

Description of the Apalachicola Redhorse (Catostomidae: *Moxostoma*)

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Abstract

The Apalachicola Redhorse is a species that has been long known amongst North American ichthyologists and is herein described as *Moxostoma antelunare* new species. The Apalachicola Redhorse differs from other gray-tailed Redhorses based on a combination of gill raker count, lateral line scale count, and caudal peduncle depth and the species is supported by two potential osteological autapomorphies: a V-shaped notch between the anteromedial and posteromedial processes of the cleithrum and the anterolateral and posteromedial laminae of the hyomandibula of equal size. The Apalachicola Redhorse occupies much of the Apalachicola River drainage of Georgia, Alabama, and Florida as well as Econfinia Creek in the St. Andrew's Bay drainage of Florida.

Key words: Fishes, Suckers, North America, Chattahoochee, Flint, Econfinia

Prologue

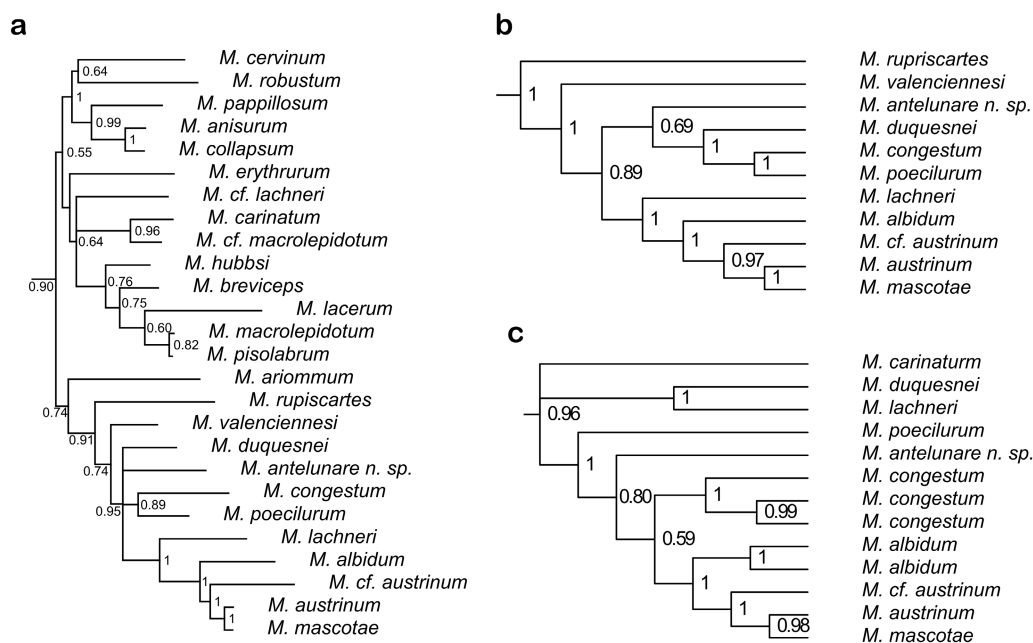
“In 1968, soon after first handling adult Apalachicola Redhorses, following extensive study of the genus, it was evident to me that the species was undescribed and most closely related to *M. poecilurum*, with which it apparently had not been closely compared.”—R. E. Jenkins

We are presenting another one of a series of new Redhorse species which was recognized by Dr. Robert E. Jenkins in 1968, one year prior to humans setting foot on the moon. While finishing this work, we thought heavily about the times in which Bob began this journey. The United States of America in the 1960s was an era of uncertainty highlighted by the Cold War, Civil Rights movements, involvement in the Vietnam War, political assassinations, and yet was capped off by one of mankind's most significant scientific achievements—putting a man on the moon. No matter how uncertain the times, Bob's legacy of love for Redhorses persisted and is a legacy that we hope to carry on. Parts of this description are from Bob's dissertation and much of the knowledge of this species is stored in the many notes he left behind, but due to the several changes that Bob made in recording meristics or measurements in his revisions, D. R. Akin re-examined and remeasured many of the specimens that Bob had examined, as well as many newer collections.

Introduction

Suckers (family Catostomidae) are broadly distributed in North America with one extant species in Siberia (*Catostomus rostratus* (Tilesius 1813)) and one extant species endemic to China (*Myxocyprinus asiaticus* (Bleeker 1864)) (Harris *et al.*, 2014). The center of origin for this family is thought to be in Asia because of the fossil representation in China (Liu and Chang, 2009; Liu *et al.*, 2016; Liu, 2021); however, the center of diversity is in eastern North America, with the most speciose genus being *Moxostoma* Rafinesque 1820 or the Redhorses and Jumprocks (Harris *et al.*, 2014). *Moxostoma* currently consists of 23 valid species (Fricke *et al.*, 2025). Many

undescribed species of *Moxostoma* have been identified by R. E. Jenkins, one of which was recently published (Jenkins *et al.*, 2025). Here we describe the Apalachicola Redhorse as a new species.



