

**“Minnow” Species (Families Cyprinidae, Xenocypridae, and Leuciscidae) Diversity
in North Carolina
By the NCFishes.com Team**

Next to our native darters (Family Percidae), our native species of minnows rival the brightly colored tropical fishes one would find in your local or big-box pet store, yet few people are aware of their existence. You might have heard people calling them Horny-Heads, Baltimore Minnows, Minnows, Knotty Heads, Horned Daces, Shad Roaches, Spawn Eaters, Minners, Crappie Minnows, or many other colloquial names. But each species has its own scientific (Latin) name, which coincidentally actually means something (please refer to The Meanings of the Scientific Names of Minnows, page 33-36), and an American Fisheries Society-accepted common name (Page et al. 2013)

“Minnows” until recently were classified in the family Cyprinidae, along with Common Carp, Goldfish, and Grass Carp. Our indigenous (native) species, 68 species in total, are now classified in the family Leuciscidae, a former subfamily of cyprinid fishes (Tan and Armbruster 2018). The nonindigenous (nonnative or introduced) Grass Carp is now classified in the family Xenocypridae (Tan and Armbruster 2018); and the nonindigenous Common Carp and Goldfish remain in the family Cyprinidae.

There are 71 species of “minnows” in North Carolina (Table 1), including 13 species found in only one river basin (Table 2), 3 species waiting to be scientifically described, and a few which may be re-named or split into additional species (Tracy et al. 2020). [Please note: Tracy et al. (2020) may be downloaded for **free** at: <https://trace.tennessee.edu/sfcproceedings/vol1/iss60/1>.] Distributional maps for every species may be found in Tracy et al. (2020). [Please note: see Supplemental Map Nos. 1-3, page XXX, showing North Carolina’s 100 counties, 21 river basins, and 4 physiographic regions.] The family Leuciscidae is our most diverse family of North Carolina’s freshwater fish assemblage (Tracy et al. 2020).

A few superlatives associated with our “minnow” fauna:

1. Two species are found in each of our 21 river basins -- Common Carp and Golden Shiner
2. Two species are found nowhere else in the World – Pinewoods Shiner, and Cape Fear Shiner
3. The smallest and largest native species -- Bridle Shiner (~50 mm Standard Length) and Ironcolor Shiner (~55 mm Standard Length) and Bull Chub (~270 mm Standard Length)
4. The prettiest species (our opinion) – Mountain Redbelly Dace, Fieryblack Shiner, Warpaint Shiner, and Taillight Shiner
5. The most non-descript species -- Eastern Silvery Minnow
6. Most unusual looking mouth and lips – Cutlip Minnow, Tonguetied Minnow, Kanawha Minnow, and Fatlip Minnow
7. The rarest species – Bridle Shiner
8. The most geographically restricted species – Cape Fear Shiner, Tonguetied Minnow, Cutlip Minnow, Spotfin Chub, Rosyface Chub, Yellowfin Shiner, Bridle Shiner, Striped Shiner, Notropis sp. “Kanawha” Rosyface Shiner, Kanawha Minnow, New River Shiner, Bigmouth Chub, and Sandhills Chub
9. The most commonly encountered and abundant species -- Central Stoneroller (Mountains), Bluehead Chub (Piedmont), and Dusky Shiner, Highfin Shiner, and Swallowtail Shiner (Coastal Plain)

In terms of species diversity:

1. The basin with the most number of species – Catawba with 27 indigenous and 7 nonindigenous species
2. The basin with the fewest number of species - Shallotte with 4 indigenous (Golden Shiner, Ironcolor Shiner, Dusky Shiner, and Coastal Shiner) and 2 nonindigenous (Grass Carp and Common Carp)
3. The basin with the most number of introduced species - Yadkin with 12 nonindigenous species - Goldfish, Common Carp, Grass Carp, Central Stoneroller, Mountain Redbelly Dace, Red Shiner, Greenfin Shiner, Warpaint Shiner, Rosefin Shiner, Comely Shiner, Swallowtail Shiner, and Fathead Minnow

4. The basins with least number of introduced species - Albemarle, Shallotte, and Waccamaw, each with two species (Common Carp and Grass Carp)

Indigenous vs. Nonindigenous Species

1. 3 species introduced into North Carolina from outside the U.S. – Common Carp, Grass Carp, and Goldfish
2. 2 species introduced into North Carolina from other states – Red Shiner and Fathead Minnow
3. 20 species that are indigenous to North Carolina have been introduced into other basins within North Carolina
4. These introductions are often the result of bait bucket dumping by fishermen, or for aquatic plant management (Grass Carp), or historically by the aquaculture trade (Common Carp)

No species have been extirpated from our state, but three species have been extirpated from a portion of their native ranges. For example, Spotfin Chub is no longer found in the French Broad basin; Spotfin Shiner is now absent from the Hiwassee basin as is Eastern Silvery Minnow from the Waccamaw basin. And because many minnow species are endemic to specific basins, 18 species are considered imperiled in North Carolina (Table 4; NCAC 2017; NCWRC 2017; NCNHP 2018).

Key characteristics for their proper identification include the presence/absence of a frenum; lateral stripe width and length; lateral line scale count; the number of un-pored lateral line scales; the positioning and pigmentation of the dorsal fin, the anal ray count, presence of spines vs. rays, the position of the mouth, the pharyngeal teeth count, the presence/absence and length and shape of maxillary barbels, the overall color pattern; and the geographical distributions of the species (please refer to the Identification Key to the Barbs and Carps, Asian Carps, and Minnows (Families Cyprinidae, Leuciscidae, and Xenocyprididae) in North Carolina. Many species can easily be told apart from one another. However, the identification of minnows with 7 or 8 anal rays and immature and female *Nocomis* spp., where species co-occur, can be very challenging.

If you have troubles with your identifications, just send us (<https://ncfishes.com/contact/>) an e-mail and include as many quality digital photographs as you can along with all the pertinent locality descriptors so that we will know from where the fish came.

Table 1. “Minnow” species (Families Cyprinidae, Xenocyprididae, and Leuciscidae) found in North Carolina. Common names enclosed within tick marks (“”) are scientifically undescribed species.

| Family, Scientific Name, American Fisheries Society Accepted Common Name | Family, Scientific Name, American Fisheries Society Accepted Common Name |
|---|---|
| Cyprinidae | Leuciscidae |
| <i>Carassius auratus</i> , Goldfish | <i>Nocomis raneyi</i> , Bull Chub |
| <i>Cyprinus carpio</i> , Common Carp | <i>Notemigonus crysoleucas</i> , Golden Shiner |
| Xenocyprididae | <i>Notropis alborus</i> , Whitemouth Shiner |
| <i>Ctenopharyngodon idella</i> , Grass Carp | <i>Notropis altipinnis</i> , Highfin Shiner |
| Leuciscidae | <i>Notropis amoenus</i> , Comely Shiner |
| <i>Campostoma anomalum</i> , Central Stoneroller | <i>Notropis bifrenatus</i> , Bridle Shiner |
| <i>Chrosomus oreas</i> , Mountain Redbelly Dace | <i>Notropis chalybaeus</i> , Ironcolor Shiner |
| <i>Clinostomus funduloides</i> , Rosyside Dace | <i>Notropis chiliticus</i> , Redlip Shiner |
| <i>Clinostomus</i> sp. "Hiwassee" Dace | <i>Notropis chlorocephalus</i> , Greenhead Shiner |
| <i>Clinostomus</i> sp. "Smoky" Dace | <i>Notropis cummingsae</i> , Dusky Shiner |
| <i>Cyprinella analostana</i> , Satinfin Shiner | <i>Notropis hudsonius</i> , Spottail Shiner |
| <i>Cyprinella chloristia</i> , Greenfin Shiner | <i>Notropis leuciodus</i> , Tennessee Shiner |
| <i>Cyprinella galactura</i> , Whitetail Shiner | <i>Notropis lutipinnis</i> , Yellowfin Shiner |
| <i>Cyprinella labrosa</i> , Thicklip Chub | <i>Notropis maculatus</i> , Taillight Shiner |
| <i>Cyprinella lutrensis</i> , Red Shiner | <i>Notropis mekistocholas</i> , Cape Fear Shiner |
| <i>Cyprinella monacha</i> , Spottfin Chub | <i>Notropis micropteryx</i> , Highland Shiner |
| <i>Cyprinella nivea</i> , Whitefin Shiner | <i>Notropis petersoni</i> , Coastal Shiner |
| <i>Cyprinella pyrrhomelas</i> , Fieryblack Shiner | <i>Notropis photogenis</i> , Silver Shiner |
| <i>Cyprinella spiloptera</i> , Spottfin Shiner | <i>Notropis proche</i> , Swallowtail Shiner |
| <i>Cyprinella zanema</i> , Santee Chub | <i>Notropis rubricroceus</i> , Saffron Shiner |
| <i>Cyprinella</i> sp. "Thinlip" Chub | <i>Notropis scabriceps</i> , New River Shiner |
| <i>Erimystax insignis</i> , Blotched Chub | <i>Notropis scepticus</i> , Sandbar Shiner |
| <i>Exoglossum laurae</i> , Tonguetied Minnow | <i>Notropis spectrunculus</i> , Mirror Shiner |
| <i>Exoglossum maxillingua</i> , Cutlip Minnow | <i>Notropis telescopus</i> , Telescope Shiner |
| <i>Hybognathus regius</i> , Eastern Silvery Minnow | <i>Notropis volucellus</i> , Mimic Shiner |
| <i>Hybopsis amblops</i> , Bigeye Chub | <i>Notropis</i> sp. "Kanawha" Rosyface Shiner |
| <i>Hybopsis hypsinotus</i> , Highback Chub | <i>Notropis</i> sp. "Piedmont" Shiner |
| <i>Hybopsis rubrifrons</i> , Rosyface Chub | <i>Phenacobius crassilabrum</i> , Fatlip Minnow |
| <i>Luxilus albeolus</i> , White Shiner | <i>Phenacobius teretulus</i> , Kanawha Minnow |
| <i>Luxilus cerasinus</i> , Crescent Shiner | <i>Pimephales notatus</i> , Bluntnose Minnow |
| <i>Luxilus chrysocephalus</i> , Striped Shiner | <i>Pimephales promelas</i> , Fathead Minnow |
| <i>Luxilus coccogenis</i> , Warpaint Shiner | <i>Rhinichthys atratulus</i> , Eastern Blacknose Dace |
| <i>Lythrurus ardens</i> , Rosefin Shiner | <i>Rhinichthys cataractae</i> , Longnose Dace |
| <i>Lythrurus matutinus</i> , Pinewood Shiner | <i>Rhinichthys obtusus</i> , Western Blacknose Dace |
| <i>Nocomis leptocephalus</i> , Bluehead Chub | <i>Semotilus atromaculatus</i> , Creek Chub |
| <i>Nocomis micropogon</i> , River Chub | <i>Semotilus lumbee</i> , Sandhills Chub |
| <i>Nocomis platyrhynchus</i> , Bigmouth Chub | |

Table 2. “Minnow” species found in only one river basin in North Carolina.

| River Basin | Species |
|------------------|---|
| New | Bigmouth Chub, New River Shiner, Kanawha Minnow, <i>Notropis</i> sp. "Kanawha" Rosyface Shiner, Tonguetied Minnow |
| Little Tennessee | <i>Clinostomus</i> sp. "Smoky" Dace |
| Hiwassee | <i>Clinostomus</i> sp. "Hiwassee" Dace |
| Savannah | Rosyface Chub |
| Catawba | Greenhead Shiner |
| Broad | <i>Notropis</i> sp. "Piedmont" Shiner |
| Roanoke | Eastern Blacknose Dace, Cutlip Minnow |
| Cape Fear | Cape Fear Shiner |

Table 3. “Minnow” species that have been introduced into North Carolina from outside the United States (*), from outside North Carolina (), or which have been transferred from one river basin into a new river basins from within North Carolina.**

| Family, Species | Family, Species |
|------------------------|--------------------|
| Cyprinidae | Leuciscidae |
| Goldfish* | Rosefin Shiner |
| Common Carp* | Bluehead Chub |
| Xenocyprididae | Golden Shiner |
| Grass Carp* | Whitemouth Shiner |
| Leuciscidae | Comely Shiner |
| Central Stoneroller | Redlip Shiner |
| Mountain Redbelly Dace | Tennessee Shiner |
| Rosyside Dace | Yellowfin Shiner |
| Greenfin Shiner | Swallowtail Shiner |
| Whitetail Shiner | Saffron Shiner |
| Red Shiner** | Mirror Shiner |
| Highback Chub | Mimic Shiner |
| Crescent Shiner | Fathead Minnow** |
| Warpaint Shiner | |

