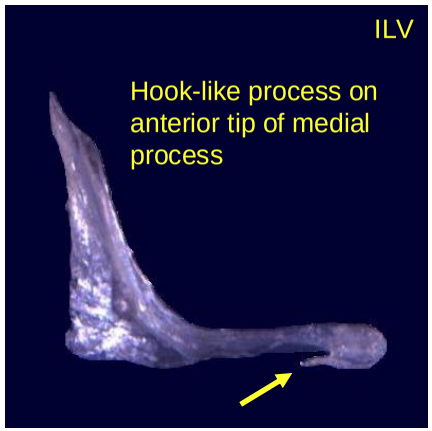
Emerald shiner (*Notropis atherinoides)*

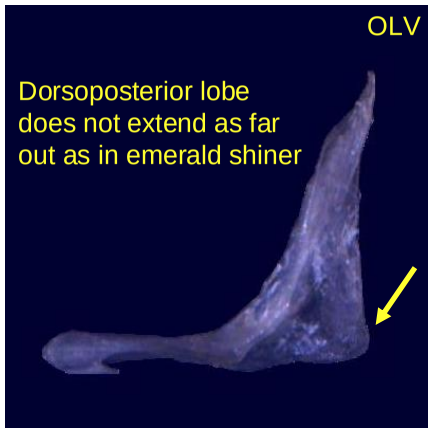






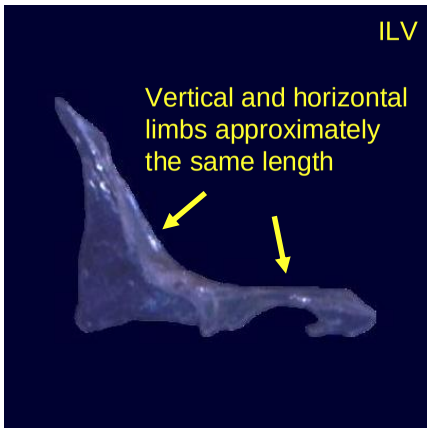
Spottail shiner (*Notropis hudsonius)*

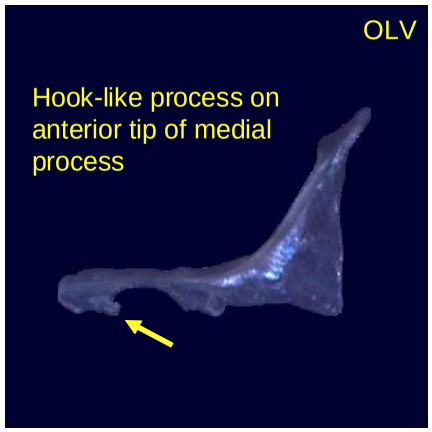


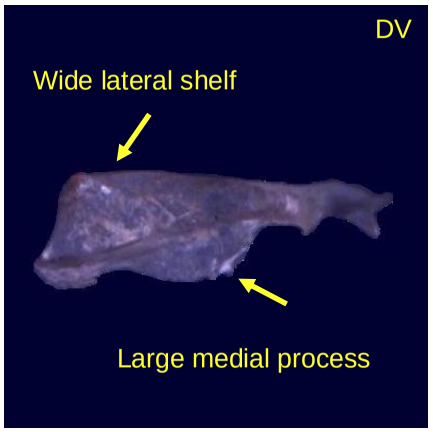


Family Cyprinidae, continued

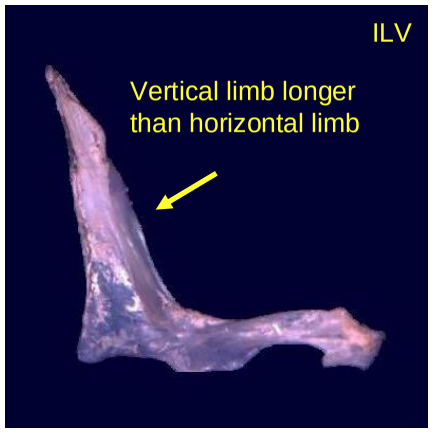
Bluntnose minnow (*Pimephales notatus)*

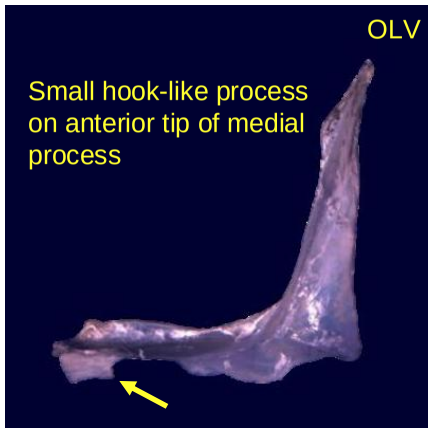


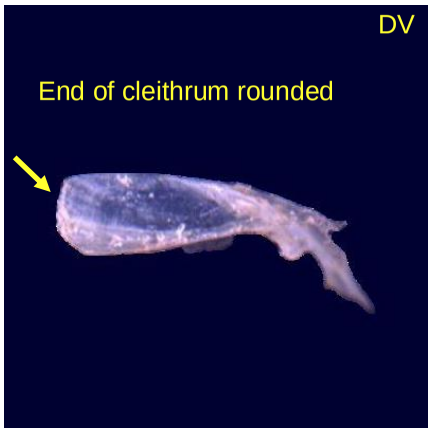




Golden shiner (*Notemigonus crysoleucas)*

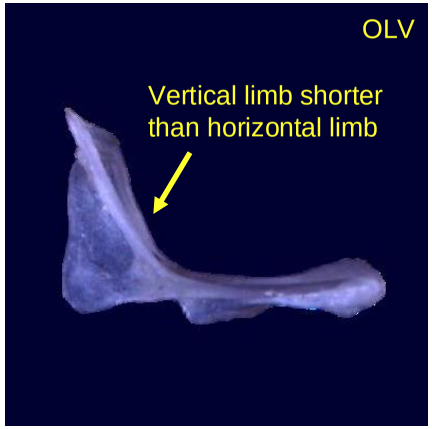


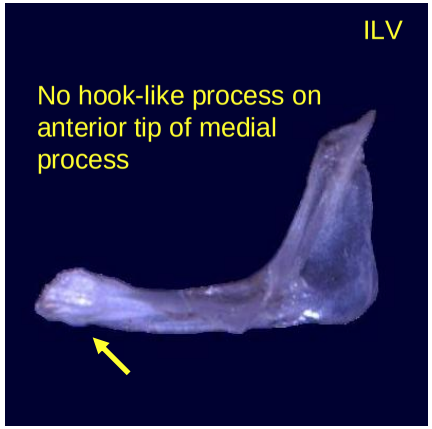




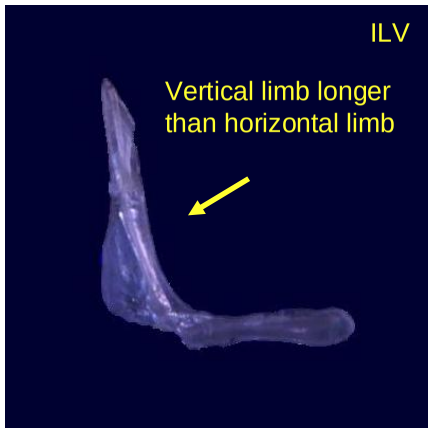
Family Cyprinidae, continued

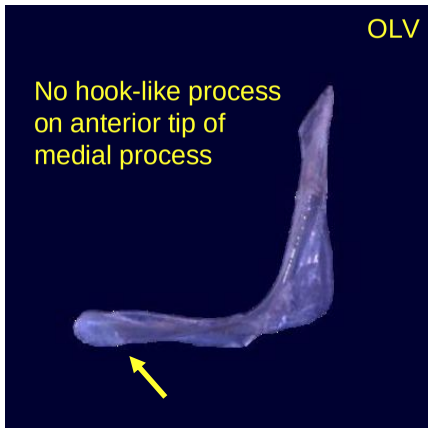
Northern redbelly dace (*Phoxinus eos)*

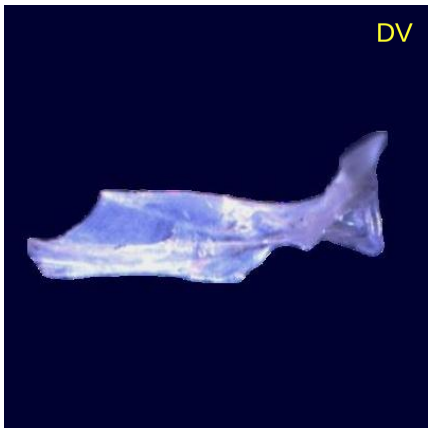




Finescale dace (*Phoxinus neogaeus)*

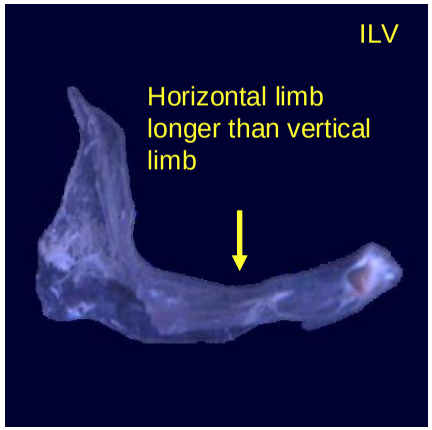


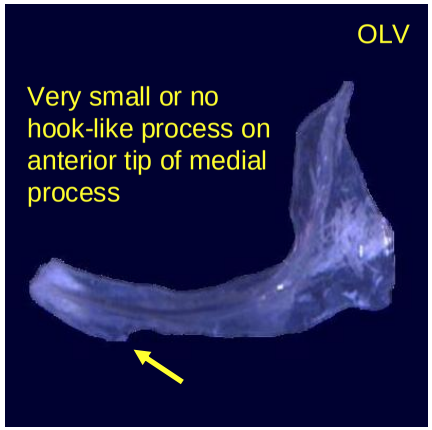


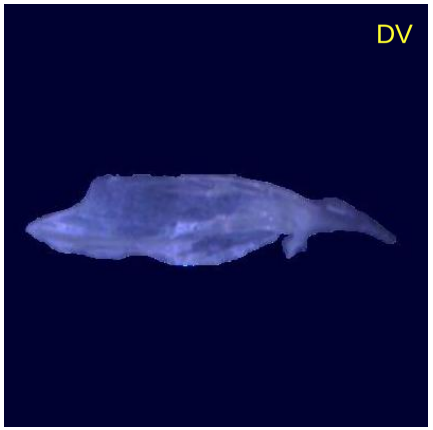


Family Cyprinidae, continued

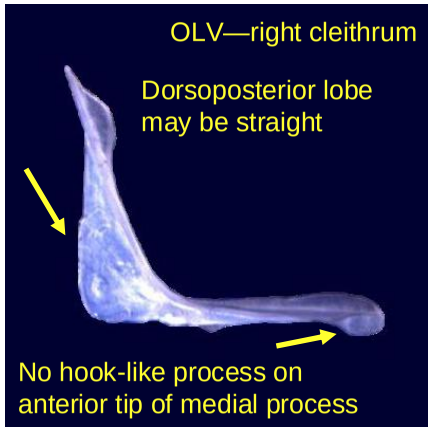