Buth (1979) found the Apalachicola Redhorse to be distinctive genetically. Harris *et al.* (2002) first presented results of a phylogeny constructed using the mitochondrial gene *cytb*, which proposed the Apalachicola Redhorse as belonging to an unresolved polytomy including most of the Jumprocks (formerly *Scartomyzon* Fowler 1913), *M. duquesnei*, *M. poecilurum* (as sister to *M. congestum*), and *M. valenciennesi* Jordan 1885. Doosey *et al.* (2010) found similar results with the mitochondrial ND4 and ND5 genes. Clements *et al.* (2012) found similar results with *cytb* and additionally constructed a phylogeny using Growth Hormone Intron 1 sequences that recovered the Apalachicola Redhorse as sister to *M. lachneri* and recovered *M. poecilurum* in an unresolved polytomy with most of the rest of *Moxostoma*. The most complete and recent phylogenetic analysis of *Moxostoma* was published by Bagley *et al.* (2018), who recovered the following topologies (Figure 1) based on nuclear data (IRBP, *RPS7*, GHI), mitochondrial data (*cytb*, ND2, *cox1*), and total evidence (molecular and morphological characters)—i) the Apalachicola Redhorse in an unresolved polytomy with *M. duquesnei*, a clade containing *M. poecilurum* and *M. congestum* as sister species, and a clade comprised of *M. lachneri* and a clade of Texas and Mexico or Southern Group species (*M. congestum*, *M. albidum* (Girard 1856), *M. austrinum*, *M. mascotae* Regan 1907) (total evidence, Figure 1a); ii) the Apalachicola Redhorse as sister to a clade of *M. duquesnei*, *M. poecilurum*, and *M. congestum* with the latter two recovered as sister species (mitochondrial, Figure 1b); and iii) *M. poecilurum* as sister to a clade

containing the Apalachicola Redhorse and the clade of Southern Group species, with the Apalachicola Redhorse recovered as sister to the remainder of the clade (nuclear, Figure 1c). Thus, the relationships of the Apalachicola Redhorse to the rest of *Moxostoma* is unknown with the consensus perhaps being the total evidence phylogeny of Bagley *et al.* (2018).

Despite not formally describing the Apalachicola Redhorse until the present paper, it became well known to many workers and entered the literature by the name Grayfin Redhorse (e.g. Yerger, 1977), but it would become named the Apalachicola Redhorse (e.g. Grabowski *et al.* 2012). As Jenkins himself mentioned on the topic of Redhorse common names, “it is endemic to that drainage and occasionally it has orange in lower fins” (Southeastern Fishes Council, 1998). We also discuss biogeography, and the presence of a population outside of the Apalachicola River drainage basin that has only been recently confirmed.

Material and methods

Institutional acronyms follow Sabaj (2020). Counts and measurements presented as a range from the 10th percentile to the 90th percentile (or roughly 80% of the specimens) with outlier minimum and maximum values indicated in parentheses. For example, (11)12–13 indicates that about 80% of specimens have a count of 12 or 13 and 11 as the minimum value was an outlier, and because no outlier maximum value was reported then 13 must also be the maximum. Counts and measurements follow Hubbs & Lagler (1958) precisely as described by Jenkins *et al.* (2025), except for the following discrepancies. A somewhat arbitrary size bin was determined that adults are classified as ≥ 180 mm standard length (SL) and juveniles as < 180 mm SL based on Jenkins (1970). A second measure of head length was taken from the posteromedial tip of the supraoccipital to the snout tip. Two measures of head depth were taken, one perpendicular through the eye, and the more traditional head depth taken from the supraoccipital. Head width was taken at the dorsal margin of the preopercle to avoid compression of the operculum. Cheek height was taken from ventral margin of orbit vertically to ventral margin of preopercle. An additional measurement was taken from the posterior margin of the orbit to the inside angle of the preopercle. Upper lip length is the distance from the anterior most point of the upper lip to the lateral point of connection between the upper and lower lips on the left side of the specimen. Pelvic-fin rays were counted on only the left side of each specimen. When counting pharyngeal teeth on the pharyngeal bone, broken teeth were counted but spaces without clear stubs of broken teeth were not.

One hundred and sixty-three specimens from 80 lots of the new species were examined by D. R. Akin, with 157 individuals deemed typical and included in the meristics and measurements. Additionally, five lots examined by R. E. Jenkins are included as paratypes but specified as not measured, so that the measurements presented in the description are all consistent and recorded by only D. R. Akin. R. E. Jenkins examined or partially examined 57 additional lots of over 100 additional specimens, which are listed under Non-Types. All of these specimens have catalog numbers, but some of these specimens may be lost or may be at unknown institutions. Data from these specimens are in Supplemental File 1 (available at Akin *et al.* 2025). Specimens examined are sorted by drainage basin, state, county, and then catalog number. Lists are presented as catalog number(s), number of specimens in a particular catalog number (in parentheses, only provided for split lots), field number (in parentheses), total number of specimens examined, size range, age range, common location, latitude, longitude, collectors, and date. Abbreviations used are: nm = not measured and sk = skeletonized (these were measured prior to skeletonization in most cases).

Dried Redhorse skeletons were prepared by R. E. Jenkins. Examined here are the Apalachicola Redhorse and species sympatric or potentially related to it. These results are preliminary and will be part of a larger study on the osteological diversity of Redhorse by J. W. Armbruster. Additionally, skeletons of other Redhorse, *Carpioides* Rafinesque 1820, *Erimyzon* Jordan 1876, *Hypentelium* Rafinesque 1818b, *Ictiobus* Rafinesque 1820, *Thoburnia* Jordan & Snyder (in Jordan 1917), and *Vexillichthys* Armbruster 2024, were also examined for key characters. Thus far, only the neurocrania, hyomandibulas, jaws, and Weberian complex vertebrae have been examined.