Table 4. Imperiled “minnow” species in North Carolina (NCAC 2017, NCNHP 2018, and NCWRC 2017). *Federally Endangered; **Federally Threatened.

| Level of Imperilment | Species |
|----------------------|--|
| Endangered | Bridle Shiner, Cape Fear Shiner* |
| Threatened | Spotfin Chub**, Rosyface Chub, Mimic Shiner |
| Special Concern | <i>Clinostomus</i> sp. "Hiwassee" Dace, <i>Clinostomus</i> sp. "Smoky" Dace, Cutlip Minnow, <i>Cyprinella</i> sp. "Thinlip" Chub, Striped Shiner, Yellowfin Shiner, Kanawha Minnow, Sandhills Chub |
| Significantly Rare | Blotched Chub, Tonguetied Minnow, Ironcolor Shiner, Highland Shiner, <i>Notropis</i> sp. "Kanawha" Rosyface Shiner |

**Identification Key to the Barbs and Carps, Asian Carps, and Minnows
(Families Cyprinidae, Leuciscidae, and Xenocyprididae) in North Carolina**

(Please refer to NCFishes.com for pictures and identifying characteristics for all species)

1. Dorsal fin long with a stout, saw-toothed spine-like ray anteriorly, followed by 13 or more branched rays. Anal fin also preceded by a stout, spine-like rayFamily Cyprinidae, 2

Dorsal fin long without a stout, saw-toothed spine-like ray anteriorly, followed by 12 or fewer branched rays. Anal fin also without a stout, spine-like ray3
2. One pair of fleshy barbels on each side located near the corner of the mouth on the upper jaw (Figure 1). Lateral line scale 35-39Common Carp, *Cyprinus carpio*

Barbels absent (Figure 2). Lateral line scales 28-32 Goldfish, *Carassius auratus*



Figure 1. Left – Yellow color morph of Common Carp; Right – Nishikigoi ornamental carp strain (popularly called “Koi”) Common Carp. Photograph of yellow Common Carp courtesy of J. Michael Swing; photograph of “Koi” courtesy of David Coughlan.



Figure 2. Pet shop Goldfish.

3. Distance from anal fin origin to tip of snout 3 or more times as long as the distance from the anal fin origin to the caudal fin base (Figure 3). Pharyngeal teeth comb-like.....
..... Family Xenocyprididae, Grass Carp, *Ctenopharyngodon idella*

Distance from anal fin origin to tip of snout less than 3 times as long as the distance from the anal fin origin to the caudal fin base. Pharyngeal teeth not comb-likeFamily Leuciscidae, 4

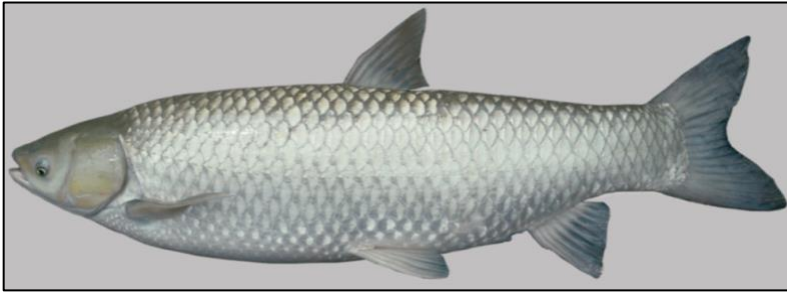


Figure 3. Grass Carp

- 4. Frenum present; premaxillae nonprotractile, attached to the snout with skin (Figure 4).....5
- Frenum absent; premaxillae protractile, separated from the snout by a groove (Figure 4).....9

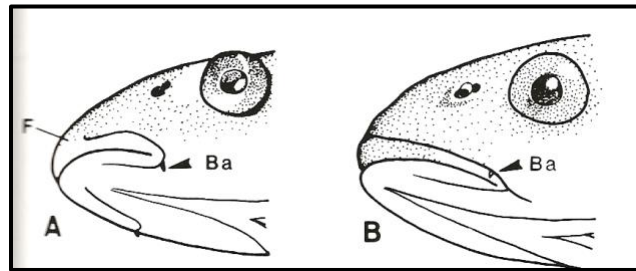


Figure 4. Left (A) - frenum (F) and barbel (Ba) present; Right (B) frenum absent and barbel present (Ba).

- 5. Lower lip appears deformed and split; central part cartilaginous, sides lobes fleshy6
- Lower lip normal, central part not cartilaginous and stiff7
- 6. Barbel present. Lower jaw tapers gradually anteriorly, not lobed, not producing a 3-lobed outline (Figure 5). Range restricted to the New basin (Figure 6)
 Tonguetied Minnow, *Exoglossum laurae*
- Barbel absent. Lower jaw lobes produce a 3-lobed outline anteriorly (Figure 5). Range restricted to the upper Roanoke basin (Figure 6) Cutlip Minnow, *Exoglossum maxillingua*



Figure 5. Ventral view of the mouths of *Exoglossum*. Left – Tonguetied Minnow; Right – Cutlip Minnow with red arrows pointing to tri-lobed lower jaw.



Figure 6. Left – Tonguetied Minnow; Right – Cutlip Minnow.

7. Mouth very inferior, projecting well forward of the mouth. Distance from snout tip to anterior point of lower jaw about equal to or greater than the diameter of the eye (Figure 7)..... Longnose Dace, *Rhinichthys cataractae*

Mouth terminal or subterminal. Snout projecting barely forward of the mouth. Distance from snout tip to anterior port of the lower jaw less than the diameter of the eye8

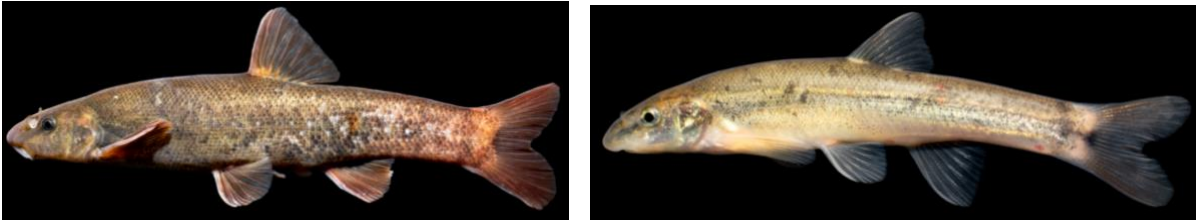


Figure 7. Longnose Dace.

8. Lateral line scales (46)51-58 (63). Breeding males with a re-orange band that occurs adjacent to and above black lateral stripes (and some slightly below it) (Figure 8). Range currently restricted to the upper Dan River (Roanoke basin)..... Eastern Blacknose Dace, *Rhinichthys atratulus*

Lateral line scales (56)57-64 (70). In breeding males the black lateral stripe is replaced by a red-orange band (Figure 9). Range not currently restricted to the upper Roanoke basin Western Blacknose Dace, *Rhinichthys obtusus*



Figure 8. Eastern Blacknose Dace. Left – Male; Right – Female. Photographs courtesy of Robert Criswell.

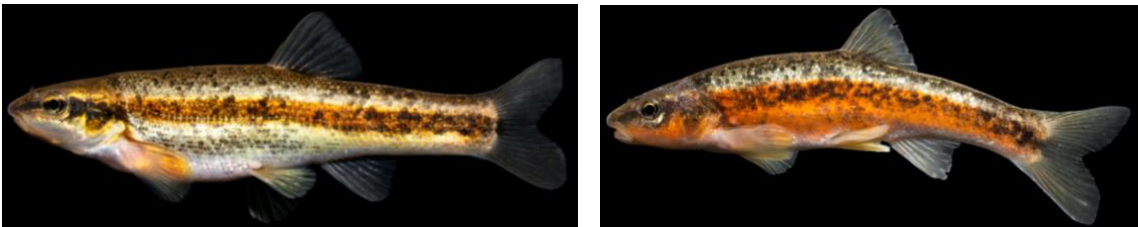


Figure 9. Western Blacknose Dace. Left – Male from the New basin; Right –Male from the Little Tennessee basin.

- 9. Lower jaw with a firm cartilaginous ridge (Figure 10).....Central Stoneroller, *Campostoma anomalum*
 Lower jaw lacking a firm cartilaginous ridge 10



Figure 10. Left - Ventral view of the mouth of Central Stoneroller with red arrow pointing to the cartilaginous ridge. Right – Central Stoneroller.

- 10. Barbel usually present (occasionally lacking in Highback Chub), located in groove above the maxilla at or slightly anterior to the posterior end of the maxilla 11
 Barbel absent. If barbel is present, then dorsal fin membranes are profusely infused with pigment, either anteriorly, posteriorly, or across the base of the dorsal fin 20
- 11. Barbel flat and triangular, located in maxillary (upper jaw) groove anterior to end of the jaw 12
 Barbel conical, located at posterior tip of the maxilla 13
- 12. Eight dorsal fin rays. Dark spot near dorsal fin origin (Figure 11). Lateral line scales 49-57. Widespread, not restricted to the Sand Hills ecoregion of the Cape Fear, Lumber, and Yadkin basins Creek Chub, *Semotilus atromaculatus*
 Nine dorsal fin rays. No dark spot near dorsal fin origin (Figure 11). Lateral line scales 46-48. Restricted to the Sand Hills ecoregion of the Cape Fear, Lumber, and Yadkin basins Sandhills Chub, *Semotilus lumbee*



Figure 11. Left – Creek Chub with white arrow pointing to the dark spot near the dorsal fin origin; Right – Sandhills Chub.

- 13. Eye large and mouth small. Eye larger than or equal to upper jaw. Mouth distinctly subterminal to inferior, nearly horizontal 14
 Eye small and mouth large. Eye smaller than upper jaw. Mouth subterminal, often oblique 17

14. Lateral blotches along the sides (Figure 12). Pharyngeal teeth 4-4 Blotched Chub, *Erimystax insignis*

 No lateral blotches along the sides. Pharyngeal teeth 1,4-4,1 15



Figure 12. Blotched Chub.

15. Breast well scaled. Body thick (Figure 13). Barbel sometimes absent. Predorsal scales 15-20. Restricted to the Broad, Catawba, and Yadkin basins; introduced into the Little River watershed in the New basin Highback Chub, *Hybopsis hypsinotus*
 Breast naked or with embedded scales scaled. Body thin (Figure 14). Barbel sometimes absent in Bigeye Chub. Predorsal scales 12-15. Restricted to the Savannah and to the Nolichucky, French Broad, Pigeon, and Hiwassee basins 16

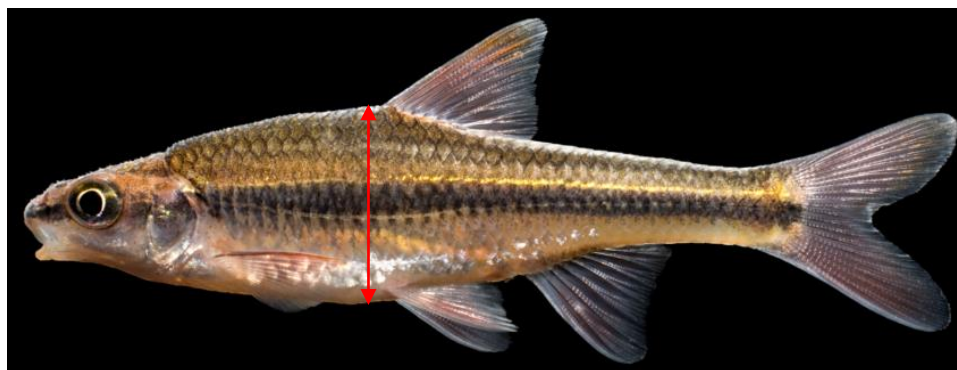


Figure 13. Highback Chub with red arrows pointing to the relative thickness of the body.

16. Eye width 1.2 times into snout length. Barbel about one-half the length of the pupil. Restricted to the Savannah basin (Figure 14) Rosyface Chub, *Hybopsis rubrifrons*
 Eye width equal to snout length. Barbel less than one-half the length of the pupil, often absent. Restricted to the Nolichucky, French Broad, Pigeon, and Hiwassee basins (Figure 14) Bigeye Chub, *Hybopsis amblops*

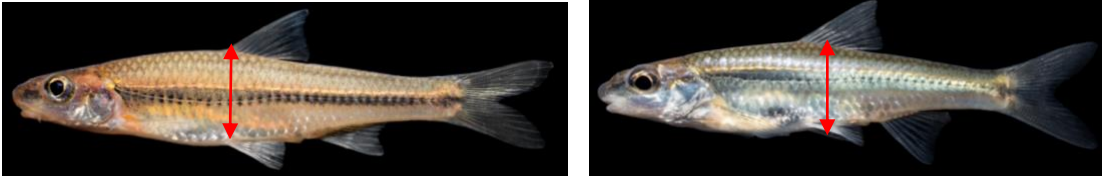


Figure 14. Red arrows pointing to the relative thinness of the body. Left – Rosyface Chub; Right – Bigeye Chub.