Blacknose shiner (*Notropis heterolepis)*

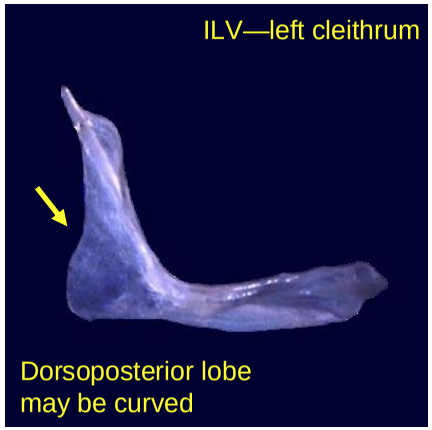






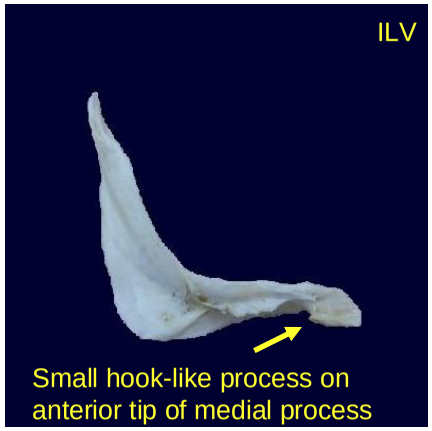
Northern pearl dace (*Margariscus nachtriebi)*



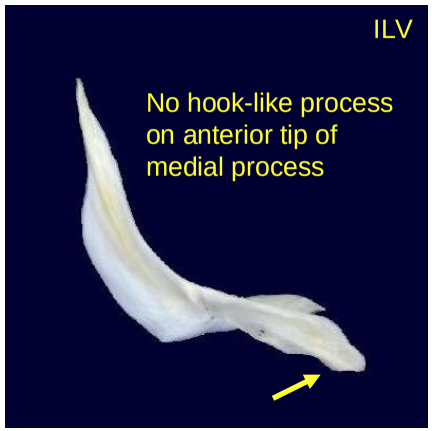


Family Cyprinidae, continued

Common carp (*Cyprinus carpio)*

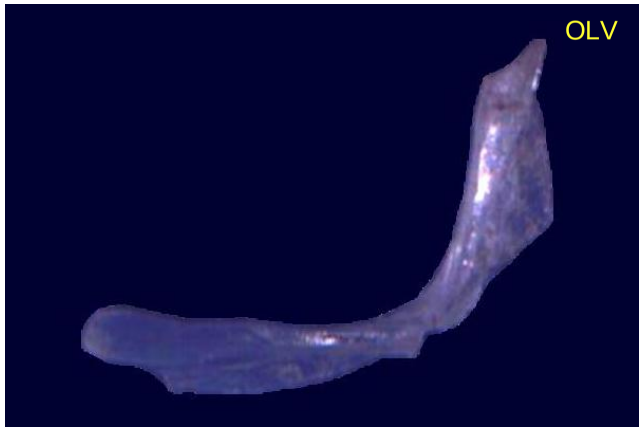


Goldfish (*Carassius auratus)*

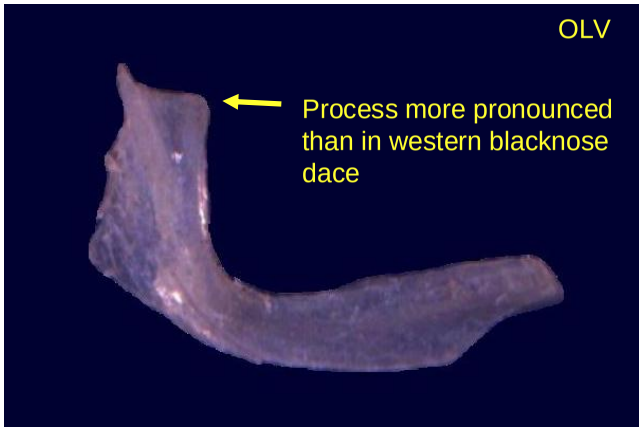


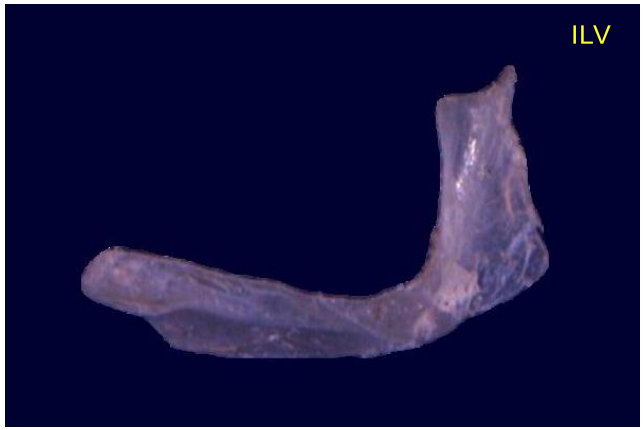
Family Cyprinidae, continued

Western blacknose dace (*Rhinichthys obtusus)*



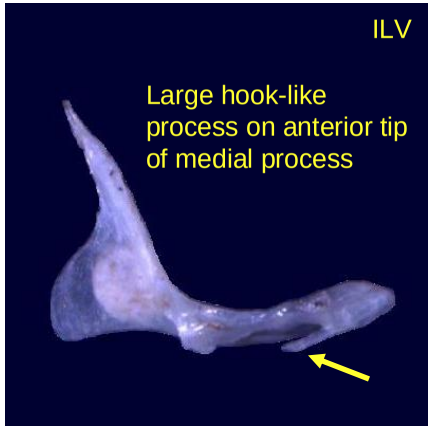
Longnose dace (*Rhinichthys cataractae*)

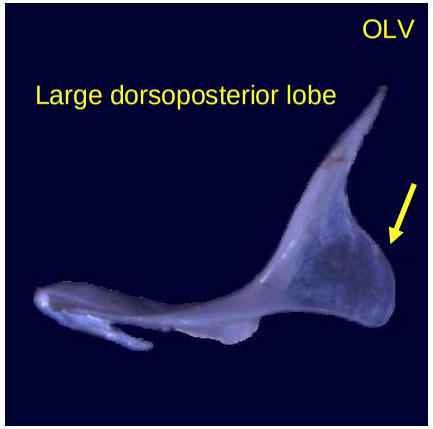




Family Cyprinidae, continued

Brassy minnow (*Hybognathus hankinsoni)*

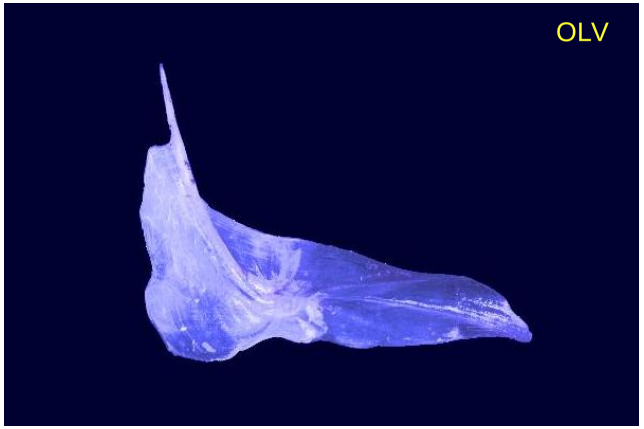


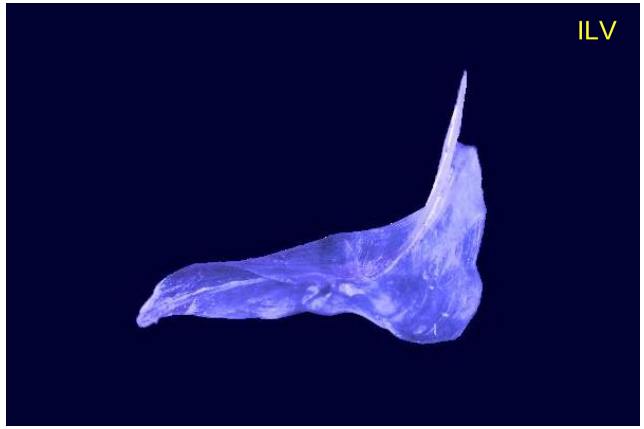


Subfamily Coregoninae

Cleithra are difficult to differentiate with the exception of round whitefish. The cleithra of coregonids are characterized by large dorsoposterior lobes, thick horizontal limbs, and a long spine at the apex of the vertical limb.