Some measurements of the skeletons were also made. Measurements included skull length (distance from tip of dermethmoid/mesethmoid to occipital condyle, measured from dorsal side), skull width (widest point at sphenotics), orbital width (measured at the junction of the lateral ethmoids with the frontals), premaxilla ascending process length (from oral surface to dorsal tip of premaxilla), and premaxilla oral surface length (from midline to distal margin along main body of premaxilla), maxilla length (greatest), maxilla width (from distal margins of the greatest

dorsal and ventral extents of maxilla), fontanelle length (greatest length of median cranial fontanelle), fontanelle width (greatest width, may be on palatine or frontal), basioccipital pharyngeal process length (from anterior horn of process to posterior tip), basioccipital pharyngeal process width (greatest at anterior horns), posterior portion of basioccipital pharyngeal process (distance from dorsal aorta foramen to posterior tip). These data are included in Supplemental File 2 (available at Akin *et al.* 2025).

To assess the distribution of this species we additionally requested collection records from the Georgia Department of Natural Resources (GA DNR) Stream Survey Team. We also obtained collection and locality data from the following institutions: the Academy of Natural Sciences of Philadelphia, the Auburn Museum of Natural History, the Cornell University Museum of Vertebrates, the Tulane University Biodiversity Research Institute, the University of Alabama Ichthyological Collection, the Florida Museum of Natural History, the University of Tennessee Etner Ichthyological Collection, the University of Michigan Museum of Zoology, the North Carolina Museum of Natural Sciences, and the Natural History Museum of Los Angeles County (Accessed through the Fishnet2 Portal, www.fishnet2.org, 2025-03-26) by searching for records of TAXON = “*Moxostoma grammarion*” and also searching for all records of TAXON = “*Moxostoma*” and OTHER = “Apalachicola”. We then cross-referenced all collections with our own data, verified and removed collections that appeared to be mislabeled or otherwise appeared in our search for some other reason pertaining to “Apalachicola,” and separated them into three discrete categories in this priority order: i) type material from this study, ii) non-types of this study examined by R. E. Jenkins, and iii) collections from GA DNR and Fishnet.

To create a rudimentary drainage basin reconstruction at the last glacial maximum, we obtained bathymetric raster data from General Bathymetric Chart of the Oceans (GEBCO 2023). We uploaded this file to ArcGIS Pro version 3.0 (Esri 2022) alongside a shapefile for the Southeastern United States and Gulf of Mexico. We used the Create Polygon tool to delimit our region of interest and the Extract By Mask tool to create a raster file of the bathymetric data cropped to our region of interest. We used the Contour tool to set 125-meter interval contour lines on this region. We then used the Info tool to identify the unique ID of both the modern coastline and the contour line 125 meters below the modern coastline to approximate the coastline during the last glacial maximum. Using the Editor Toolbar, we converted these polyline features to polygon features. We again used the Extract By Mask tool to extract the bathymetry data to our new polygon which approximates the landmass and coastline during the last glacial maximum. From here we used Hydrology Toolset, starting with the Fill, Flow Direction, and Flow Accumulation tools. These tools output a raster file that models water moving and collecting throughout the landscape—imagine each cell of the raster receiving one unit of water simultaneously and then moving downhill and accumulating as it moves. We then used the Stream Order tool and Stream to Feature tool to create a shapefile of modelled rivers. Each raster cell is treated as a river, so this shapefile will first appear as a completely filled polygon because every cell will be defined as at least a stream order of one, therefore we somewhat arbitrarily defined our layer in the layer properties to be only stream orders seven or larger for our modelled rivers. Finally, we used the Basins tool to model the Gulf drainages during the last glacial maximum. A model is included as Supplemental File 3 (available at Akin *et al.* 2025).

Conservation Status was examined using IUCN criteria (IUCN 2012). Extent of Occurrence (EOO) and Area of Occurrence (AOO) were estimated using GeoCAT (<https://geocat.iucnredlist.org>; Bachman & Moat 2012) with AOO calculated with 25 km² cell width.

Results

Moxostoma antelunare new species, Akin, Jenkins, and Armbruster

Apalachicola Redhorse

Figure 2

Myxostoma duquesnii Jordan, 1877:357 ([in part] Nancy Creek, Georgia). Jordan & Brayton, 1878:39, 43 ([in part; UMMZ-IU 2956, possibly mislabeled as from Eufaula, Alabama] Chattahoochee system, Georgia).

Moxostoma duquesnii Fowler, 1945:24 ([in part] range).

Moxostoma duquesnei Robins & Raney, 1956:13, 14 ([in part; CU 17128, Vickery Creek, Georgia] characters). Yerger & Suttkus, 1962:323–326 ([in part; 3 UF-FSU lots, 5 TU lots, Apalachicola River, Florida; 2 TU lots, upper Apalachicola drainage, Georgia] description; comparisons; associates).