17. Head tubercles or scars present in prenasal and subnasal areas in adult males (Figure 15). Upon dissection, intestine with a simple S-shaped configuration (Figure 16)..... 18

Head tubercles or scars absent from prenasal and subnasal area in adult males (Figure 15). Upon dissection, intestine moderately whorled (Figure 16) (Figure 17).....
 Bluehead Chub, *Nocomis leptocephalus*

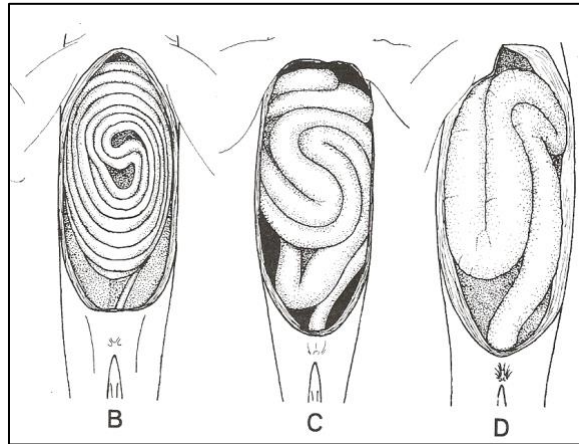


Figure 16. Examples of intestinal coiling in Eastern Silvery Minnow (B), Bluehead Chub (C), and Bull Chub (D).



Figure 17. Bluehead Chub with red arrows pointing to tubercle scars atop the head, absent from the nasal and subnasal areas, and maxillary barbel.

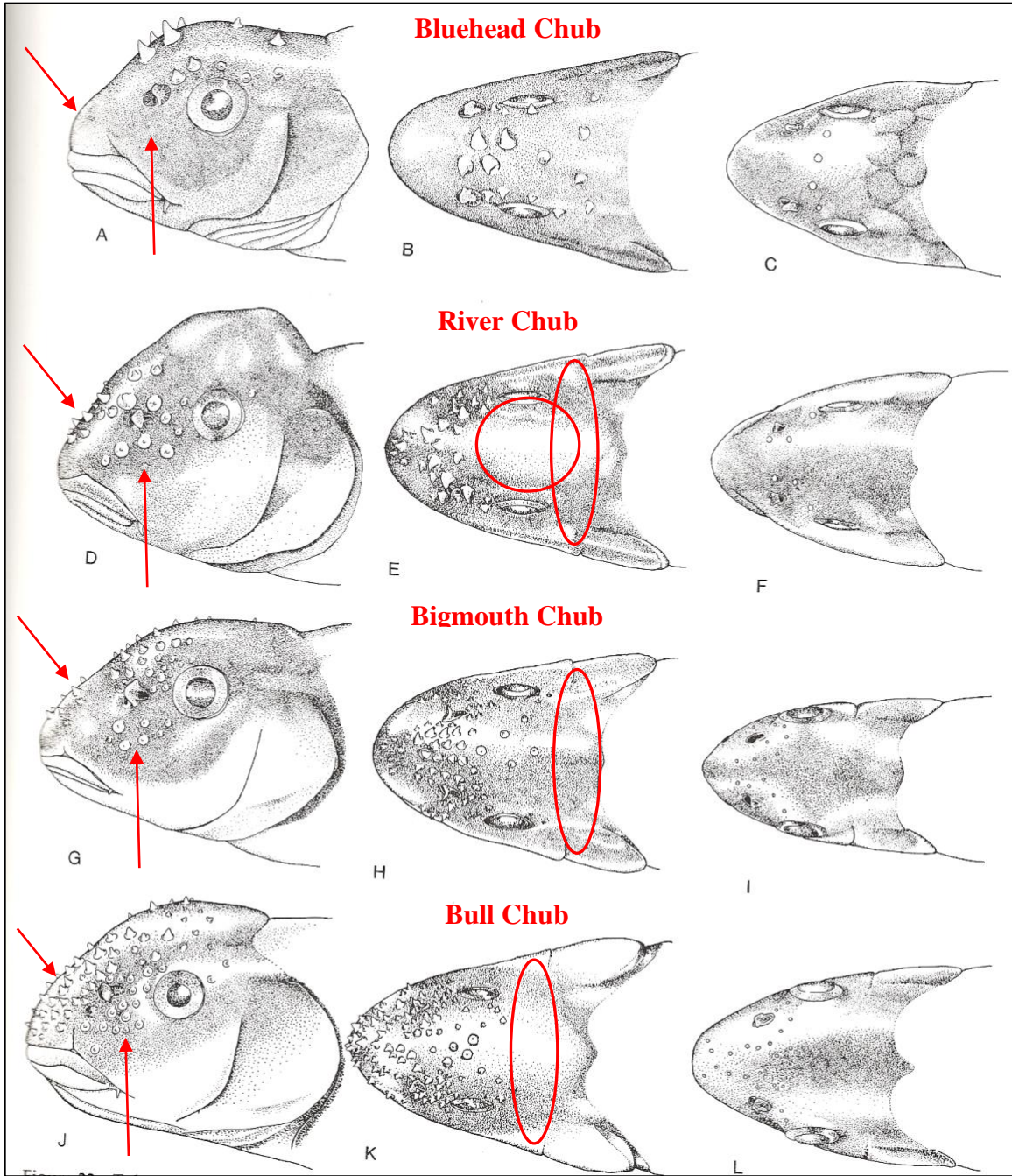


Figure 15. Left – Tuberculation in *Nocomis*. Left and center column – nuptial crested males. Right column – juveniles. Red arrows pointing to prenasal and subnasal areas. Red circle and ovals showing an absence of tubercles in the interorbital and occipital areas.

18. Tubercles usually fewer than 60 on head, do not extend into interorbital area (Figure 15). Predorsal circumferential scales usually 30-33 (Figure 18)River Chub, *Nocomis micropogon*
- Tubercles 60-200 on head in specimens longer than 100 mm, extending into interorbital area (Figure 15). Predorsal circumferential scales usually 32-36 19



Figure 18. River Chub with red arrows pointing to the tubercle scars absent from atop the head, but present in the nasal and subnasal areas.

19. Range restricted to the Neuse, Tar, and Roanoke basins (Figure 19)Bull Chub, *Nocomis biguttatus*
 Range restricted to the New basin (Figure 19) Bigmouth Chub, *Nocomis platyrhynchus*

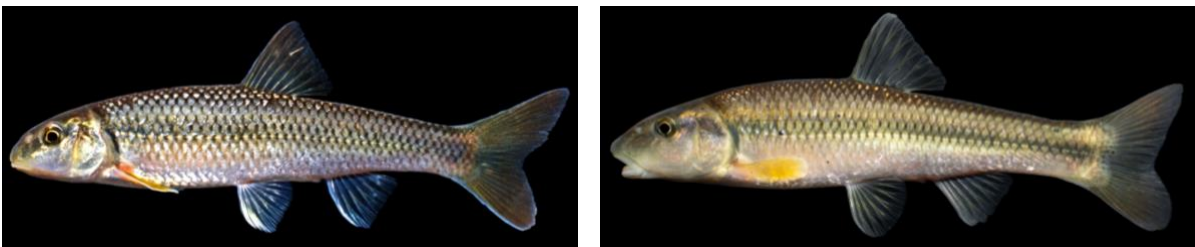


Figure 19. Left – Bull Chub; Right – Bigmouth Chub.

20. Midline of belly between pelvic fins and anal fin with a nonscaled ridge (keel). Anal fin falcate with 12 or more rays. Lateral line strongly curved downward. Black lateral stripe on young (Figure 20)
Golden Shiner, *Notemigonus crysoleucas*
 Midline of belly between pelvic fins and anal fin without a nonscaled ridge (keel). Anal fin not falcate with 11 or fewer rays. Lateral line not strongly curved downward 21

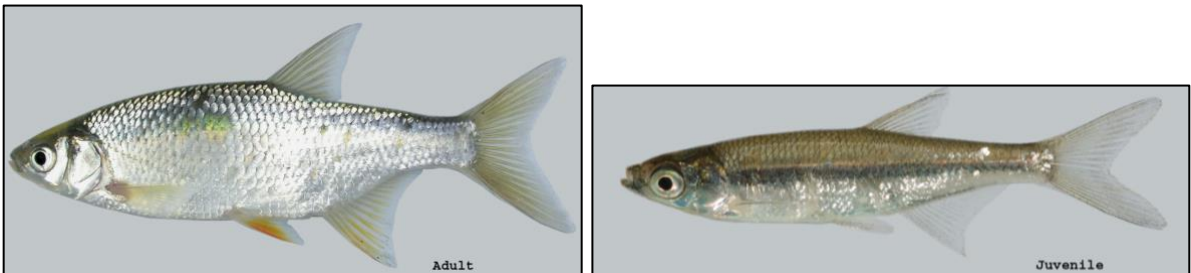


Figure 20. Golden Shiner. Left – Adult; Right – Juvenile.

21. Predorsal scales smaller than lateral scales, appear crowded behind the head. (Figure 21). First dorsal fin ray in adult short and stout, separated from first principal ray by a membrane 22

Predorsal scales nearly same size as lateral scales, not crowded (Figure 21). First dorsal fin ray in adult slender, not separated from first principal ray by a membrane 23

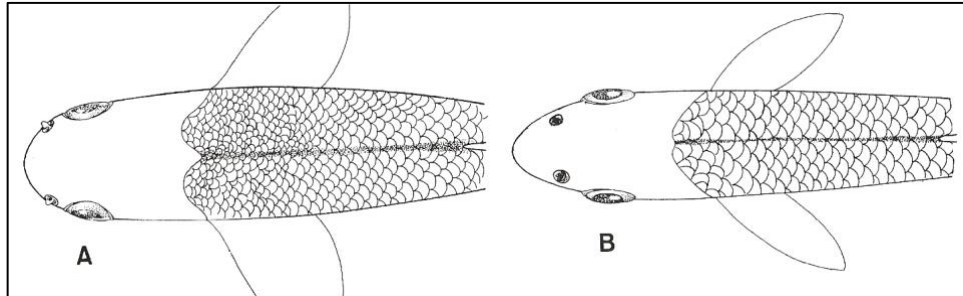


Figure 21. Predorsal squamation. Left (A) – Scales small and crowded anteriorly; Right (B) – typical scale pattern.

22. Lateral line complete. Basicaudal spot distinct. Mouth inferior, almost horizontal (Figure 22), Restricted to the New, Nolichucky, French Broad, and Hiwassee basins Bluntnose Minnow, *Pimephales notatus*

Lateral line usually incomplete. Basicaudal spot indistinct or absent. Mouth nearly terminal, oblique (Figure 22). Nonindigenous, introduced as a bait fish, wide-spread Fathead Minnow, *Pimephales promelas*



Figure 22. Left – Bluntnose Minnow; Right – Fathead Minnow. Photograph of Fathead Minnow courtesy of the North American Native Fishes Association.

23. Lateral line short or absent. Scales small and thin, difficult to observe. Lateral line scales 70-90 (Figure 23) Mountain Redbelly Dace, *Chrosomus oreas*

Lateral line usually complete. Scales clearly visible. Lateral line scales less than 70..... 24



Figure 23. Mountain Redbelly Dace.

- 24. Lips papillose, sucker-like; lower lip forms a fleshy lobe (Figure 24). Mouth inferior 25
- Lips not papillose. Mouth seldom inferior 26

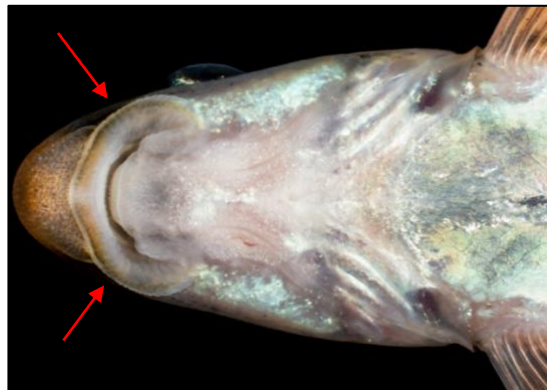


Figure 24. Fatlips Minnow with red arrows pointing to the inferior mouth with papillose lips.