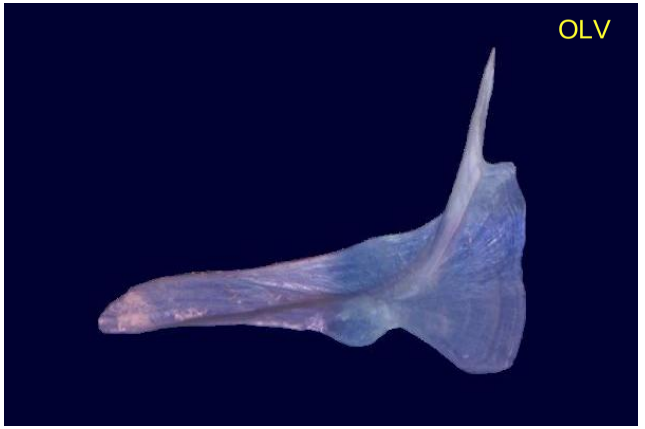
Shortjaw cisco (*Coregonus zenithicus)*



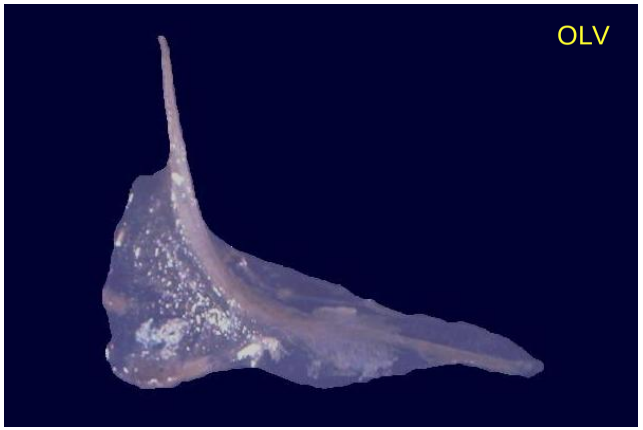


Subfamily Coregoninae, continued

Bloater (*Coregonus hoyi)*

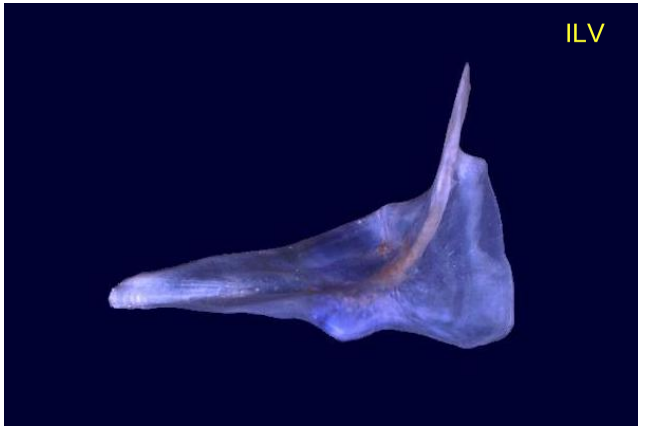


Kiyi (*Coregonus kiyi*)

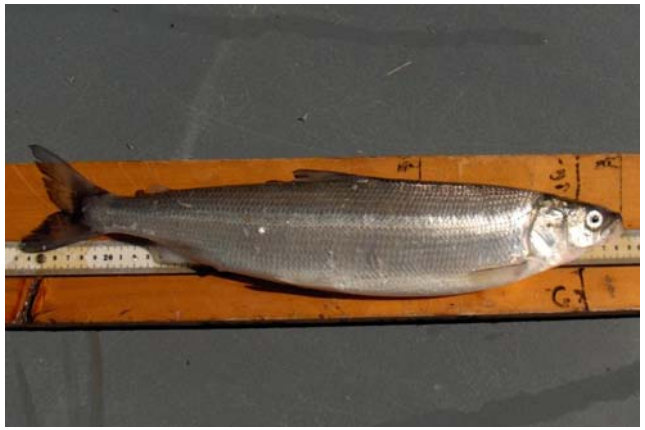


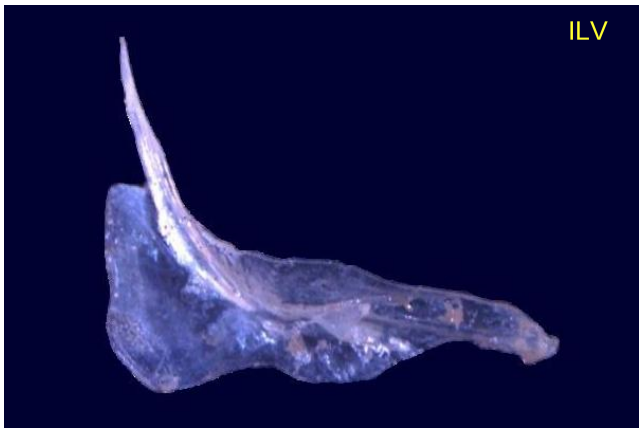
Subfamily Coregoninae, continued

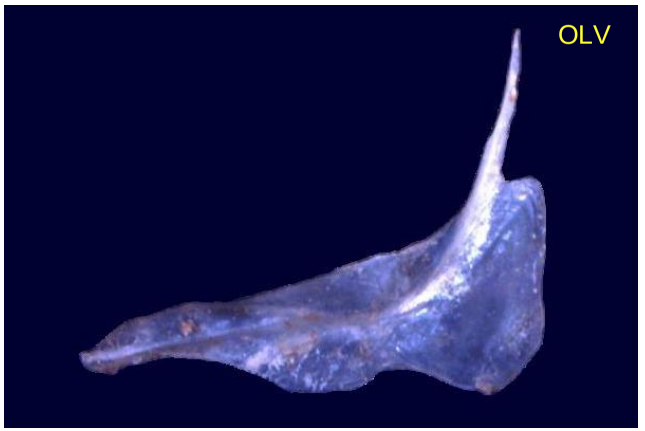
Lake whitefish (*Coregonus clupeaformis)*



Cisco (*Coregonus artedi*)

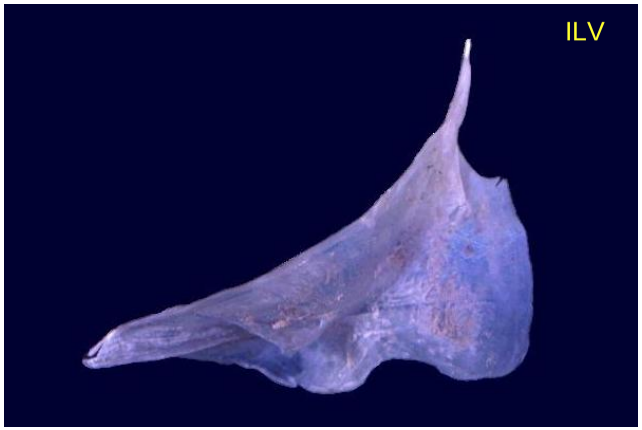






Subfamily Coregoninae, continued

Round whitefish (*Prosopium cylindraceum)*



Subfamily Salmoninae

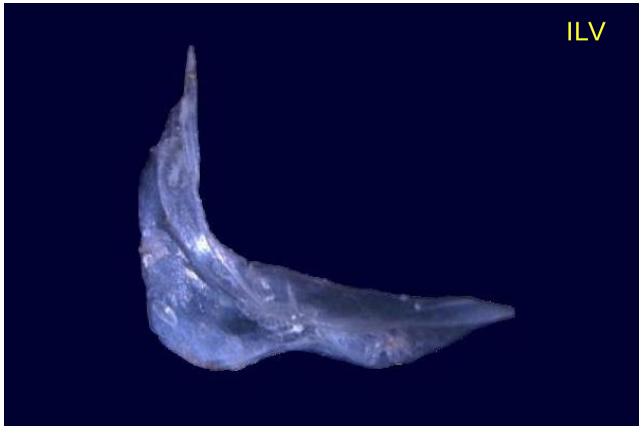
Cleithra of trout and salmon are very similar. They are characterized by horizontal and vertical limbs of approximately equal length, narrow dorsoposterior lobes, and a short spine at the apex of the vertical limb.

Splake (brook trout *Salvelinus fontinalis* x lake trout *S. namaycush)*

Subfamily Salmoninae, continued

Brook trout (*Salvelinus fontinalis)*

Lake trout (*Salvelinus namaycush*)



Subfamily Salmoninae, continued

Rainbow trout (steelhead)—Michigan strain (*Oncorhynchus mykiss*)

Rainbow trout—Eagle Lake strain (*Oncorhynchus mykiss*)

Subfamily Salmoninae, continued

Chinook salmon (*Oncorhynchus tschawytscha)*

Coho salmon (*Oncorhynchus kisutch*)

Subfamily Salmoninae, continued

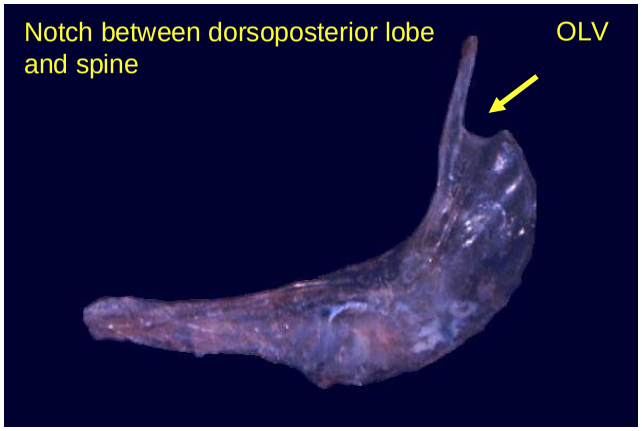
Atlantic salmon (*Salmo salar)*

Brown trout (*Salmo trutta*)

Family Umbridae

Central mudminnow cleithra are characterized by a large, curved dorsoposterior lobe; long spine at the apex of the vertical limb; and notch between the spine and dorsoposterior lobe.