Myxostoma macrolepidotum Jordan & Brayton, 1878:86 ([in part; name switched from variety *duquesnii*] range).
Moxostoma poecilurum Bailey *et al.*, 1954:155 ([in part; UMMZ 134607, Flint River mouth, Georgia-Florida] range).
Moxostoma erythrurum Robins & Raney, 1956:13, 14 ([in part; CU 26578, Little River, Georgia; CU 26579, Hatchechubee Creek tributary, Alabama] characters).
Moxostoma carinatum Smith-Vaniz, 1968:64 ([in part; TU 20893, Chipola River, Florida] Apalachicola drainage record).
Moxostoma sp. Smith-Vaniz, 1968:64, 125 (Apalachicola drainage, zoogeography). McSwain & Pasch, 1973 (life history, range, Flint system, Georgia).
Moxostoma sp. cf. *poecilurum* Dahlberg & Scott, 1971:29, 61 (range in Georgia). Buth, 1978:134–187 (biochemical systematics).
Moxostoma sp. cf. *M. poecilurum* Boschung & Mayden, 2004:318, 319 (comparison; range; habitat).
Moxostoma species Page & Burr, 1991:185 (comparison; range; habitat).
Moxostoma sp. Apalachicola Redhorse Dosey & Bart, 2011:1092–1108 (comparison; anatomy). Robins *et al.*, 2018: 139–140 (comparison; range; habitat).
Moxostoma “grammarion” Jenkins, 1970:348–359, 380–383 ([unpublished] new species; description; comparison; relationships; biology, range, habitat).
Grayfin Redhorse Jenkins, 1980:430 (range map).

Holotype.—AUM 88125 (ex AUM 86398; REJ 1481), male, 338 mm SL, Georgia, Heard County, Chattahoochee-Apalachicola River Basin, Centralhatchee Creek, Rt. 27 bridge 2.3 miles N of Franklin, 33.3112, -85.1046, 13 April 1996, R.E. Jenkins, B. Freeman, D.M. Walters.

Paratopotypes.—AUM 86398 (REJ 1481), 12, 293–336 mm SL, 2 sk, 318–366 mm SL, collected with holotype.

Paratypes.—From Apalachicola River Basin and neighboring St. Andrew’s Bay Basin.

Apalachicola River system: Florida. Calhoun Co.: UF 124567, 1, 124.1 mm SL, Bee Tree Slough at head in Apalachicola River, 30.3001, -85.0581, S. Walsh, W. Tate, M. Burgess, 25 April 2002; UF 130578, 1, 111.7 mm SL, Apalachicola river, Mary Slough at head in Apalachicola River, 30.2729, -85.0630, S. Walsh, W. Tate, M. Burgess, 25 April 2002; UF 237835, 3, 221.0–301 mm SL, Chipola River, boat ramp at Johnny Boy Landing, 4.6 km WSW of Altha, FL, 30.5525, -85.1709, J. Williams, Z. Randall, D. Boyd, A. Strickland, 24 July 2015. Franklin Co.: AUM 73569, 2, 141.3–167.6 mm SL, East River, from Apalachicola River to ~300 meters inside, 29.8595, -85.0129, D.C. Werneke, D.R. Akin, C. Myles-McBurney, L.N. Patterson, K.D. Thornhill, 13 May 2021. Gadsden Co.: UF 44546, 2, 294.0–396 mm SL, E shore Apalachicola River 200–1000 yds below Jim Woodruff Dam., 30.7042, -84.8633, C. Swift, G. Laurence, 2 May 1967; UF 54900, 1, 319.0 mm SL, Apalachicola River, E side, 100 yd S of US 90 bridge at Chattahoochee., 30.7000, -84.8594, J. Barkuloo, 5 June 1959; UF 55268, 3, 327.0–349 mm SL, Apalachicola River at shoal 0.25 mi south of St Rte 90 below bridge., 30.6964, -84.8589, J. Barkuloo, E. Grover, Corbin, Willis, 1 October 1959; UF 75600, 2, 341.0–353 mm SL, Apalachicola River, ca 0.5 mi downstream from Jim Woodruff Dam at Chattahoochee., 30.7042, -84.8633, H. Beecher, J. Stowe, 28 January 1975; NCSM 45829, 4, 353.0–417 mm SL, Apalachicola River, immediately above US Highway 90, 0.75 kilometers below Jim Woodruff Lock and Dam, [ca. 1.0 air miles ESE center] Chattahoochee, 30.7030, -84.8602, S. Young, P. Ely, T. Grabowski, 15 March 2007; NCSM 53267, 1, 354.0 mm SL, Apalachicola R., Apalachicola River, 1.2 mile reach from just below Woodruff Dam to mouth of Mosquito Creek, on W side of town of Chattahoochee, 30.7076, -84.8626, W. C. Starnes, G. M. Hogue, J. J. Isely, J. Tannahill, T. Ingram, 16 April 2009; UF 55680, 4, 302.0–384 mm SL, Apalachicola River from Woodruff Dam to bridge on Rte 90., 30.7042, -84.8633, J. Barkuloo, Grover, August 1959; UF 60223, 3, 336.0–368 mm SL, Apalachicola River at Chattahoochee., 30.7042, -84.8633, R. Yerger, *et al.*, 19 October 1963; UF 66476, 1, 139.2 mm SL, Apalachicola River, E bank behind deflectors & discharge canal at Gulf Power Station., 30.6625, -84.8878, B. Auth, J. Wolfe, 11 June 1968. Gulf Co.: AUM 73504, 2, 264.0–268 mm SL, Spider Slough, ~550 meters inside from Chipola River, 30.0072, -85.0921, D.C. Werneke, D.R. Akin, C. Myles-McBurney, L.N. Patterson, K.D. Thornhill, 12 May 2021; UF 120248, 6, 54.6–67.17 mm SL, Douglas Creek at head of feeder slough at river mile 30.3B, Pool 3, 30.0244, -85.1167, S. Walsh, R. Lewis, A. Hester, 15 November 2001; UF 120256, 3, 57.3–76.8 mm SL, Douglas Creek at head of feeder slough at river mile 30.3B. Pool 2, 30.0244, -85.1167, S. Walsh, R. Lewis, A. Hester, 15 November 2001; UF 237849, 1, 253.0 mm SL, Apalachicola River near junction of Chipola Cutoff, ENE of Wewahitchka, 30.1294, -85.1446, J. Williams, Z. Randall, D. Boyd, A. Strickland, T. Alfermann, S. Bisping, 23 September 2015. Jackson Co.: UF 44547, 2, 173.2–332 mm SL, East shore of Apalachicola River below Jim Woodruff Dam., 30.7042, -84.8633, C. Swift, G. Laurence, 2 May 1967; UF 79965, 7, 190.0–329 mm SL, Chipola River ca 1.5 mi downstream of bridge on St Rte 278, 0.7 mi W of intersection with St Rte 71., 30.6106, -85.1650, G. Burgess, *et al.*, 8 May 1989; UF 130162, 1, 198.0 mm SL, Chipola River from point below river rise to south