- 25. Lateral line scales 44-49. Basicaudal spot usually absent (Figure 25). Restricted to the New Basin Kanawha Minnow, *Phenacobius teretulus*

Lateral line scales 52-58. Basicaudal spot distinct to faint (Figure 25). Restricted to the Nolichucky, French Broad, and Little Tennessee basins Fatlips Minnow, *Phenacobius crassilabrum*

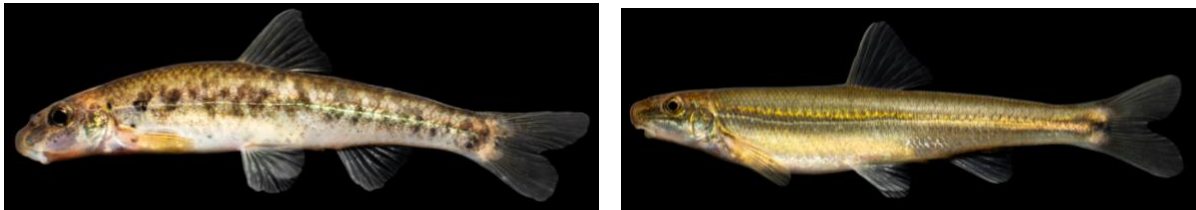


Figure 25. Left – Kanawha Minnow; Right – Fatlips Minnow.

- 26. Mouth large, upper jaw extends beyond front of pupil. Mouth usually slightly superior, oblique. Chin elongate, lower jaws converge inwardly when viewed from below 27

Mouth small, upper jaw seldom reaches to pupil. Mouth usually terminal or subterminal; angle variable. Chin wide, lower jaws do not converge inwardly when viewed from below 28

- 27. Restricted to the Hiwassee basin (Figure 26) *Clinostomus* sp. “Hiwassee” Dace

Restricted to the Little Tennessee basin (Figure 26) *Clinostomus* sp. “Smoky” Dace

Widely distributed from the Piedmont to the New and to seven of the Atlantic slope basins; introduced into the Little Tennessee, French Broad, Nolichucky, and Watauga basins (Figure 26)..... Rosyside Dace, *Clinostomus funduloides*



Figure 26. Top – *Clinostomus* sp. “Hiwassee” Dace; Middle – *Clinostomus* sp. “Smoky” Dace, and Bottom – Rosyside Dace.

28. Mouth small, crescent shaped. Small groove along anteroventral edge of lachrymal extends markedly dorsad from groove that separates side of snout from upper lip. Sides with silvery or dusky lateral stripe (Figure 27). Upon dissection, intestine long and strongly coiled (Figure 16) Eastern Silvery Minnow, *Hybognathus regius*

Mouth usually large, except in Cape Fear Shiner. Upon dissection, intestine short and not long or strongly coiled, except in Cape Fear Shiner 29



Figure 27. Eastern Silvery Minnow with red arrows pointing to the small mouth and lachrymal groove.

29. Dorsal fin interradi al membranes profusely infused with black pigment, either anteriorly, posteriorly, or across the base of the dorsal fin (Figure 28). Maxillary barbel present or absent (Figure 28).
 Anterolateral scales with a diamond-shaped pattern, in distinct diagonal rows 30
- Dorsal fin interradi al membranes not profusely infused with black pigment, either anteriorly, posteriorly, or across the base of the dorsal fin (Figure 28). Maxillary barbel absent (Figure 28).
 Anterolateral scales not usually with a diamond-shaped pattern, seldom in distinct diagonal rows.
 40

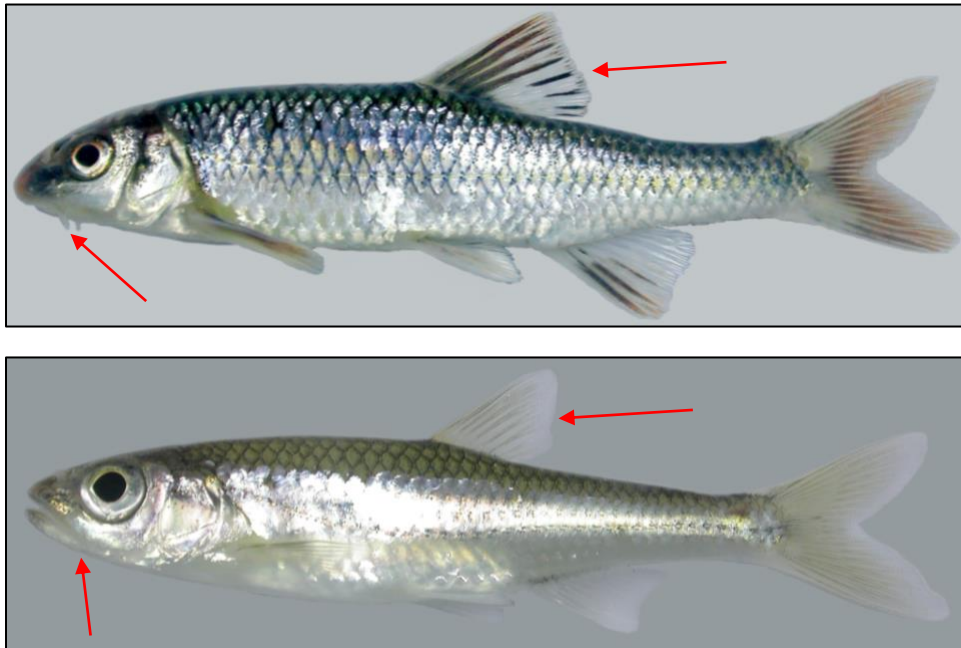


Figure 28. Top – Red arrows pointing to dorsal fin membranes with black pigment and maxillary barbel; Bottom – Red arrows pointing to dorsal fin membranes without black pigment and maxillary barbel absent.

30. Maxillary barbel present 31
 Maxillary barbel absent 34
31. Maxillary barbel small. Currently restricted to the Little Tennessee basin (Figure 29).....
 Spotfin Chub, *Cyprinella monacha*
- Maxillary barbel not small. Restricted to the Broad, Catawba, Yadkin, Lumber, or Cape Fear basins
 32



Figure 29. Spotfin Chub. Photograph courtesy of the North Carolina Wildlife Resources Commission

32. Dorsal fin origin approximately over origin of pelvic fin (Figure 30). Anal fin slightly pointed; margin nearly straight. Small, dark blotches and cross hatching on back and side. Body deep, depth going 4.3-4.8 times into Standard Length Thicklip Chub, *Cyprinella labrosa*

Dorsal fin origin 2 or 3 scales behind origin of pelvic fin (Figure 30). Anal fin not pointed; margin nearly rounded. No dark blotches and cross hatching on back and side. Body slender, depth going 5.0-5.7 times into Standard Length 33



Figure 30. Left - Thicklip Chub showing dorsal fin origin approximately over origin of pelvic fin; Right – Santee Chub showing dorsal fin origin 2 or 3 scales behind origin of pelvic fin.

33. Barbel long, going 1.2-1.5 times into pupil width. Upper lip broad, length going less than 2 times into pupil width. 16-18 predorsal scales. Restricted to the Broad and Catawba basins (Figure 31) Santee Chub, *Cyprinella zanema*

Barbel short, going 2.0-2.2 times into pupil width. Upper lip thin, length going more than 2 times into pupil width. 19-22 predorsal scales. Restricted to the lower Yadkin, Lumber, and Cape Fear basins (Figure 31). *Cyprinella* sp. "Thinlip" Chub

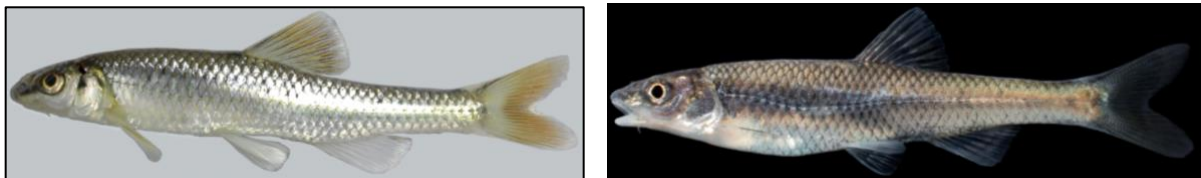


Figure 31. Left - Santee Chub; Right – Thinlip Chub.

34. Entire dorsal fin evenly pigmented. Body deep in adults, depth going less than 3.6 times in Standard Length (Figure 32). Red Shiner, *Cyprinella lutrensis*

Dorsal fin pigmentation restricted to or concentrated in last 2 or 3 interradial membranes. Body slender, depth going usually more than 3.6 times in Standard Length (Figure 32) 35

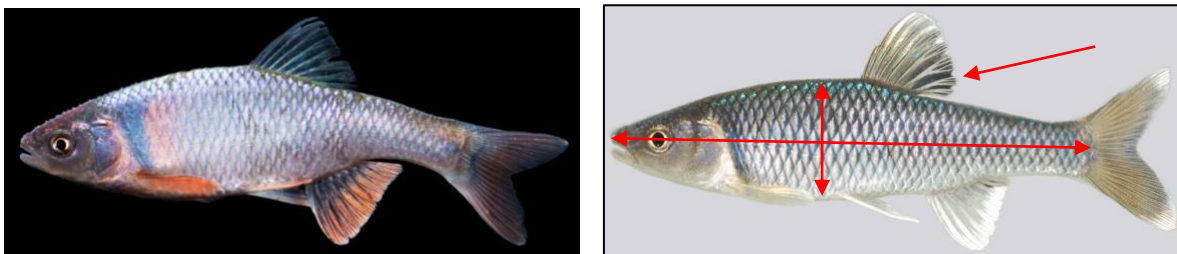


Figure 32. Left – Red Shiner; Right – Satinfish Shiner with red arrows pointing to the dorsal fin pigmentation concentrated in last 3 interradial membranes and slender body depth going more than 3.6 times in Standard Length.

35. Anal fin rays modally 8, rarely 9 36
 Anal fin rays modally 9-11 38
36. Predorsal circumferential scales above lateral line 15 (13-15). Lateral line scales 37-40. Lateral stripe black, distinct anterior to dorsal fin origin. Mouth inferior, snout extends beyond upper lip a distance equal to width of upper lip (Figure 33)..... Whitefin Shiner, *Cyprinella nivea*
- Predorsal circumferential scales above lateral line 11-13. Lateral line scales 35-38 (Spotfin Shiner) or 32-35 (Greenfin Shiner). Lateral stripe not distinct anterior of dorsal fin origin. Mouth usually subterminal, slightly oblique 37

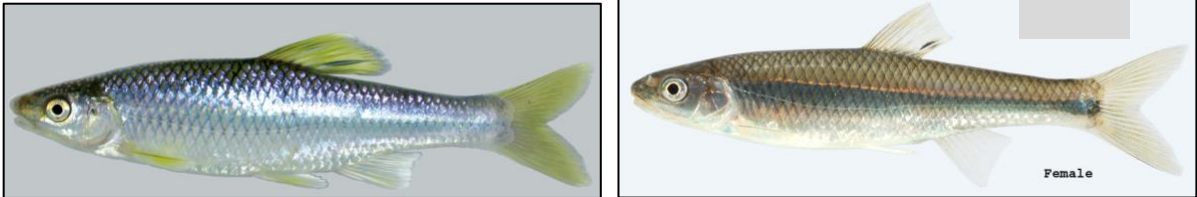


Figure 33. Left – Male Whitefin Shiner; Right – Female Whitefin Shiner showing lateral stripe extending past the dorsal fin origin.

37. Predorsal circumferential scales above lateral line 11, rarely 13. Lateral line scales 32-35. Range restricted to the Broad and Catawba basins (one record from the Yadkin basin) (Figure 34) Greenfin Shiner, *Cyprinella chloristia*
- Predorsal circumferential scales above lateral line 13. Lateral line scales 35-38. Range restricted to the New, Nolichucky, French Broad, Pigeon, and Hiwassee basins (Figure 34) Spotfin Shiner, *Cyprinella spiloptera*

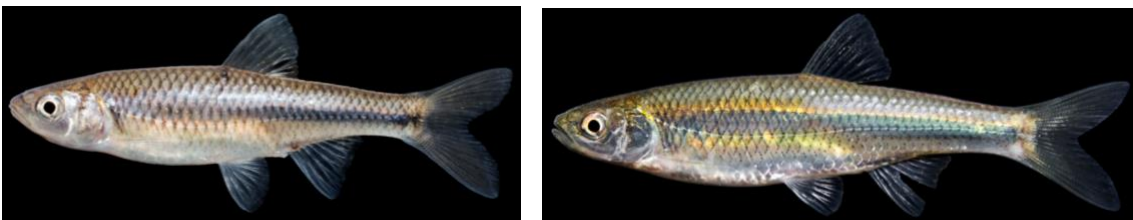


Figure 34. Left – Greenfin Shiner; Right – Spotfin Shiner.