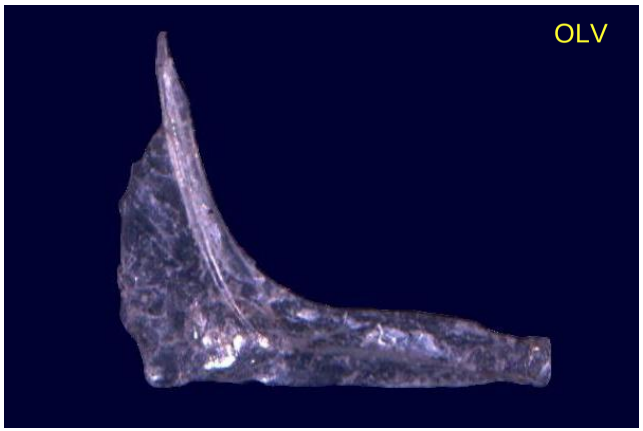
Central mudminnow (*Umbra limi*)

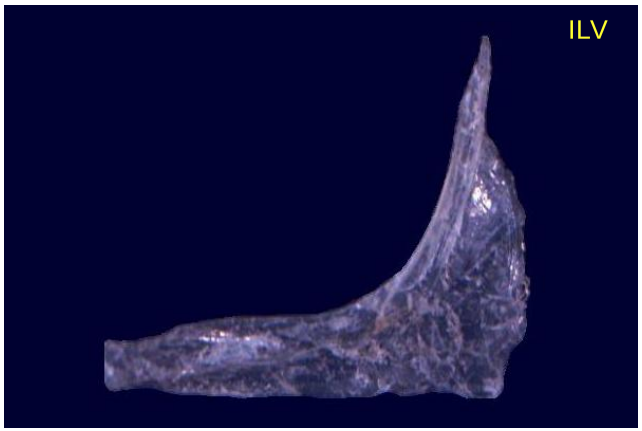


Family Osmeridae

Rainbow smelt cleithra have horizontal and vertical limbs of approximately equal length, a large dorsoposterior lobe, and a long spine at the apex of the vertical limb.

Rainbow smelt (*Osmerus mordax*)



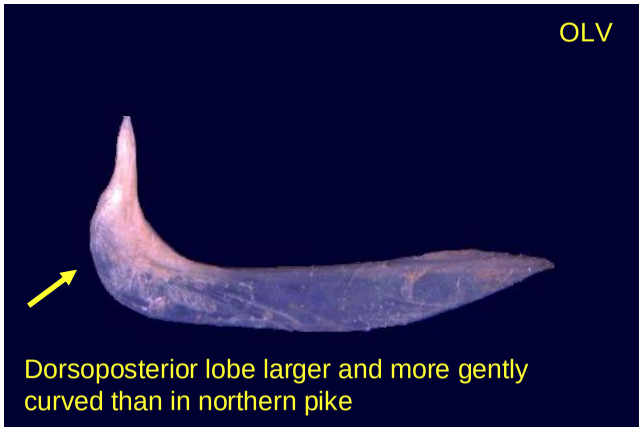


Family Esocidae

Cleithra have long horizontal limbs, short vertical limbs, small dorsoposterior lobes, and a short spine at the apex of the vertical limb. Northern pike and muskellunge cleithra are similar but can be differentiated by the size and shape of the dorsoposterior lobe.

Northern pike (*Esox lucius)*

Muskellunge (*Esox masquinongy*)



Family Gadidae

Burbot cleithra have long horizontal limbs, short vertical limbs, and a short, stout spine at the apex of the vertical limb. Burbot cleithra have a triangle-shaped process on the ventral side of the dorsoposterior lobe.

Burbot (*Lota lota)*

Family Amiidae

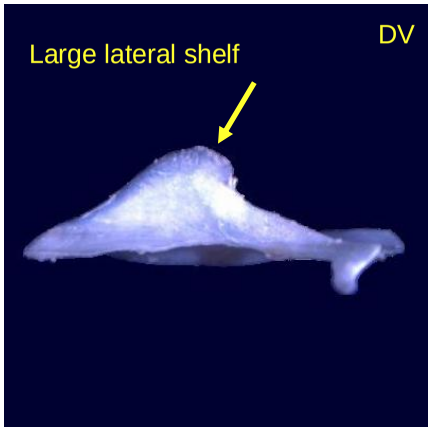
Bowfin cleithra have long horizontal limbs; short vertical limbs; and a short, stout spine at the apex of the vertical limb. Cleithra are similar to the cleithra of northern pike and muskellunge but have a proportionally larger dorsoposterior lobe.

Bowfin (*Amia calva*)

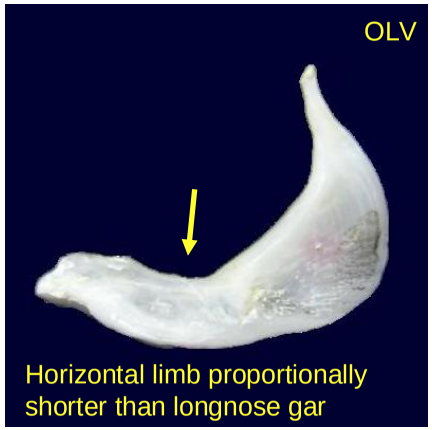
Family Lepisosteidae

Gar cleithra are characterized by a very large dorsoposterior lobe, short spine at the apex of the vertical limb, and large lateral shelf.

Longnose gar (*Lepisosteus osseus)*



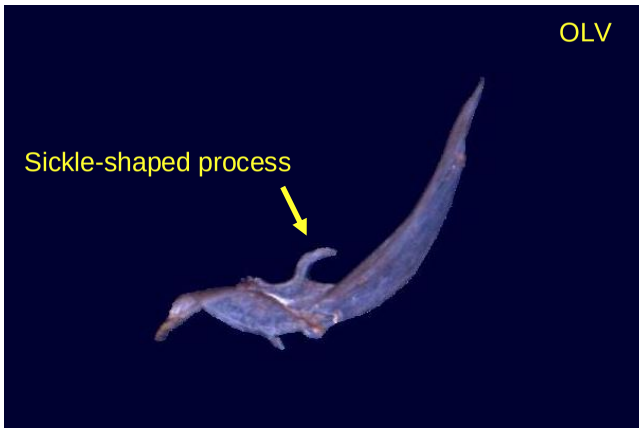
Spotted gar (*Lepisosteus oculatus*)

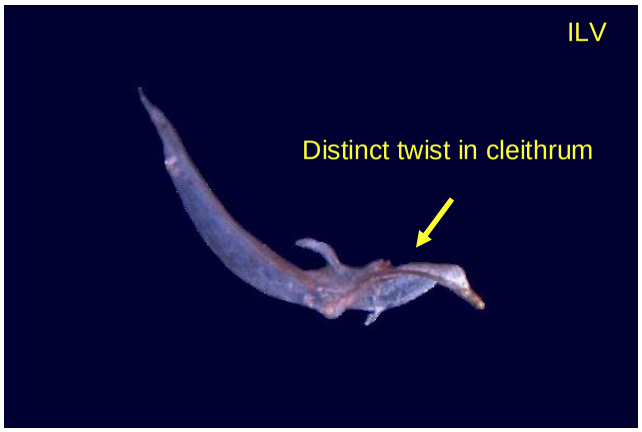


Family Clupeidae

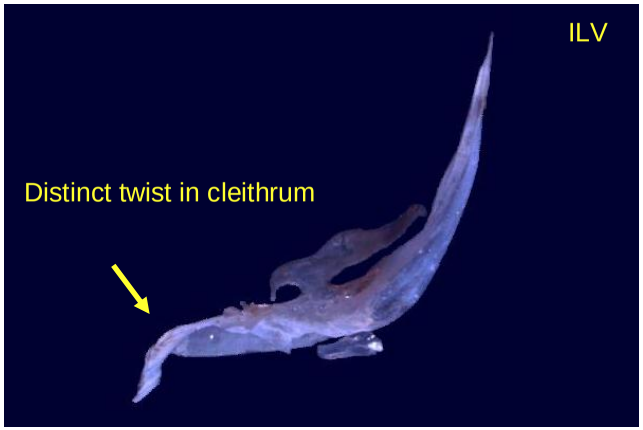
Cleithra are easily distinguished from other families. They have thin horizontal and vertical limbs and a ventral fold in the horizontal limb. Alewife cleithra have a sickle-shaped process located medially. Gizzard shad also have a medially located process, but it is much larger than the sickle-shaped process of alewife.