boundary of park—Florida Caverns State Park, 30.8148, -85.2322, S. Walsh, J. Williams, R. Lewis, 1 May 2002; UF 132238, 1, 134.2 mm SL, Chipola River on Highway 166 at Northeast side of Marianna, 30.7923, -85.2212, J. Williams, K. McDonald, J. Couch, 28 May 2003. Liberty Co.: AUM 73553, 1, 390.0 mm SL, Swift Slough, from head at Apalachicola River to ~200 meters inside, 30.1217, -85.1297, D.C. Werneke, D.R. Akin, C. Myles-McBurney, L.N. Patterson, K.D. Thornhill, 12 May 2021; UF 119078, 2, 101.7–103.46 mm SL, Apalachicola River, river mile 41.6, at sandbar adjacent to east shoreline, across from Chipola “cut-off.”, 30.1288, -85.1450, J. Williams, S. Walsh, *et al.*, 22 September 2000; UF 121986, 2, 64.9–68.75 mm SL, Hog Slough at head on left descending bank of Apalachicola River just upriver of RM 40, 30.1163, -85.1292, S. Walsh, R. Lewis, G. Garrett, 19 October 2001; UF 124620, 1, 140.3 mm SL, Moccasin Slough upstream from mouth into River Styx, 30.1071, -85.1351, S. Walsh, W. Tate, M. Burgess, 12 February 2002; UF 124839, 2, 93.4–121.8 mm SL, Pool at mouth of Battle Bend into Apalachicola River, 30.0175, -85.0999, S. Walsh, W. Tate, M. Burgess, 12 February 2002; UF 130140, 4, 105.9–115.8 mm SL, River Styx on both shorelines, between two unnamed sloughs on left descending bank, 30.0879, -85.1297, S. Walsh, W. Tate, M. Burgess, 4 November 2002; UF 169417, 2, 71.7–85.74 mm SL, Moccasin Slough connector to main river near head, 30.1109, -85.1389, W. Tate, M. Burgess, R. Gerwig, 30 July 2003; UF 32909, 3, 235.0–411 mm SL, Apalachicola River., 30.2380, -85.0835, B. Auth, D. Cox, February or March 1969; UF 75357, 1, 167.7 mm SL, Apalachicola River ca 0.5 mi N of St Rd 20 bridge at Bristol., 30.4389, -84.9928, H. Beecher, T. Lewis, 22 July 1976.