38. Upper and lower portion of caudal fin base each with a distinct large pale patch (Figure 35). Predorsal stripe dark.....Whitetail Shiner, *Cyprinella galactura*
- Upper and lower portion of caudal fin base each without a distinct large pale patch. Predorsal stripe usually faint..... 39

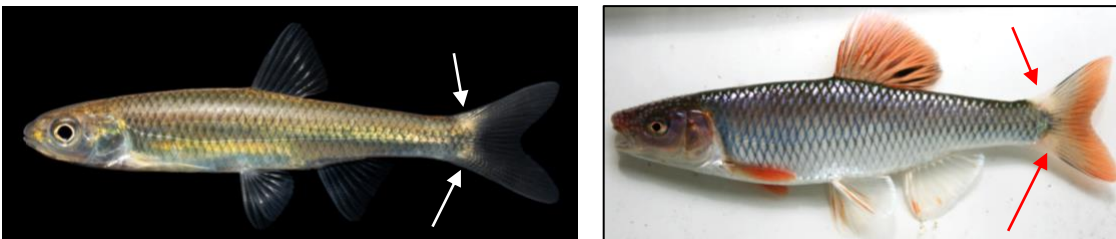


Figure 35. Whitetail Shiner with white and red arrows pointing to the white patches on the upper and lower caudal fin base. Right – male in breeding colors.

39. Anal fin rays (9) 10 or 11. Caudal fin with black edge preceded by red in large males. No lightly pigmented area at the base of the caudal fin. Humeral bar black. Eye large (Figure 36)
 Fieryblack Shiner, *Cyprinella pyrrhomelas*

Anal fin rays modally 9. No pigment in caudal fin. Light basicaudal bar behind caudal spot. Humeral bar faint. Eye small (Figure 36)
 Satinfin Shiner, *Cyprinella analostana*

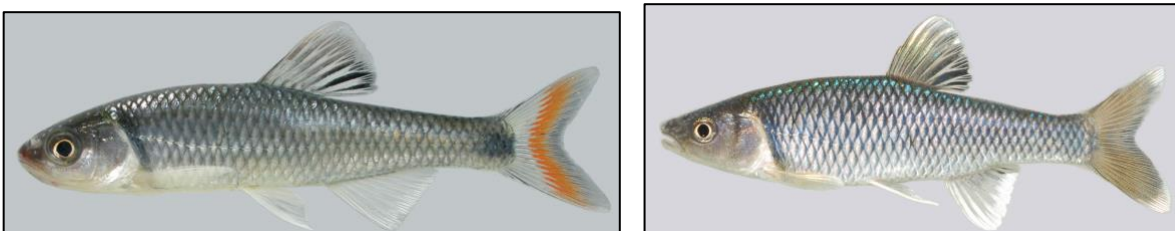


Figure 36. Left – Fieryblack Shiner; Right – Satinfin Shiner.

40. Exposed portion (lunula) of anterior lateral line scales much more than 2 times as high as wide (Figure 37A). Anal fin rays modally 9 41

Exposed portion of anterior lateral line scales 2 times or less as high as wide (except for Mimic Shiner which has modally 8 anal rays) (Figure 37B and 37C). Anal fin rays 7-12 44

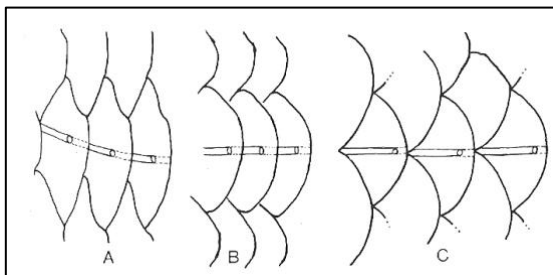


Figure 37. Height relative to width of exposed portion (lunula) of anterior lateral line scales. Left (A) – *Luxilus* species; Center (B) – Mimic Shiner, and Right (C) – typical of most *Notropis* species.

41. Mouth superior (often terminal or slightly subterminal in young). Caudal and often dorsal fins with light base and dark submarginal stripe. Humeral bar black, dark in young (Figure 38)
 Warpaint Shiner, *Luxilus coccogenis*

Mouth subterminal or terminal. Caudal and dorsal fins with no dark stripe. Humeral bar seldom black and distinct (Figure 38) 42

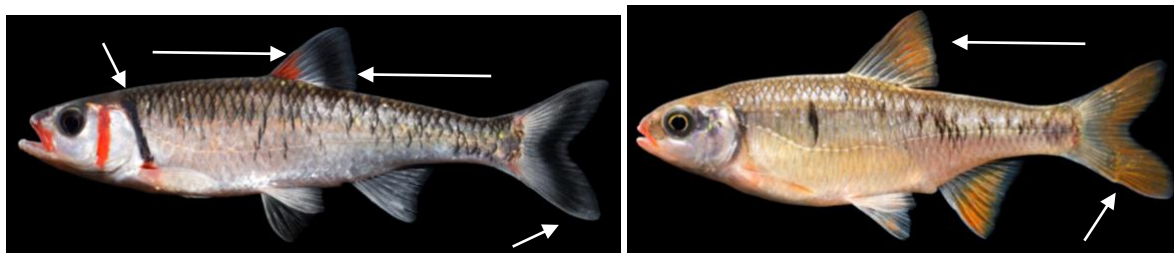


Figure 38. Left - Warpaint Shiner with white arrows pointing to black humeral bar and caudal and dorsal fins with dark submarginal stripes; Right – Crescent Shiner showing white arrows pointing to caudal and dorsal fins lacking black stripes.

42. Predorsal scales 13-16; mid-row usually distinct and scales easily counted. 2 or 3 wavy dark horizontal lines running between dorsal fin insertion and lateral stripe (Figure 39). Restricted to Nolichucky, French Broad, Pigeon, and Hiwassee basins Striped Shiner, *Luxilus chrysocephalus*

Predorsal scales 17-25; mid-row seldom straight, usually difficult to count. Range restricted to the New and Atlantic slope basins 43



Figure 39. Striped Shiner with white arrows pointing to the wavy dark horizontal lines running between dorsal fin insertion and lateral stripe.

43. Sides with irregularly blackened scales extending below lateral line (Figure 40). Scales near lateral line with dark pigment in center, margin clear. Opercle usually with no silvery patch. Appressed pectoral fin nearly reaches pelvic fin origin. Range restricted to Roanoke basin, introduced into the upper Haw River system in the Cape Fear basin Crescent Shiner, *Luxilus cerasinus*

Sides with no irregularly scattered dark scales (occasionally with irregular dark bars 2 or 3 scales deep) (Figure 40). Opercle usually with silvery patch in adults. Range restricted to the New, Roanoke, Chowan, Tar, Neuse, and Cape Fear basins..... White Shiner, *Luxilus albeolus*

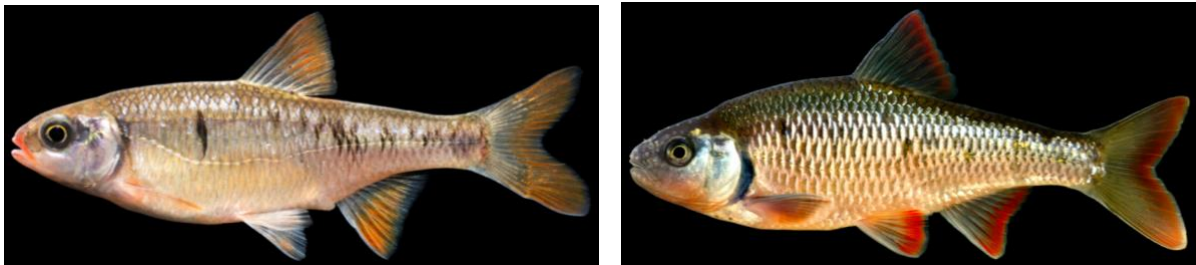


Figure 40. Left – Crescent Shiner; Right – White Shiner.

44. Black spot on dorsal fin near origin. Anterodorsolateral scales distinctly smaller than postdorsal scales. Mouth terminal, oblique. Body very elongate. Dorsal fin origin moderately or much posterior to pelvic fin base. Anal rays usually 10 or 11. Breast usually naked 45

No black spot on dorsal fin near origin. Anterodorsolateral scales about the same size as the postdorsal scales 46

45. Vivid, blood-red chromatic colors restricted to upper head and median fins (Figure 41). Females in nuptial condition masculinized, with tubercle development on dorsum of head equal to that of males. Range restricted to the Tar and Neuse basins Pinewoods Shiner, *Lythrurus matutinus*

Less extensive development of red on fins (Figure 41). Females in nuptial condition not masculinized, with no or weakly developed tubercles on dorsum of head. Range restricted to the Roanoke River basin with introduced populations in the Cape Fear and Yadkin basins Rosefin Shiner, *Lythrurus ardens*



Figure 41. Left – Pinewoods Shiner; Right – Rosefin Shiner.

46. Anal fin rays usually 10-12 47

Anal fin rays usually 7 or 8 54

47. Lateral stripe dark, extends from dark caudal fin spot to around tip of snout and on the lips. Lateral line often incomplete, not set off by dark dashes. Anal fin base often dark..... 48

Lateral stripe if dark, not encircling the snout. Caudal fin spot seldom dark. Lateral line complete, often set off with black spots or dashes. Anal fin base pigment absent to faint 49

48. Dark lateral stripe extending anteriorly onto the opercle, confined to upper 60% of the opercle, ventral margin horizontal (Figure 42) Black lateral stripe above lateral line in region of pelvic fin. Light zone dorsal above dark lateral stripe usually continuous to head. Anal fin base generally not pigmented. Mouth strongly oblique. Pharyngeal teeth usually 2,4-4,2 Highfin Shiner, *Notropis altipinnis*

Anterior extension of the dark lateral stripe on opercle, covering most of the opercle, ventral margin sloping anteroventrally (Figure 42). Black lateral stripe extending 1 or 2 scale rows below the lateral line in region of pelvic fin. Light zone dorsal above dark lateral stripe usually slightly obscured anteriorly behind head by dark pigment edging scales. Anal fin base black, pigment extending to under caudal peduncle. Mouth less oblique. Pharyngeal teeth usually 1,4-4,1..... Dusky Shiner, *Notropis cummingsae*



Figure 42. Left – Highfin Shiner; Right – Dusky Shiner.

49. Predorsal scales large, 13-16, mid-row straight and distinct. Predorsal circumferential scales above lateral line 10 or 11. Eye large, going 5.6-6.9 times in predorsal length. 2 dark lines on head between the eyes. Dorsolateral scales often with dark margin and a median row of dark dots. Dorsolateral scales form 2 or 3 horizontal stripes bordered with brown or black (Figure 43)..... Telescope Shiner, *Notropis telescopus*

Predorsal scales small, 17-29 (15-29), mid-row seldom distinct anteriorly. Predorsal circumferential scales above lateral line 13-17. Eye small, going 6.9-8.4 times in predorsal length (large in Sandbar Shiner). Dorsolateral scales do not form distinct horizontal stripes 50



Figure 43. Telescope Shiner.

50. Eye large, going 5.8-6.8 times in predorsal length. Lateral line scales 34-36. Predorsal scale rows 14-16. Predorsal profile curves down above nostrils. Upper margin of lateral stripe higher anteriorly than posteriorly, curves down under dorsal fin (Figure 44) Sandbar Shiner, *Notropis scepticus*

Eye small, going 6.0-9.0 times in predorsal length. Lateral line scales 36-40. Predorsal scale rows 16-22. Predorsal profile does not curve abruptly down above nostrils. Upper margin of lateral stripe same height anteriorly as posteriorly, does not curve down under dorsal fin..... 51



Figure 44. Sandbar Shiner.

51. Predorsal circumferential scales above lateral line 15. Anal fin rays 11 (10-12). Predorsal profile straight in adults (Figure 45). Restricted to Atlantic slope basins Comely Shiner, *Notropis amoenus*

Predorsal circumferential scales above lateral line 13 (11-13). Anal fin rays 10 (9-12). Predorsal profile slightly rounded in adults. Lateral line usually with dark dashes. Restricted to New and basins west of the Appalachian Mountains 52



Figure 45. Comely Shiner.