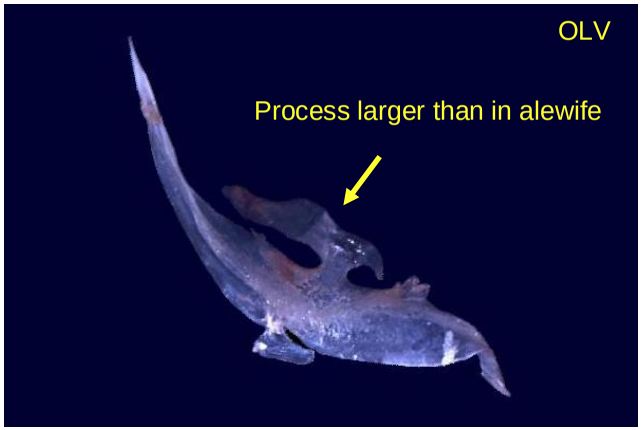
Alewife (*Alosa pseudoharengus*)





Gizzard shad (*Dorosoma cepedianum*)

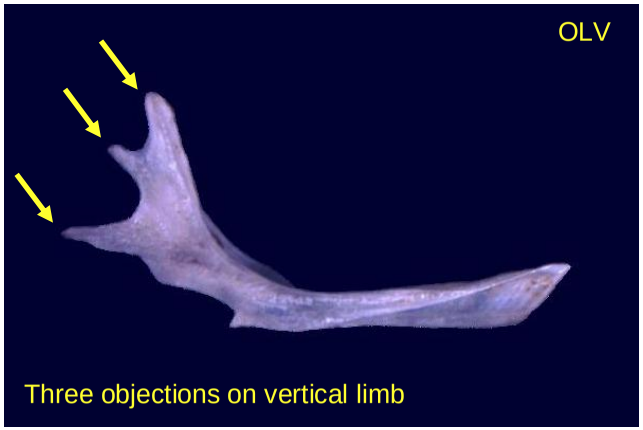




Family Ictaluridae

Cleithra are characterized by three objections on the vertical limb.

Brown bullhead (*Ameiurus nebulosus)*

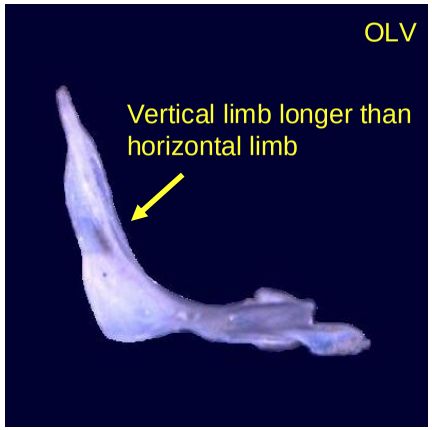


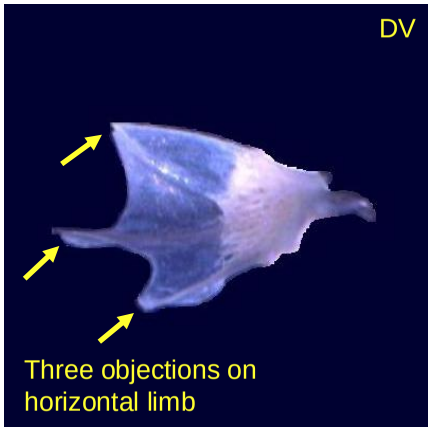
Channel catfish (*Ictalurus punctatus*)

Family Catostomidae

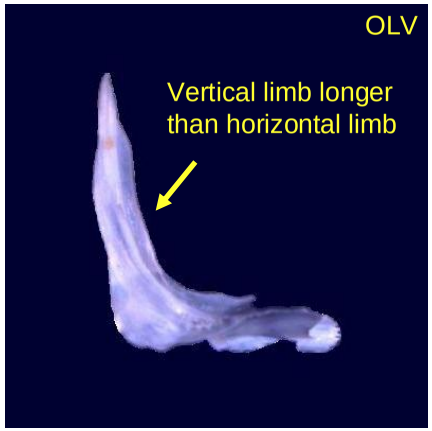
Cleithra are characterized by a wide horizontal limb terminating in three objections. A dorsal view of the lateral shelf is helpful in distinguishing between the species within this family.

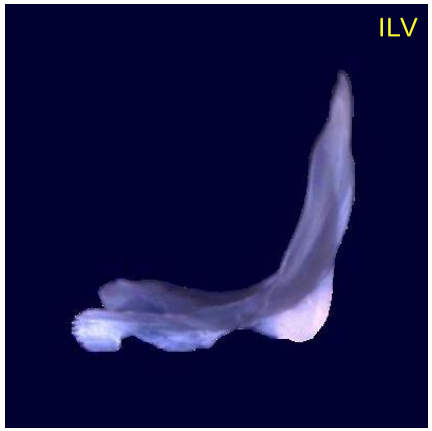
White sucker (*Catostomus commersonii)*





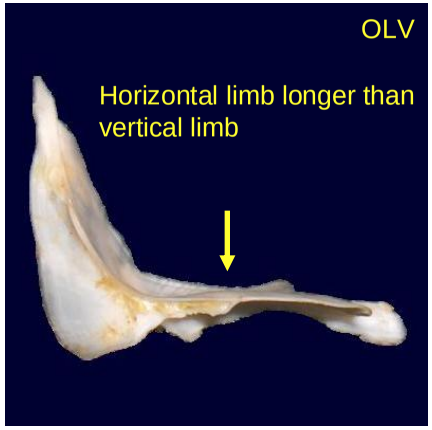
Silver redhorse (*Moxostoma anisurum)*



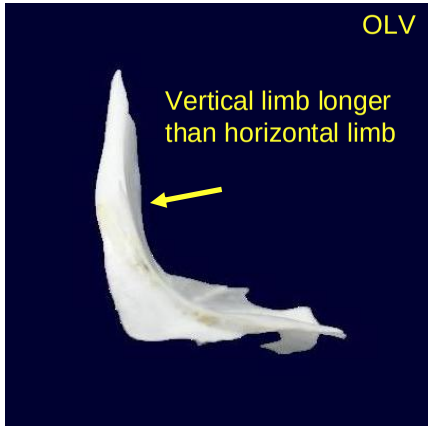


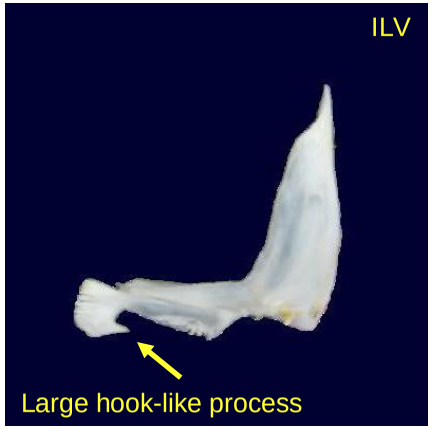
Family Catostomidae, continued

Longnose sucker (*Catostomus catostomus)*



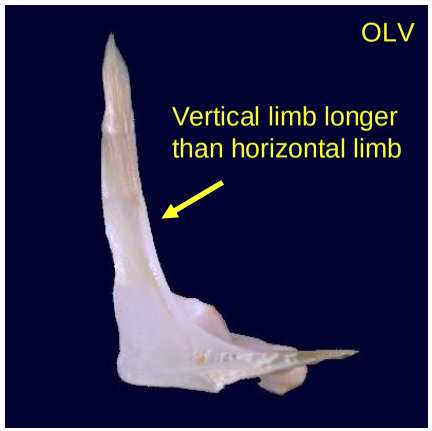
Northern hog sucker (*Hypentelium nigricans*)



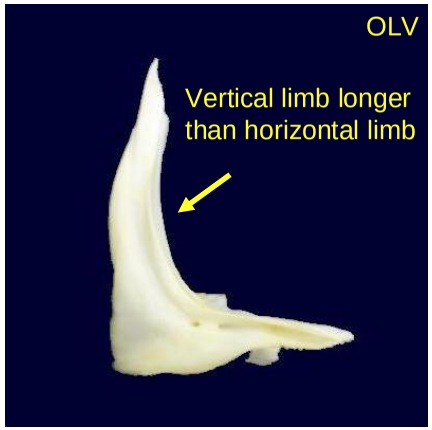


Family Catostomidae, continued

Golden redhorse (*Moxostoma erythrurum)*

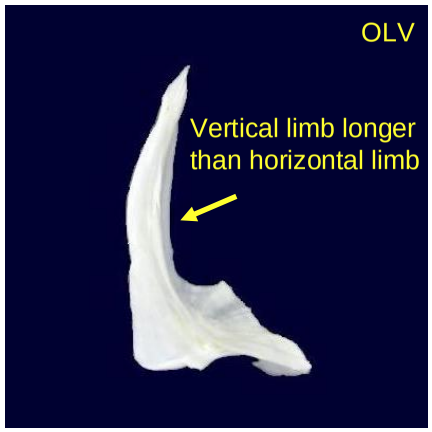


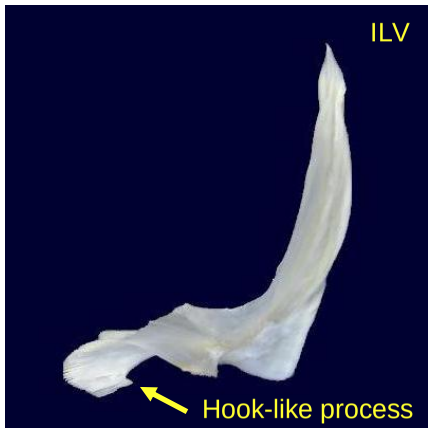
Shorthead redhorse (*Moxostoma macrolepidotum)*