Chattahoochee River system: Alabama. Barbour Co.: AUM 29198, 1, 182.7 mm SL, Middle Fork Cowikee Cr, David Jones Rd 2 mi N Hawkinsville, 32.0544, -85.2277, J.W. Armbruster, M. Hardman, 26 May 1999. Lee Co.: AUM 1518, 2, 111.8–130.48 mm SL, Halawakee Creek, 10.0 miles NE of Opelika, 32.6908, -85.2156, R.J. Gilbert, H. Hurst, W. Mixon, M. Habel, 12 December 1968; AUM 29184, 2, 92.4–183.25 mm SL, Wacoochee Creek, CR 379 0.5 miles SSE Dupriest Crossroad, 32.6228, -85.1327, J.W. Armbruster, J.D. Evans, M. Hardman, 25 May 1999; AUM 61916, 1, 198.2 mm SL, Little Uchee Creek, at CR 175, at Meadows Mill, 32.5276, -85.2541, A.R. Henderson, C.P. Cleveland, T.M. Farmer, 15 June 2004; TU 180185, 3, 47.0–53.25 mm SL, Halawakee Creek at County Road 390, NE Opelika—Segment 9., 32.6958, -85.2558, H.L. Bart, C. Gradney & K. Richardson, 16 August 1995. Russell Co.: AUM 686, 1, 87.6 mm SL, Uchee Cr., 7.6 mi N.Cottonton on HWY 165, 32.3158, -85.0129, R.J. Gilbert, L.A. Johnson, 1 September 1967; AUM 934, 1, 310.0 mm SL, Lake Eufaula, ca.2 mi S of Cottonton, 32.1375, -85.0592, M.V. Rawson, *et al.*, 1 August 1968. Georgia. Carroll Co. AUM 13661, 1, 126.3 mm SL, Snake Creek, (channelized) 1.7 mi N of Whitesburg, Co.Rd., 33.5174, -84.9070, G.C. Mitchell, *et al.*, 26 November 1975. Douglas Co. GMNH 2494, 4, 158.2–199.03 mm SL, Dog River at County Road 217 crossing, 4.25 air miles SW of Douglasville, 33.6664, -84.8717, GA DNR, 7 May 1992; GMNH 2495, 2, 115.0–252 mm SL, Mobley Creek at County Road 198 crossing, 7.5 air miles SW of Douglasville, 0.25 air miles W of junction of CR 203 and CR 198, 33.6664, -84.8717, GA DNR, 7 May 1992; GMNH 2510, 1, 110.3 mm SL, Crawfish Creek at County Road 238 crossing, 3.75 air miles NNW of Fairplay, 33.6725, -84.8883, GA DNR, 27 May 1992. Habersham Co. NCSM 4951, 8, 102.9–273 mm SL; CU 53291 [nm], 1, 193 mm SL; CU 52972 [nm], 36, 48–126 mm SL [in two jars]; KU 13061 [nm], 6, 94–252 mm SL; UAIC 2843 [nm], 2, 229–260 mm SL; UMMZ 187714 [nm], 2, 235–273 mm SL; USNM 204008 [nm], 5, 102–262 mm SL, all from Chattahoochee River, 1.0 miles S GA Route 115, [ca. 8.0 air miles ESE of Cleveland], 34.5622, -83.6279, Georgia Department of Natural Resources crew, and Donald C. Scott and his ichthyology class, 24 October 1963; . Hall Co. GMNH 2630, 1, 109.6 mm SL, West Fork Little River, downstream of bridge on County Road 49, 5.10 air miles SSW of Clermont, 34.4153, -83.8214, J.C. DeVivo, USGS, 3 November 1993; GMNH 2658, 3, 63.1–73.49 mm SL, West Fork Little River, downstream of bridge on Co. Rd. 49, 5.10 air miles SSW of Clermont, 34.4153, -83.8214, J.C. DeVivo, USGS, 6 June 1994. Harris Co. AUM 368, 2, 143.6–153.2 mm SL, Osahatchee Creek, 2.6 miles N of Cataula, Hwy 27, 32.6887, -84.8569, J.S. Ramsey, R.J. Gilbert, 05 August 1967; GMNH 2643, 1, 149.0 mm SL, Ossahatchee Creek, upstream of bridge on County Road 173, 2.30 air miles ENE of Catula, 32.6675, -84.8328, CA Couch, USGS, 20 October 1994. Heard Co. AUM 31035, 1, 279.0 mm SL, Hillabatchee Creek, 3 miles WSW of Franklin; CR 210, 33.3109, -85.1881, J. Biagi, 01 September 1999; GMNH 43237, 1, 144.6 mm SL, Centralhatchee Creek just downstream of US Hwy 27, 2.2 air miles North of Franklin city center. Heard Co, GA, 33.3112, -85.1046, M.C. Freeman, P.A. Marcinek, J. Shields, USGS, 3 September 2003;. Lee Co. AUM 7024, 1, 224.0 mm SL, Kinchafoone Cr., at mouth of Middle Cr. 4.8 mi W of Leesburg, 31.7589, -84.2533, L.E. McSwain, R.M. Gennings, *et al.*, 30 September 1971; AUM 18330, 1, 300.0 mm SL, Kinchafoonee Cr., 4.8 airmi WNW of Leesburg, at junction with Middle Cr., 31.7589, -84.2533, T. Scott, GA Game & Fish Division, 19 September 1973. Meriwether Co. GMNH 3206, 1, 263.0 mm SL, Cane Creek 4.3 air

miles SW of Woodbury on St Rd 85 W, 32.9421, -84.6368, GA DNR, 1 July 1991; GMNH 3240, 2, 143.0–158.63 mm SL, Rocky Ford Creek 2.4 air miles NNW of Warm Springs on St Rd 27 Alt, 32.9222, -84.6942, GA DNR, 30 July 1991. Muscogee Co. GMNH 2560, 1, 143.4 mm SL, Bull Creek at Schatulga Road in Ft. Benning Military Reservation, 32.5090, -84.8694, R.H. Pegram, P.M. Purcell, 13 May 1994. Troup Co. AUM 33475, 1, 318.0 mm SL, Wehadkee Creek, from confluence with Chattahoochee River; 4 miles S. of Evansville to 0.5 miles NW of hwy 238 bridge, 33.0784, -85.2226, Shelton, Hiranvat, Singholka, 7 July 1972; GMNH 2508, 1, 196.1 mm SL, Flat Shoals Creek at Secondary Route 1428 crossing, 9.25 air miles SE of LaGrange, 32.9617, -84.9011, GA DNR, 26 May 1992; GMNH 2540, 1, 244.0 mm SL, Sulphur Creek at County Road 191 crossing, 4.1 air miles NNE of Oak Grove, 32.9447, -84.8714, GA DNR, 1 July 1992; GMNH 2547, 4, 214.0–235 mm SL, Yellow Jacket Creek at State Route crossing, 1.0 air mile NW of Hogansville, 33.1786, -84.9292, GA DNR, 9 July 1992; GMNH 2641, 1, 226.0 mm SL, Flat Shoals Creek, upstream of bridge crossing on County Road 524, 9.25 air miles ESE of LaGrange, 32.9617, -84.9011, J.C. DeVivo, J.W. Garrett, M.J. Zieg, S. Jones, 18 May 1994. White Co. GMNH 3777, 1, 67.6 mm SL, Sautee Creek at County Route 101 (Lynch Mountain Road) crossing, 8.1 air miles NNE of Cleveland, GA city center., 34.6849, -83.6692, M.M. Hagler, J.A. Harper, C.E. Menken, R.L. Machyousky, D.E. Sedgwick, 23 June 2003.