52. Middorsal line dark, distinct. Dorsal fin origin 1.5-2.5 scales behind pelvic fin origin (Figure 46). Dorsal fin not unusually far back on body, distance from dorsal fin origin to hypural plate greater than distance from dorsal fin origin to center of pupil. Pigment on sides extends below lateral line. Dark crescents often visible between nostrils. Middorsal line faint, diffuse. Pelvic fin rays 9 or 10 Silver Shiner, *Notropis photogenis*

Middorsal line faint, diffuse. Dorsal fin origin 2.5-4.0 scales behind pelvic fin origin (Figure 46) Dorsal fin far back on body, distance from dorsal fin origin to hypural plate less than distance from dorsal fin origin to center of pupil. No pigment on sides below lateral line. No dark crescents visible between nostrils Pelvic fin rays 8 53

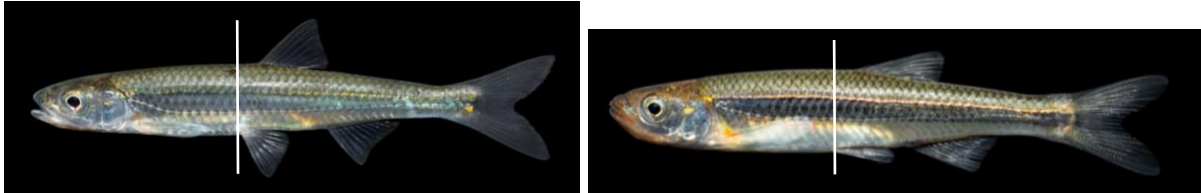


Figure 46. Left - Silver Shiner showing dorsal fin origin 1.5-2.5 scales behind pelvic fin origin; Right - *Notropis* sp. “Kanawha” Rosyface Shiner showing dorsal fin origin 2.5-4.0 scales behind pelvic fin origin.

53. Restricted to New basin (Figure 47)..... *Notropis* sp. “Kanawha” Rosyface Shiner

Restricted to Nolichucky, French Broad, Pigeon, Little Tennessee, and Hiwassee basins (Figure 47)Highland Shiner, *Notropis micropteryx*

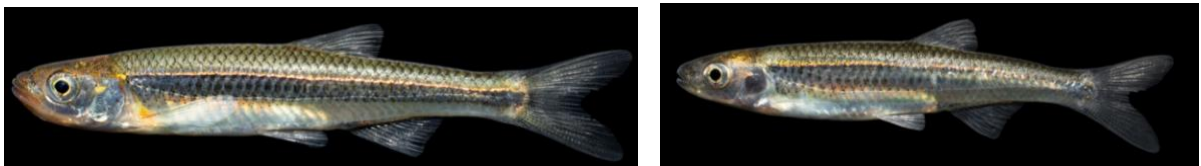


Figure 47. Left – *Notropis* sp. “Kanawha” Rosyface Shiner; Right – Highland Shiner.

54. Anal fin rays modally 7 55

Anal fin rays modally 8 58

55. Snout almost equal to or longer than diameter of the eye. Mouth large extends backward almost even with front of eye (Figure 48). Anal and pelvic fin rays outline with black. Lateral stripe absent just behind eye (Figure 48). Body along anal fin base black, pigment extending to under caudal peduncle. Pre- and postdorsal midline stripe broad, pigment encircling dorsal fin. Triangular caudal spot. Pharyngeal teeth 2,4-4,2 Coastal Shiner, *Notropis petersoni*

Snout distinctly shorter than diameter of the eye. Anal and pelvic fin rays not outlined with black. Mouth variable, generally small. Body along anal fin base with little pigment (except in Swallowtail Shiner). Pre- and postdorsal midline stripe variable. Caudal spot variable. Pharyngeal teeth 4-4 ... 56



Figure 48. Coastal Shiner - Left – close-up view of the length of the snout compared to the width of the eye and the large mouth extending backwards almost even with front of the eye; Right - Coastal Shiner.

56. Breast half scaled at most, often entirely naked. Pigmented predorsal stripe present. Anal fin base well pigmented, pigment extends along caudal peduncle. Smudge of dark pigment on body beneath origin of dorsal fin. Dark lateral stripe does not encircle snout (Figure 49). Light stripe absent on snout above dark stripe. Caudal fin spot usually not connected to lateral stripe. Males in breeding condition yellow or slightly brighter yellow (Figure 49) Swallowtail Shiner, *Notropis procne*

Breast usually half to fully scaled. Predorsal stripe absent. Anal fin base sometimes slightly pigmented. No dark smudge on body at origin of dorsal fin. Dark lateral stripe encircling the snout (Figure 50) 57



Figure 49. Swallowtail Shiner. Left – Red arrows pointing to the dark lateral stripe not encircling the snout and a pigmented snout.

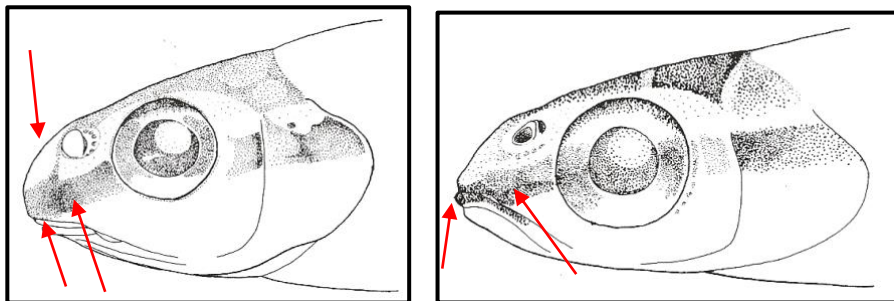


Figure 50. Red arrows pointing to the dark lateral stripe encircling the snout. Left – Whitemouth Shiner with red arrows pointing to the dark lateral stripe encircling the snout, the white snout, and white lips; Right – Bridle Shiner with red arrows pointing to the dark lateral stripe encircling the snout and the pigmented upper lip.

57. Band of dark pigment encircling snout (Figure 50), about uniform in width or slightly narrowed at snout tip. Front of upper lip usually devoid of melanophores (black pigment cells). Mouth subterminal, horizontal. Red pigment in upper eye (Figure 51).....Whitemouth Shiner, *Notropis alborus*

Band of dark pigment encircling the snout, markedly constricted at snout tip (Figure 50). Front of upper lip liberally peppered with melanophores (Figure 50). Mouth terminal, oblique (Figures 50 and 51)..... Bridle Shiner, *Notropis bifrenatus*



Figure 51. Left – Whitemouth Shiner; Right – Bridle Shiner.

58. Lateral line incomplete. Caudal fin spot black, larger than pupil, surrounded by distinct light area (Figure 52). Lower lip with pigment. Large black blotch along front of dorsal fin Taillight Shiner, *Notropis maculatus*

Lateral line usually complete. Caudal fin spot, if present, no deeper than lateral stripe black 59



Figure 52. Taillight Shiner with white arrows pointing to the large black blotch along front of dorsal fin and large black caudal fin spot.

59. Dorsal fin rounded. Caudal spot triangular, much darker than lateral stripe which is faint to absent. Body cylindrical. Predorsal scales crowded, thin, and embedded or absent. Head flat between the eyes (Figure 53)Mirror Shiner, *Notropis spectrunculus*

Dorsal fin pointed. Predorsal scales not crowded, clearly visible. Head shape and caudal fin spot variable. Body compressed. Lateral stripe medium to well developed. Light streak usually present over dark lateral stripe 60



Figure 53. Mirror Shiner with white arrows pointing to the flat head and triangular caudal fin spot.

60. Body along anal fin base black with pigment extending under caudal peduncle. Lateral stripe distinct and black. Mouth small, not reaching to front of eye. Roof of mouth black. Rays of anal and pelvic fins usually bordered with black (Figure 54)Ironcolor Shiner, *Notropis chalybaeus*

Body along anal fin base with little or no pigment. Lateral stripe less distinct than above. Mouth size variable. Roof of mouth unpigmented. Anal fin rays not bordered with black..... 61

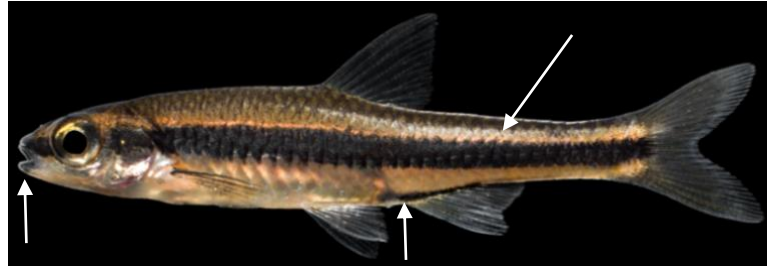


Figure 54. Ironcolor Shiner with white arrows pointing to a small mouth, dark lateral stripe, and darkly pigmented anal fin base.

61. Dorsal fin pointed, first ray usually reaching 2 or 3 scales behind last ray. Dorsal fin origin over or anterior to pelvic fin origin. Mouth nearly horizontal (Figure 55)..... Spottail Shiner, *Notropis hudsonius*

Dorsal fin not strongly pointed, first ray reaching 0 or 1 scales behind last ray. Dorsal fin origin behind pelvic fin origin. Mouth usually oblique..... 62

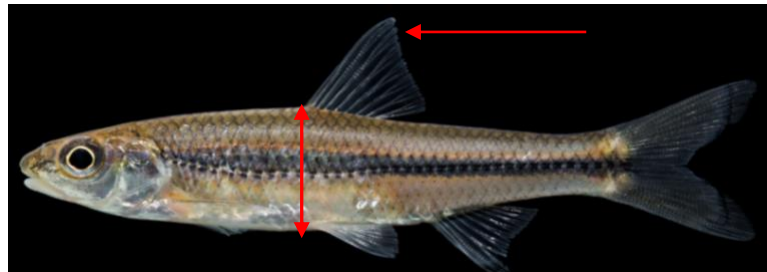


Figure 55. Spottail Shiner with red arrows pointing to the dorsal fin origin over the pelvic fin origin and to a pointed dorsal fin.

62. Lateral line bordered with dashes. Caudal fin spot rectangular. Light stripe present over lateral stripe posterior of dorsal fin origin (Figure 56)..... Tennessee Shiner, *Notropis leuciodus*

Lateral line not bordered with dashes, except in New River Shiner. Light stripe usually absent over dark lateral stripe posterior of dorsal fin origin. Caudal fin spot, if present, round. 63



Figure 56. Tennessee Shiner with white arrows pointing to the rectangular caudal fin spot and lateral line bordered with dashes. Right – male in breeding colors.

63. Body under posterior dorsal fin with a dark blotch. Pre-dorsolateral scales arranged in clearly defined diagonal rows. Eyes bulge out, directed upward more than usual (Figure 57). Restricted to the New basin New River Shiner, *Notropis scabriceps*

Body under posterior dorsal fin with or without a dark blotch. Pre-dorsolateral scales not usually arranged in clearly defined diagonal rows. Eyes not bulging out, usually directed sideways. Not restricted to the New basin..... 64



Figure 57. New River Shiner.

64. Anterior lateral line scales elevated, exposed width going 2.1-2.9 times in height (best observed in the 3rd-7th scales from the head) (Figures 37 and 58). Extensive development of neuromasts on the anterior half of the head dorsum, snout, subnasal area, around the orbit, particularly on the cheek, and on the anterior portion of lateral line scales. Lateral stripe diffuse, not unusually black, not entering snout, dorsal margin of lateral stripe not serrate. Caudal fin spot faint to absent (Figure 58) Mimic Shiner, *Notropis volucellus*

Lateral line scales not elevated anteriorly, width going less than 2 times in the height (Figure 37). Lateral stripe usually black, stripe enters snout, dorsal margin often serrate. Caudal fin spot black, often joined to lateral stripe. 65



Figure 58. Mimic Shiner with white arrows pointing to anterior lateral line scales which are elevated, the diffuse lateral line, and a caudal spot that is faint to absent.

65. Dorsal fin origin anterior or above pelvic fin origin (Figure 59). Distinct black lateral stripe extends from preorbital area to caudal fin spot. Mostly scaled anterior breast area. Lower lip usually lined with dark pigment (Figure 59). Males bright brassy yellow-gold (Figure 59). Restricted to the Cape Fear basin Cape Fear Shiner, *Notropis mekistocholas*

Dorsal fin origin posterior to pelvic fin origin. If present, distinct black lateral stripe not extending from preorbital area to caudal fin spot. Breast mostly naked. Lower lip not lined with dark pigment. Breeding males brightly colored with yellow, red, or white colored fins. Not restricted to the Cape Fear basin 66



Figure 59. Left - Cape Fear Shiner with white arrow pointing to the lower lip with dark pigment; Right – Cape Fear Shiner with white line showing dorsal fin anterior or above pelvic fin origin.