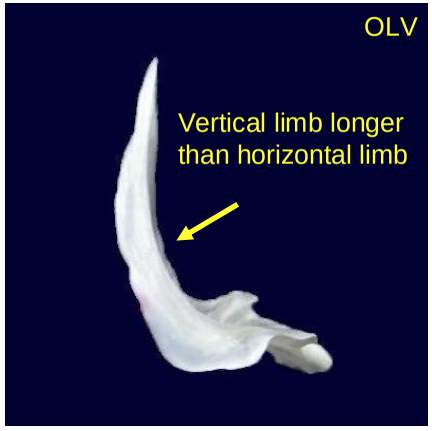
Family Catostomidae, continued

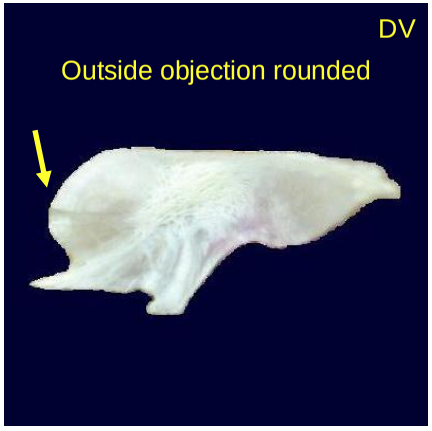
Spotted sucker (*Minytrema melanops)*



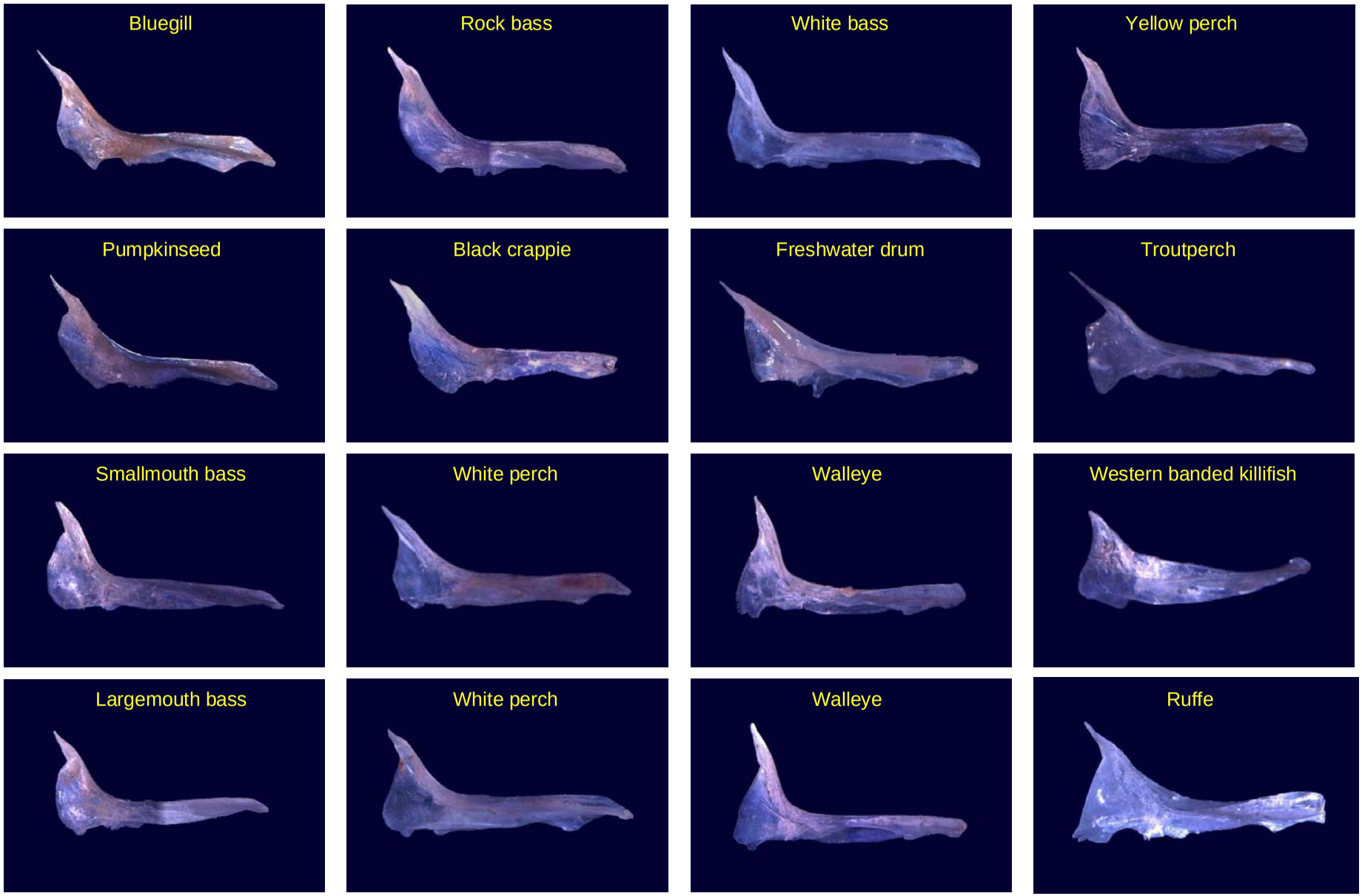


Quillback (*Carpiodes cyprinus)*

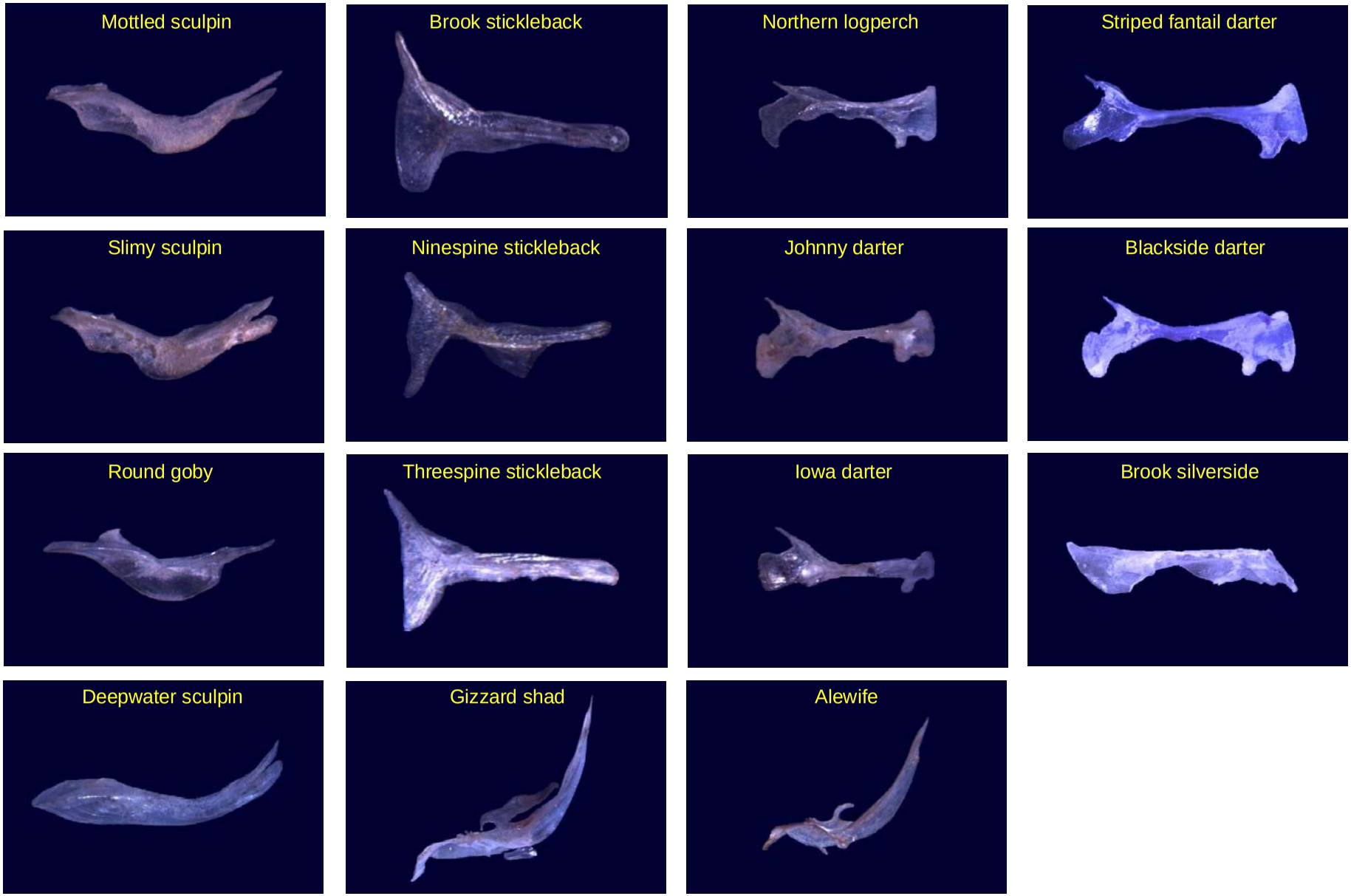