Flint River system: Georgia. Baker Co. GMNH 2312, 1, 162.4 mm SL, Big Cypress Creek, ca. 0.2 mi. down from SR 91 crossing, 31.2020, -84.4979, B.J. Freeman, M.C. Freeman, B. Wooten, M. Maynard, 5 October 1991; GMNH 2378, 2, 122.9–204.02 mm SL, Ichawaynochaway Creek, between old power dam and SR 200 crossing, 31.2901, -84.4917, B.J. Freeman, M.C. Freeman, R.N. Smith, 18 May 1992. Clayton Co. UF 110599, 1, 296.0 mm SL, Flint River, North Bridge Road at JW Smith water treatment plant, 33.4154, -84.3851, D. Ruessler, *et al.*, 11 December 1997. Crawford Co. GMNH 2640, 2, 135.1–138.14 mm SL, Ulcohatchee Creek, upstream of bridge crossing on County Road 85, 9.30 air miles West of Roberta, 32.7236, -84.1726, J.C. DeVivo, J.W. Garrett, M.J. Zieg, S. Jones, 18 May 1994. Macon Co. AUM 86400, 6, 81.1–269 mm SL, Flint River, 3 miles NNE of Montezuma, 32.3469, -84.0413, J.W. Evans, B. Freeman, M.C. Freeman, R.E. Jenkins, 08 May 1993; GMNH 2949, 2, 179.5–202.74 mm SL, Flint River, upstream at CR 267, upstream several miles to above junction with Whitewater Creek, ca. 1.25 air miles N of Montezuma., 32.3528, -84.0412, B.J. Freeman, J.W. Evans, R.E. Jenkins, 8 May 1993. Pike Co. GMNH 3128, 1, 174.5 mm SL, Elkins Creek off Dripping Rock Road at bridge crossing., 32.9704, -84.5161, D.S. Ruessler *et al.*, 11 November 1997. Sumter Co. GMNH 2677, 1, 190.6 mm SL, Lime Creek, upstream of bridge crossing on Co. Rd. 53, 5.2 air miles N of Cobb, 32.0349, -83.9926, J.C. DeVivo, USGS, 17 May 1995. Talbot Co. GMNH 4619, 1, 55.3 mm SL, Flint River just downstream Big Lazer Creek at Big Lazer Creek WMA., 7.2 air miles SE Thomaston, 32.8103, -84.4013, B.J. Freeman, C.R. Straight, C.M. Storey, M.M. Hagler, 1 August 2001;. Upson Co. GMNH 3295, 3, 179.1–243 mm SL, Tobler Creek 7.2 air miles ESE of Thomaston on CR 192, 32.8418, -84.2318, GA DNR, 4 September 1991. Worth Co. UF 105280, 1, 124.3 mm SL, Mercer Mill Pond on unnamed tributary of Mill Creek, below the dam, on CR 12, 7 air miles South of Oakfield, 31.6584, -84.0147, J. Brim-Box, R. Lattimore, O'Brien, 25 June 1994.

St. Andrew's Bay: Florida. Washington Co.: AUM 86814, 2, 285.0–321 mm SL, Econfina Creek, At Cr 388, 30.38464, -85.5569, J.R. Knight, 30 April 2024.

Non-types (cataloged, not measured).

Apalachicola River system: Florida. Gulf County: TU 20893 (2), Chipola cutoff, 1959; TU 34871 (1), Chipola cutoff, 1964; UF 3164 (1), Chipola River, 1954; TU 41298 (1), Calhoun County, Dead Lake, 1966. Gulf-Liberty County: TU 22467 (2), Apalachicola River, from Chipola River to below mouth Florida River, 1959; TU 32084 (1), TU 32089 (2), Apalachicola River, RM 44.5, 1963; TU 21108 (1), “bulls arm” slough mouth, 1959; Gadsden-Jackson County, Apalachicola River in area from Jim Woodruff Dam to about 3 miles downstream, near Chattahoochee, 1959; TU 22380 (4); 1960: UF 57992 (4), TU 22899 (9); 1961: TU 24473 (2); 1962: TU 25713 (2), TU 29878 (2); 1963.