66. Humeral bar usually dark. Lateral stripe faint anteriorly, does not enter head (if entered into head, lateral stripe would pass above eye). Lateral line located 1 or 2 scales under top of diffuse lateral stripe in front of dorsal fin 67

Humeral bar faint. Lateral stripe dark anteriorly, passes uninterrupted from hypural plate onto opercle, crosses opercle level with eye, often passes through eye. Lateral line located in, or at lower edge of, lateral stripe in front of dorsal fin 68

67. Small pale spots at each end of dorsal fin with base of dorsal fin having melanophores covering one-fourth to one-third of the interradial membranes (Figure 60). Ventral portion of the mid-lateral stripe fades anteriorly, especially along lateral line and beginning at posterior end of dorsal fin. Dark pigmented scales absent below lateral line. Scattered blotches present on sides of body (Figure 61) Redlip Shiner, *Notropis chiliticus*

No small pale spot at each end of dorsal fin base, with dorsal fin having melanophores covering only the interradial membranes at its base (Figure 60). Mid-lateral stripe usually extending from head to tail. Scales having well-pigmented posterior margins extending 1 or 2 rows below lateral line in front of dorsal fin. Sides with no scattered dark blotches (Figure 61) Saffron Shiner, *Notropis rubricroceus*

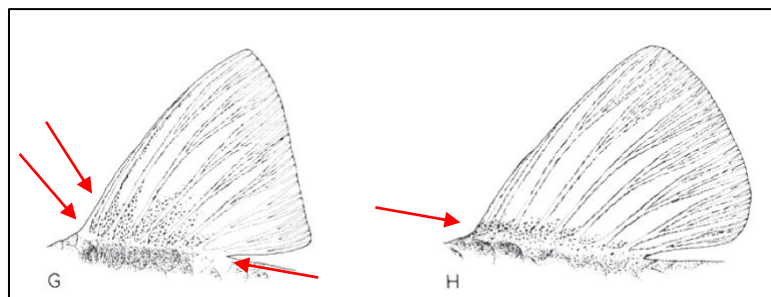


Figure 60. Left (G) – Dorsal fin of Redlip Shiner with red arrows pointing to the pale spot at both ends of the dorsal fin and the melanophores on the interradial membranes; Right (H) – Saffron Shiner with arrow pointing to the melanophores at the fin's base.

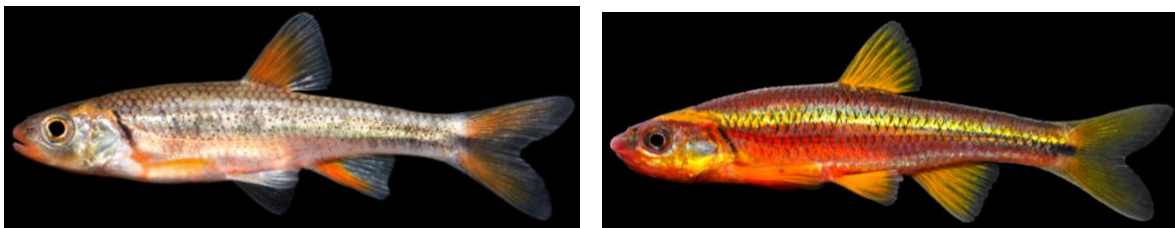


Figure 61. Left - Redlip Shiner; Right – Saffron Shiner.

68. Lateral line occurs in bottom half of lateral stripe (including all pigmented areas) below dorsal fin origin (Figure 62). Pigment usually absent from 2nd scale row below lateral line anterior to dorsal fin. Lower margin of lateral stripe on the same level on opercle as on cheek. Pharyngeal teeth 2,4-4,2. Range restricted to the Savannah basin with introduced populations in the Little Tennessee basin Yellowfin Shiner, *Notropis lutipinnis*

Lateral line occurs in bottom half of lateral stripe (including all pigmented areas) below dorsal fin origin or in middle of lateral stripe (including all pigmented areas) below dorsal fin origin. Pigment present on 2nd scale row below lateral line anterior of dorsal fin or usually absent from 2nd scale row below lateral line anterior to dorsal fin. Lateral stripe lower on opercle than on cheek. Pharyngeal teeth 1,4-4,1, or 2,4-4,2, or 1,4-4,2, or 2,4-4,1. Range restricted to the Broad or Catawba basins .. 69



Figure 62. Yellowfin Shiner.

69. Pelvic, pectoral, and anal fins yellow to yellow + white, rarely red (Figure 63). Range restricted to the Broad basin *Notropis* sp. "Piedmont" Shiner

Pelvic, pectoral, and anal fins white (Figure 63). Range restricted to the Catawba basin Greenhead Shiner, *Notropis chlorocephalus*



Figure 63. Left – *Notropis* sp. "Piedmont" Shiner; Right – Greenhead Shiner.

Glossary

(Adapted from Jenkins and Burkhead (1994) and Rohde et al. (2009))

Anteromedially – towards the anterior middle region of the breast between the pectoral fins.

Basicaudal Spot – Spot at the base of the caudal fin

Caudal Peduncle – Narrow posterior part of a fish that connects the tail to the body

Embedded Scales – Scales that are not obvious owing to deep embedment in or full covering by skin

Frenum – Fleishy bridge or connection between the snout and the upper lip

Humeral Bar – Pigmented bar in the Shoulder (scapular) area, laterally just behind the head

Hypural Plate – Expanded bones that form the support for the caudal fin rays. The end of the plate usually appears as a crease across the caudal peduncle.

Interorbital Area – The region on the top of the head between the eyes

Interradial Membranes – Membranes between rays in the fins

Lachrymal Groove – A small groove on the lower side of snout, caused by folding of skin under edge of lachrymal bone just above upper lip

Lunula – The visible, exposed posterior part of a scale when in its natural position

Maxilla – Bone in the upper jaw that lies immediately above (or behind) and parallel to the premaxilla (the most anterior bones in the upper jaw)

Maxillary Barbel – A slender fleshy protuberance, tiny to long, usually tapered to a point, found on the lip, jaw (maxillary), or elsewhere on head in some fishes; usually taste sensory.

Nape – The dorsal area between the posterior end of the head (occiput) and the dorsal fin

Neuromasts – Tiny pitlike sensory structures

Papillose – Bearing papillae (small rounded fleshy protuberances, knob-like or elongate)

Pharyngeal Arch – The bony modified last (posterior) gill arch; term applied when this arch bears definitive teeth as in suckers

Pharyngeal Teeth – Teeth on the pharyngeal arch

Predorsal Profile – Profile of the body anterior to the dorsal fin

Predorsal Circumferential Scale Count – A count of the number of scales encircling the body anterior to the dorsal fin

Premaxillae - One of the paired, superficial, usually toothed, dermal bones of the upper jaw, proximal or anterior to the maxillaries.

Prenasal – Anterior to the nares (nostril openings)

Preorbital Stripe – Stripe anterior to the orbit (eye)

Occipital Area – Posterior part of the head just anterior to the nape

Serrate – With a sawtooth or jagged edge

Standard Length (SL) – Distance from the anterior most point on a fish to the posterior end on the bony caudal fin base (hypural plate)

Subnasal – Below the nostrils

Tubercles – Small, hard protuberances on the skin or a fin, usually present only on a breeding male

References

(Identification key adapted from these references)

(Permission to use Figures 26 (page 256), 27 (page 257), 30 (page 259), 33 (page 263), 34 (page 266), 35 (page 267), and 36 (page 270) in Jenkins, and Burkhead (1994) was granted by the American Fisheries Society, October 19, 2020)

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The Meanings of the Scientific Names of Minnows

(adopted from Jenkins and Burkhead (1994), Rohde et al. (2009), and from the ETYFish Project by Christopher Scharpf and Kenneth J. Lazara, accessed October 23, 2020, <http://www.etyfish.org/>)

Family Cyprinidae

1. **Carassius Jarocki 1822** tautonymous with *Cyprinus carassius*, from the French *carassin*, carp
 - i. **Carassius auratus (Linnaeus 1758)** gilded, referring to golden color
2. **Cyprinus Linnaeus 1758** *kyprinos*, Greek for carp, possibly derived from Kypris, also known as Aphrodite, goddess of love, referring to fecundity of *Cyprinus carpio*
 - i. **Cyprinus carpio Linnaeus 1758** latinization of the Old French *carpe*

Family Xenocyprididae

1. **Ctenopharyngodon Steindachner 1866** *cteno*, comb; *pharynx*, throat; *odon*, tooth, referring to comb-like pharyngeal teeth
 - i. **Ctenopharyngodon idella (Valenciennes 1844)** etymology not explained, probably a diminutive of the Eurasian *Leuciscus idus* (Leuciscidae), in whose genus it was originally placed

Family Leuciscidae

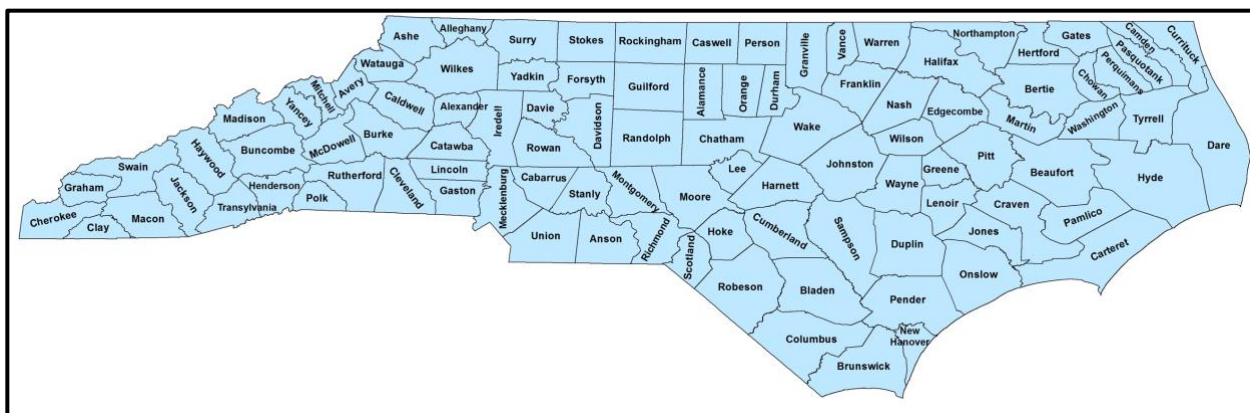
1. **Campostoma Agassiz 1855** *campo*, curved; *stoma*, mouth, referring to U-shaped mouth
 - i. **Campostoma anomalum (Rafinesque 1820)** anomalous, differing from all other Ohio minnows by its “unequal bilobed tail” (not different or abnormal appearance of ridge on lower jaw, as reported by some authorities)
2. **Chrosomus Rafinesque 1820** *chroma*, color; *soma*, body, referring to vibrant coloration of *Chrosomus erythrogaster*
 - i. **Chrosomus oreas Cope 1868** of the mountains, referring to occurrence in montane and upland region
3. **Clinostomus Girard 1856** *clino*, inclined; *stoma*, mouth, referring to its oblique shape
 - i. **Clinostomus funduloides Girard 1856**–*oides*, having the form of: referring to superficial resemblance to topminnows (Cyprinodontiformes: Fundulidae, *Fundulus*)
4. **Cyprinella Girard 1856** diminutive of *cypris*, carp, i.e., a small carp or minnow
 - i. **Cyprinella analostana Girard 1859** –*ana*, belonging to: Analostan (now Theodore Roosevelt) Island, Potomac River, Washington, D.C., USA, type locality
 - ii. **Cyprinella chloristia (Jordan & Brayton 1878)** *chloros*, green; *histia*, sail, referring to green dorsal fin
 - iii. **Cyprinella galactura (Cope 1868)** *galactos*, milk; *oura*, tailed, referring to two clear-to-white areas on caudal fin base
 - iv. **Cyprinella labrosa (Cope 1870)** thick-lipped, referring to its “prominent” lips
 - v. **Cyprinella lutrensis (Baird & Girard 1853)** –*ensis*, suffix denoting place: *lutra*, otter, referring to Otter Creek, Oklahoma (erroneously reported as Arkansas), USA, type locality
 - vi. **Cyprinella monacha (Cope 1868)** solitary, referring to its isolated suite of characters and the fact that Cope only saw it “singly or in pairs”
 - vii. **Cyprinella nivea (Cope 1870)** snow, referring to white fins of breeding males
 - viii. **Cyprinella pyrrhomelas (Cope 1870)** *pyrrhos*, flame; *melas*, black, referring to red-black caudal fin of males
 - ix. **Cyprinella spiloptera (Cope 1867)** *spilos*, spot; *pterus*, fin, referring to black spot on dorsal fin