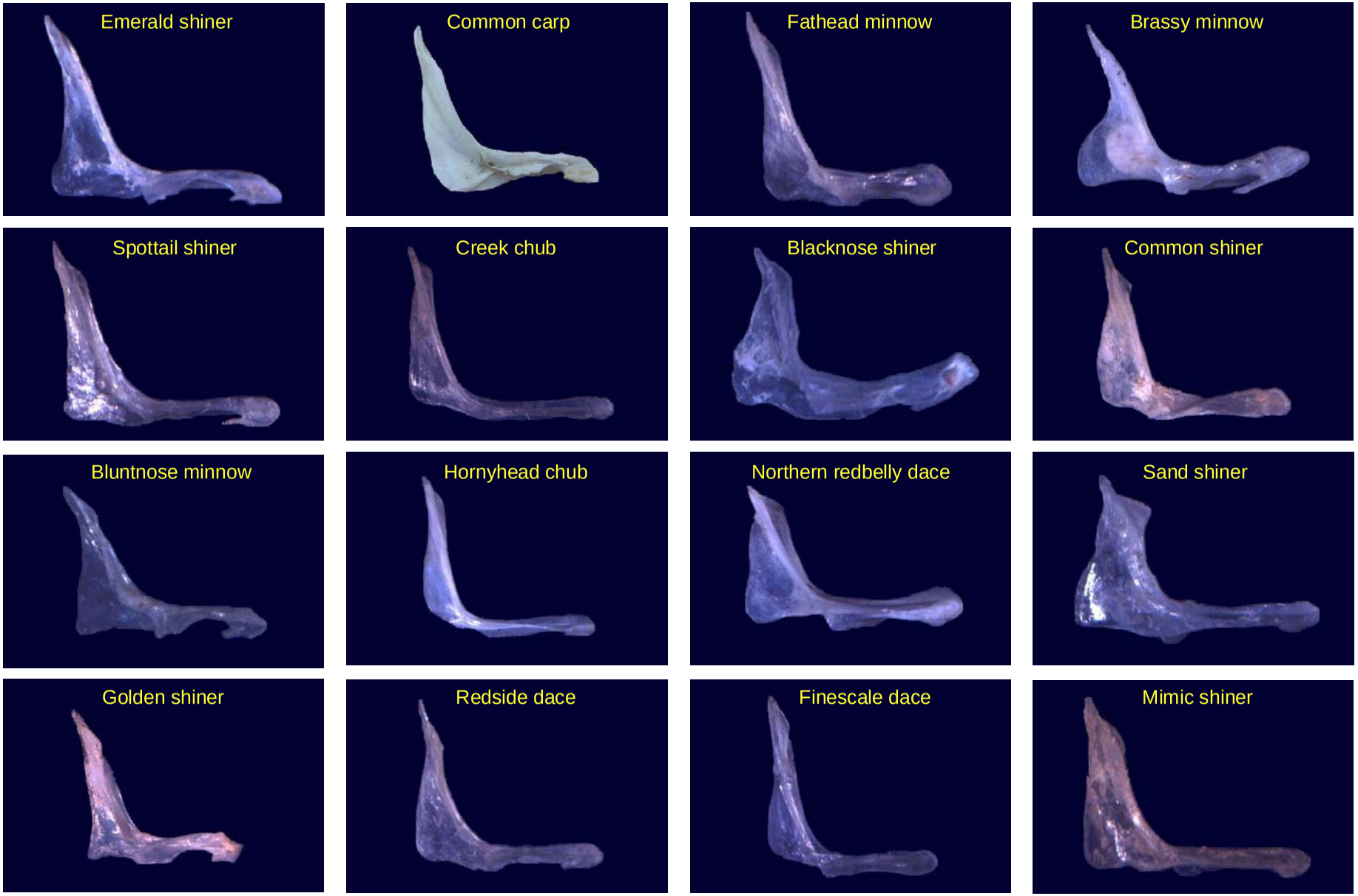
COMPARISON OF SIMILAR SPECIES



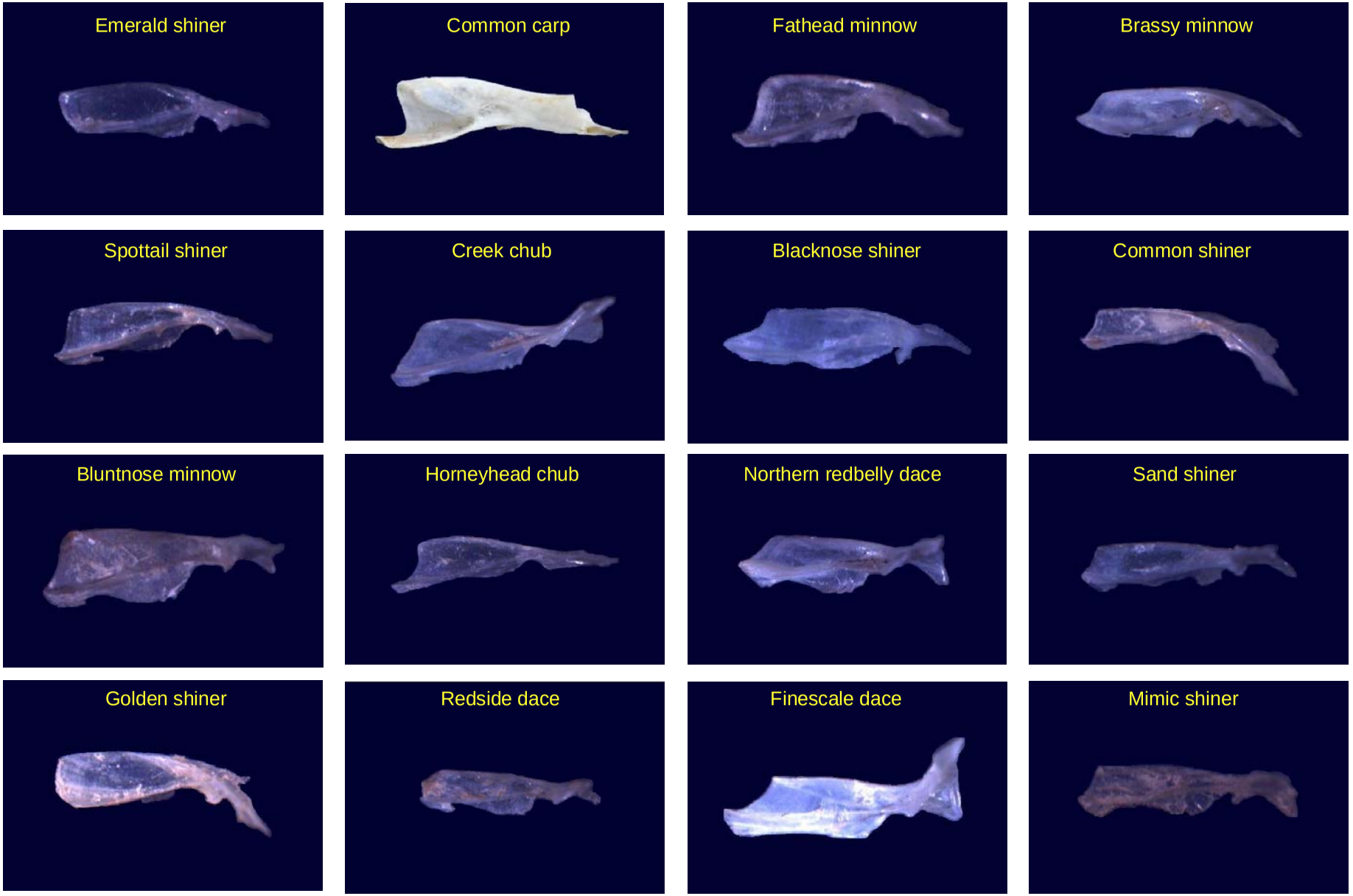
COMPARISON OF SIMILAR SPECIES, continued



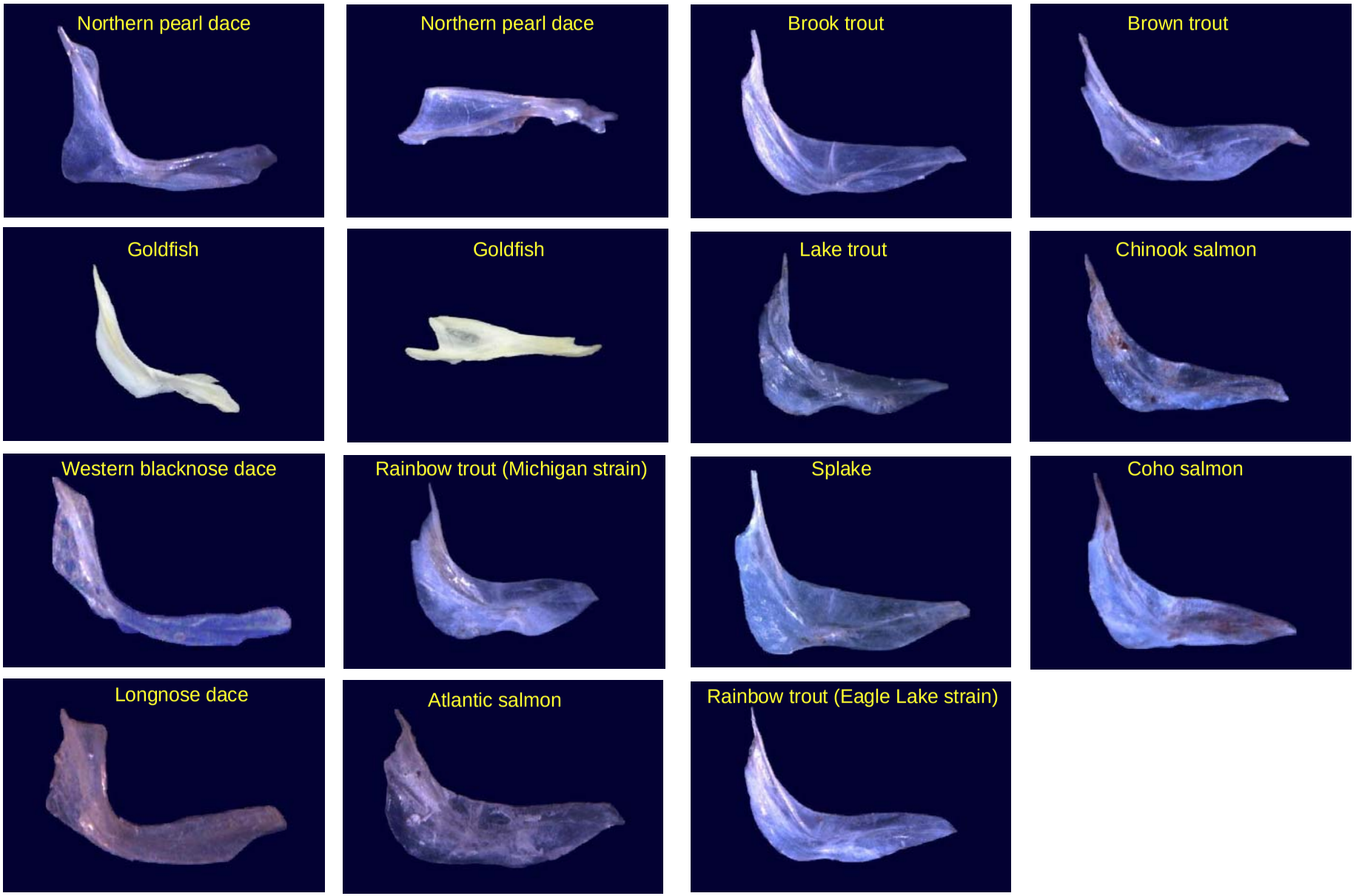
COMPARISON OF SIMILAR SPECIES, continued



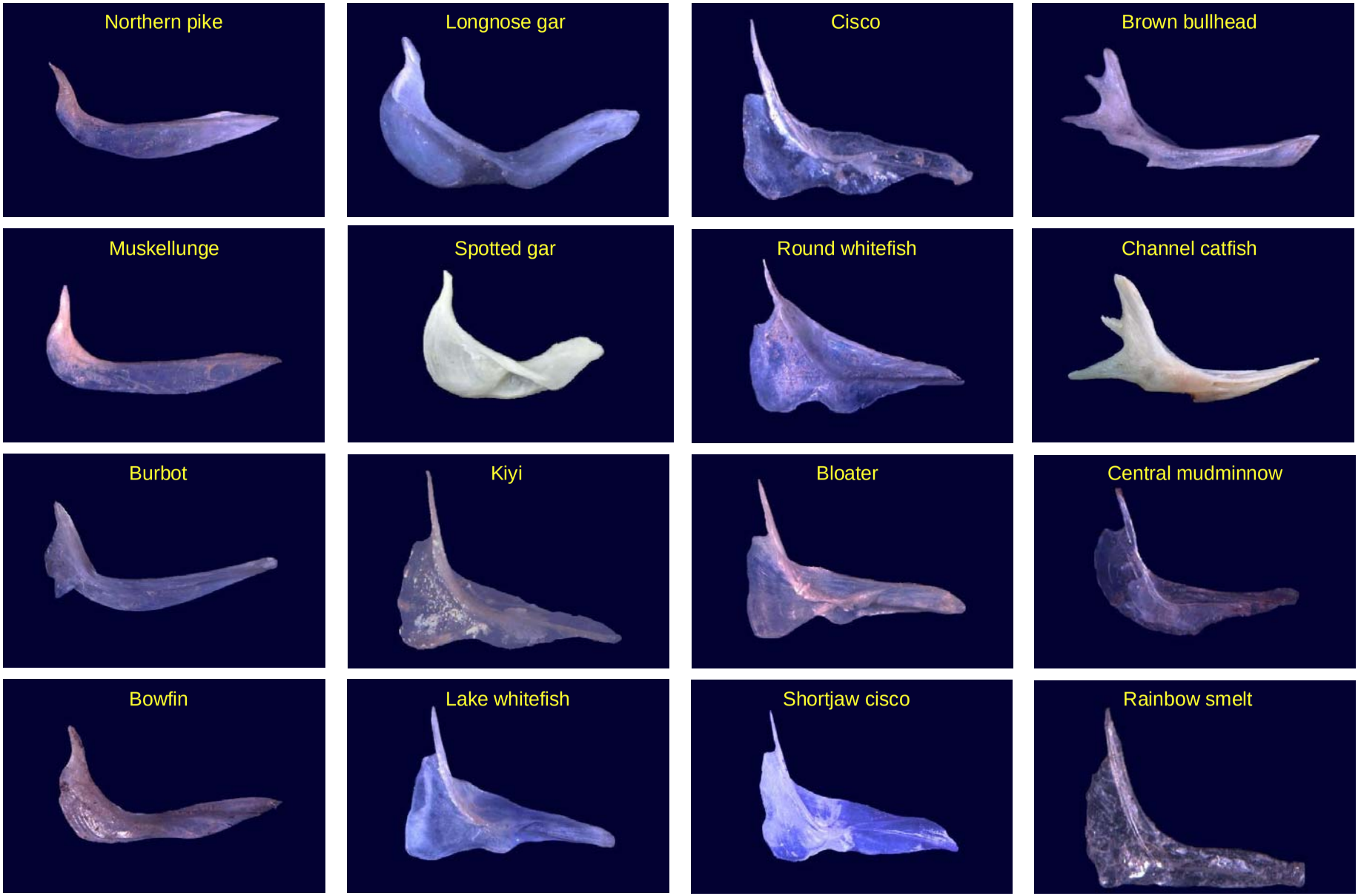
COMPARISON OF SIMILAR SPECIES, continued



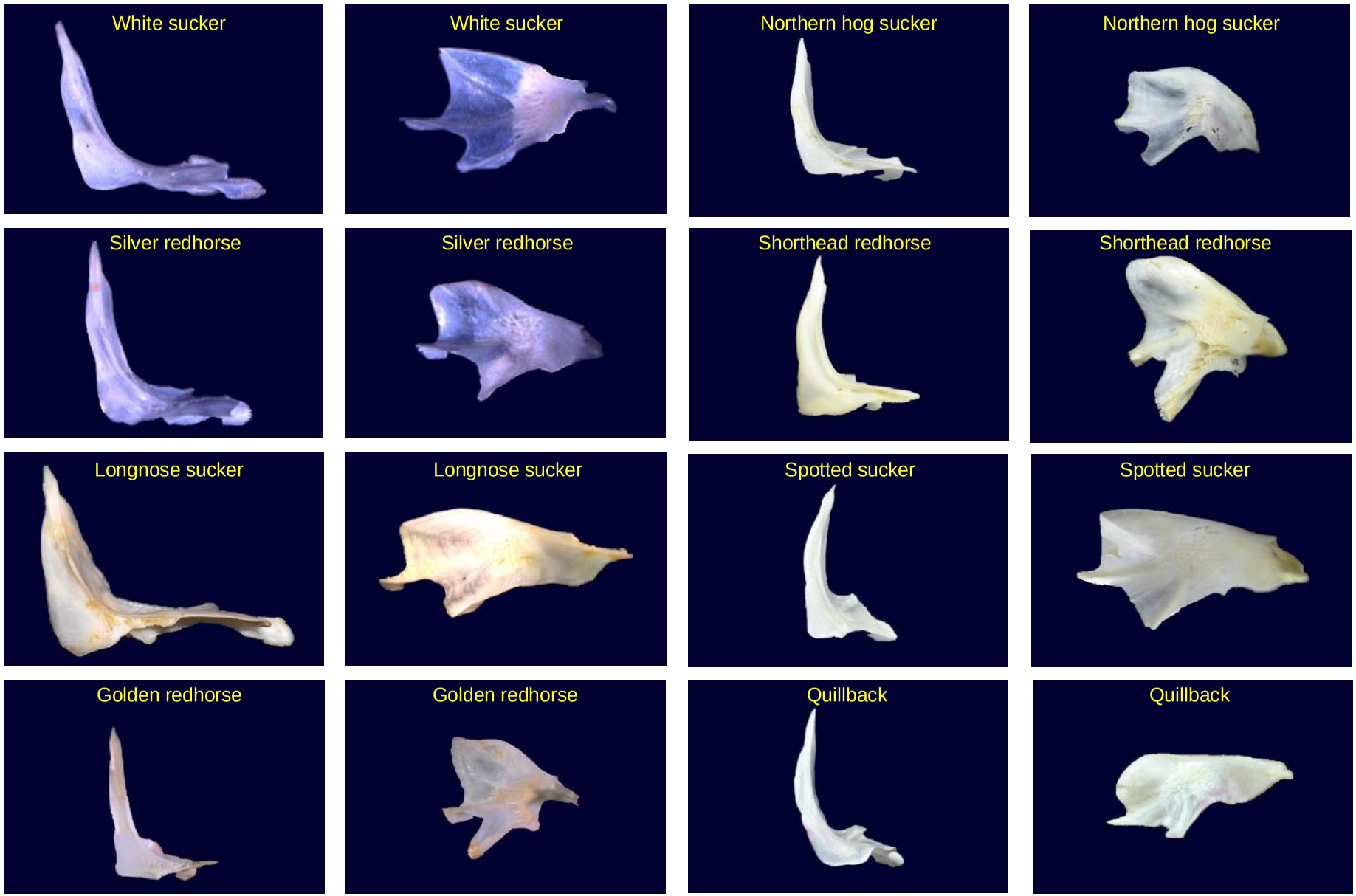
COMPARISON OF SIMILAR SPECIES, continued



COMPARISON OF SIMILAR SPECIES, continued



COMPARISON OF SIMILAR SPECIES, continued



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Cover photograph of a yellow perch cleithrum provided by D. Traynor.