- x. ***Cyprinella zanema* (Jordan & Brayton 1878)** *za*, very; *nemus*, thread, referring to “extremely long [barbels], probably longer than in any other of our Cyprinoids”
5. ***Erimystax* Jordan 1882** *eri-*, very; *mystax*, moustached, referring to barbels
- i. ***Erimystax insignis* (Hubbs & Crowe 1956)** conspicuous, referring to blotches on sides
6. ***Exoglossum* Rafinesque 1818** *ex-*, outside; *glossa*, tongue, referring to bony tongue-like extension of lower jaw
- i. ***Exoglossum laurae* (Hubbs 1931)** in honor of Hubbs’ wife, Laura (1893-1988)
 - ii. ***Exoglossum maxillingua* (Lesueur 1817)** *maxilla*, jawbone; *lingua*, tongue, referring to bony tongue-like extension of lower jaw
7. ***Hybognathus* Agassiz 1855** *hybos*, hump; *gnathus*, jaw, referring to slight protrusion of lower jaw
- i. ***Hybognathus regius* Girard 1856** royal, a “large and beautiful species, the largest [member of genus] that has, so far, come to our knowledge, some of the specimens measuring seven inches in length”
8. ***Hybopsis* Agassiz 1854** *hybos*, hump; *ops*, face or appearance, probably referring to “obtuse prominent snout” of *H. gracilis* (= *amblops*)
- i. ***Hybopsis amblops* (Rafinesque 1820)** *amblyos*, blunt; *ops*, face or appearance, referring to “round” snout
 - ii. ***Hybopsis hypsinotus* (Cope 1870)** *hypselos*, high; *notos*, back, referring to strongly arched back
 - iii. ***Hybopsis rubrifrons* (Jordan 1877)** *rubrum*, red; *frons*, forehead, referring to rosy-red color of anterior portion of body of breeding males
9. ***Luxilus* Rafinesque 1820** *lux*, light, connoting the American vernacular *shiner*; *-illus*, diminutive suffix, i.e., a small, shiny fish
- i. ***Luxilus albeolus* (Jordan 1889)** whitish, the sides and fins a “pure silvery white”
 - ii. ***Luxilus cerasinus* (Cope 1868)** cherry red, referring to body color of breeding males
 - iii. ***Luxilus chrysocephalus* Rafinesque 1820** *chryso*, golden; *cephalus*, head, referring to “gilt” head
 - iv. ***Luxilus coccogenis* (Cope 1868)** *coccom*, berry; *geneion*, cheek, referring to red mark on side of head
10. ***Lythrurus* Jordan 1876** *lythrum*, gore; *oura*, tailed, referring to blood-red caudal fin often seen on males
- i. ***Lythrurus ardens* (Cope 1868)** ardent, referring to bright colors of breeding males
 - ii. ***Lythrurus matutinus* (Cope 1870)** of the morning, or rosy, referring to “rufous” muzzle and chin
11. ***Nocomis* Girard 1856** a Native American word, presumably chosen because Girard like the sound of it [*Nookomis* is the name of a grandmother in traditional stories among the indigenous Ojibwe people of North America and was made famous in Longfellow’s 1855 epic poem “The Song of Hiawatha,” in which a major female character named Nokomis falls from the moon]
- i. ***Nocomis leptcephalus* (Girard 1856)** *leptos*, small or slender; *cephalus*, head, referring to smaller head compared to *Ceratichthys* (= *Hybopsis*) *amblops*
 - ii. ***Nocomis micropogon* (Cope 1865)** *micro-*, small; *pogon*, beard, referring to very small barbels on holotype (which was later discovered to be a *Luxilus cornutus* x *N. micropogon* hybrid; name validated by substituting holotype with a neotype)
 - iii. ***Nocomis platyrhynchus* Lachner & Jenkins 1971** *platy*, wide; *rhynchus*, snout, referring to large gape width
 - iv. ***Nocomis raneyi* Lachner & Jenkins 1971** in honor of ichthyologist Edward C. Raney (1909-1984), Cornell University, “whose enthusiasm and guidance placed many American students on the professional pathway to ichthyology”

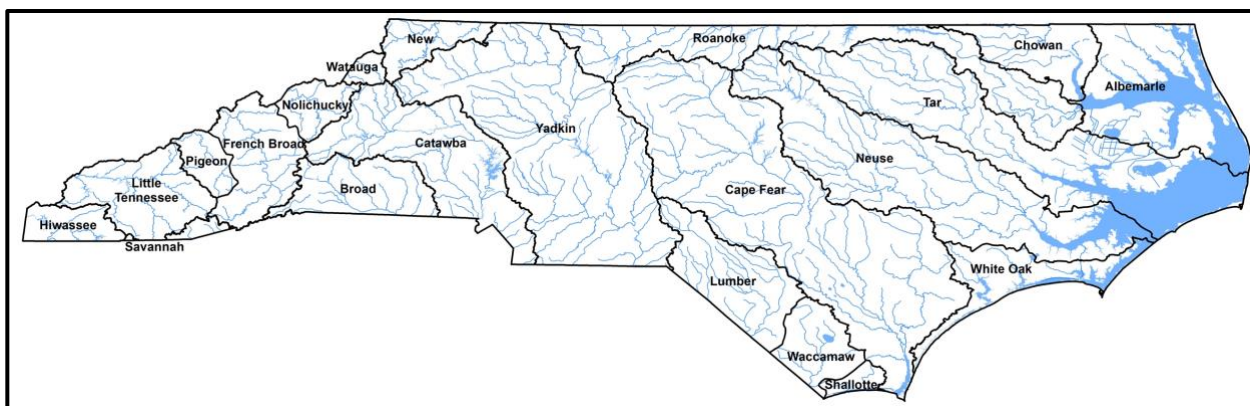
12. **Notropis Rafinesque 1818** *notos*, back; *tropis*, keeled, referring to ridged or keeled back, possibly due to shrinkage of the *N. atherinoides* specimen Rafinesque examined
- i. **Notropis alborus Hubbs & Raney 1947** *albus*, white; *oris*, mouth, referring to unpigmented lips and mouth
 - ii. **Notropis altipinnis (Cope 1870)** *altus*, high; *pinna*, fin, referring to “much elevated” dorsal fin compared to other minnows Cope grouped with this species
 - iii. **Notropis amoenus (Abbott 1874)** pleasing, or “beautiful,” as Abbott described it
 - iv. **Notropis bifrenatus (Cope 1867)** *bi-*, two, *frenatus*, bridled, referring to black bars across snout
 - v. **Notropis chalybaeus (Cope 1867)** steel-colored, referring to dark lateral stripe
 - vi. **Notropis cummingsae (Myers 1925)** in honor of Mrs. J. H. Cummings (1885-?), amateur naturalist, for her “investigation of the Wilmington [North Carolina, USA] fauna and flora” (she and her husband also hosted Myers in their houseboat during his North Carolina field work)
 - vii. **Notropis hudsonius (Clinton 1824)** *-ius*, adjectival suffix: Hudson River, New York, USA, type locality
 - viii. **Notropis leuciodus (Cope 1868)** *leucos*, white; *eidus*, form or resemblance, i.e., whitish, presumably referring to silver sides
 - ix. **Notropis lutipinnis (Jordan & Brayton 1878)** *luteus*, yellow; *pinnis*, fin, referring to color of fins on breeding males
 - x. **Notropis maculatus (Hay 1881)** spotted, referring to large caudal spot
 - xi. **Notropis mekistocholas Snelson 1971** *mekisto*, longest; *cholas*, intestine, referring to elongate, convoluted intestine, an adaptation to its herbivorous diet
 - xii. **Notropis micropteryx (Cope 1868)** *micro-*, small; *pteryx*, fin, referring to smaller fins compared to *Alburnellus jaculus* (= *Notropis rubellus*)
 - xiii. **Notropis petersoni (Fowler 1942)** in honor of C. Bernard Peterson (1906-1963), Fowler’s editor at the Academy of Natural Sciences of Philadelphia, who helped collect type
 - xiv. **Notropis photogenis (Cope 1865)** *photo-*, light; *genis*, cheek, referring to its “bright silvery” sides, “especially brilliant” on the operculum
 - xv. **Notropis prokne (Cope 1865)** Prokne, from Greek mythology, whom the gods transformed into a swallow, alluding to its deeply forked tail
 - xvi. **Notropis rubricroceus (Cope 1868)** *ruber*, red; *croceus*, saffron, referring to dominant colors of body and fins, respectively, of breeding males
 - xvii. **Notropis scabriceps (Cope 1868)** *scaber*, rough; *ceps*, head, referring to abrasive tubercles on heads of breeding males
 - xviii. **Notropis szepticus (Jordan & Gilbert 1883)** observant, referring to its large eyes
 - xix. **Notropis spectrunculus (Cope 1868)** *specca*, spot; *trunculus*, stem, referring to spot at end of caudal peduncle
 - xx. **Notropis telescopus (Cope 1868)** far seeing, referring to its large eyes
 - xxi. **Notropis volucellus (Cope 1865)** diminutive of *volucer*, flying or swift, probably referring to its “elongate fins, especially the dorsal”
13. **Phenacobius Cope 1867** *phenax*, imposter; *bios*, life; i.e., looks like an herbivore and superficially like a sucker (Catostomidae: *Catostomus*) but is neither
- i. **Phenacobius crassilabrum Minckley & Craddock 1962** *crassus*, fat; *labrum*, lip, referring to large, fleshy lips
 - ii. **Phenacobius teretulus Cope 1867** referring to terete body form
14. **Pimephales Rafinesque 1820** *pimele*, fat, *cephales*, head, the head of *P. promelas* being “soft and fat all over,” a clear reference to fleshy growth on nape of breeding males [Rafinesque twice incorrectly translated name as “Flat-head” in description of genus, possibly a typesetting error, but correctly translated it as “Fat-head” in description of *P. promelas*]
- i. **Pimephales notatus (Rafinesque 1820)** marked, probably referring to caudal fin spot
 - ii. **Pimephales promelas Rafinesque 1820** *pro-*, in front of; *melas*, black; referring to black head of breeding males

15. **Rhinichthys Agassiz 1849** *rhinos*, nose, referring to prominent snout of *R. atronasmus* (= *atratus*); *ichthys*, fish
- i. ***Rhinichthys atratus* (Hermann 1804)** dressed in black, referring to stripe on body and around snout
 - ii. ***Rhinichthys cataractae* (Valenciennes 1842)** of cataracts, referring to area around Niagara Falls, North America, type locality
 - iii. ***Rhinichthys obtusus* Agassiz 1854** blunt, referring to more blunt body compared to *R. marmoratus* (= *cataractae*)
16. **Semotilus Rafinesque 1820** marked, referring to spot on dorsal fin of *Semotilus atromaculatus*
- i. ***Semotilus atromaculatus* (Mitchill 1818)** *atro*, black; *maculatus*, spotted, referring to prominent spot on dorsal fin
 - ii. ***Semotilus lumbee* Snelson & Suttkus 1978** referring to Lumbee Indians who inhabited Lumber River system in North Carolina, USA, type locality

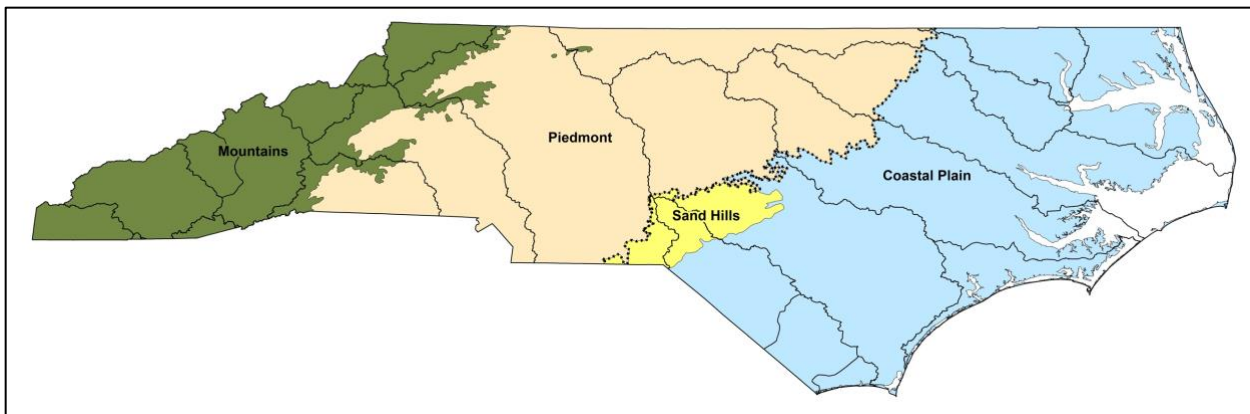
Supplemental Maps



Map No. 1. North Carolina's 100 counties. Map originally appeared in Tracy et al. (2020).



Map No. 2. North Carolina's 21 river basins. Map originally appeared in Tracy et al. (2020).



Map No. 3. North Carolina's four physiographic regions. Map originally appeared in Tracy et al. (2020).