Chattahoochee River system: Georgia. UF 56620 (1), Early County, Kirkland Creek, 1960; AUM 815 (1), Stewart County, Hannahatchee Creek, 1967; UF 57047 (1), Talbot County, South Fork Upatoi Creek, 1960; AUM 346 (3), Harris County, Mulberry Creek, 1967; UF 56674 (1), Harris County, House Creek, 1960; CU 52975 (1), Heard County, Chattahoochee River, 1959; Fulton County: CU 52980 (3), CU 52976 (2), Chattahoochee River, 1959; CU 17128 (5), Vickery Creek, 1950; TU 12217 (5), TU 12139 (1), Vickery Creek, 1955; AUM 726 (1), Forsyth County, Vickery Creek, 1967 ; CU 26578 (1), Hall County, Chattahoochee River tributary, 1952; Lumpkin County : CU 52977 (2), Chestatee River, 1958; TU 30441 (2), Chestatee River, 1963; TU 38357 (2), Cane Creek,

1965; TU 29755 (2), White County, Dukes Creek, 1962; CU 26582 (1), Habersham County, Chattahoochee River, 1951. Alabama-Georgia. CU 52979 (2), Clay-Henry County, Chattahoochee River, 1959; UMMZ (IU 2956) (2), [? Barbour-Quitman County] Eufaula, probably late 1800s; CU 52978 (1), Russell-Muscogee County, Chattahoochee River, 1959. Alabama. Russell County: CU 26579 (1), Hatchechubbee Creek tributary, 1949; Uchee Creek, 1967; AUM 1885 (1), Wartoula Creek, 1938; UAIC 1233 (1), Lee County, Wacoochee Creek, 1964.

Flint River system: Florida-Georgia UMMZ 134607 (2), Gadsden-Jackson County, Flint River mouth, 1941. Georgia. CU 52974 (3), Dooley-Sumpter County, Flint River, 1958; KU 8808 (1), Taylor-Upson County, Flint River, 1964; TU 27519 (1), Upson County, Potato Creek, 1962; CU 52973 (3), Talbot-Upson County, 1958; CU 50691 (7), OSUMZ (1), Meriwether County, Cane Creek, 1963; UG 688 (3), Fayette County, Flint River, 1959.

Diagnosis. *Moxostoma antelunare* can be separated from *M. albidum*, *M. ariommum* Robins & Raney 1956, *M. austrinum*, *M. cervinum* (Cope 1868), *M. congestum*, *M. hubbsi* Legendre 1952, *M. lachneri*, *M. mascotae*, *M. milleri* Robins & Raney 1957, *M. rupiscartes*, and *M. valenciennesi* by having 12 or 13 circumpeduncular scales (vs greater than 13, usually 16); from *M. anisurum* (Rafinesque 1820), *M. collapsum* (Cope 1870), and *M. pappillosum* (Cope 1870) by having deeply plicate lower lips (vs. semi-papillose or papillose lips); from *M. breviceps* (Cope 1870), *M. carinatum* (Cope 1870), *M. macrolepidotum* (Lesueur 1817), *M. pisolabrum* Trautman & Martin 1951, *M. robustum* (Cope 1870), and *M. ugidatli* Jenkins, Favrot, Freeman, Albanese, and Armbruster 2025 by color of caudal fin dark gray, gray, or gray with slight orange tint (vs. caudal fin reddish, red, or dark red); from *M. lacerum* (Jordan & Brayton 1877) by lacking unique mouth with cleft lower lip (vs. unique mouth with cleft lower lip); from *M. duquesnei* by number of gill rakers usually less than or equal to 27 (vs. usually greater than 27; only adult *M. antelunare* larger than 200 mm SL may rarely have greater than 27 gill rakers $n=2/46$ while only juvenile *M. duquesnei* smaller than 120 mm SL occasionally have less than 27 $n=51/148$); from *M. erythrurum* by number of lateral line scales usually 43–46 (vs. usually less than 43 (*M. antelunare* rarely with 42 lateral line scales $n=4/157$ and *M. erythrurum* occasionally having 43 or more lateral line scales $n=83/900$); from *M. poecilurum* by lacking conspicuous black stripe on the lower lobe of the caudal fin (vs. black stripe present). Within its geographic range, *M. antelunare* is most easily diagnosed from congeners *M. rupiscartes* and *M. lachneri* by having 12 or 13 circumpeduncular scales (vs greater than 13).

One potential autapomorphy for *M. antelunare* was found in the hyomandibula. The hyomandibula in catostomids has a double condyle to the sphenotic and pterotic with the larger condyle posteriorly. The bone is roughly shaped like a battle axe with the handle of the axe making an arch posterior to the orbit and the blade angled anteromedially (Figure 3). The posterior edge of the handle has a furrow that receives the anterior margin of the preopercle. In most suckers, the posteromedial lamina of this concavity is not as developed as the anterolateral lamina (Figure 3A; posteromedial lamina does not obscure the more developed anterolateral lamina) while both laminae are equally developed in *M. antelunare* (Figure 3B; posteromedial lamina obscures the equally developed anterolateral lamina). A similar state was observed in *Erimyzon* and possibly *Carpiodes* (all but one available skeleton for *Carpiodes* is articulated making the character difficult to see, but the one disarticulated specimen appeared to have the laminae equal). *Moxostoma antelunare* can additionally be identified from most other *Moxostoma* by the gap between the anteromedial and posteromedial processes of the cleithrum forming a V (Fig., 3D) vs. forming a U (Fig. 3C) or W (polarity is unclear). Mensurally, *M. antelunare* can be separated from *M. duquesnei* by having wider skulls (Skull W/SL 11.5–14.4% vs. 10.1–11.0%, Orbital Width/SL 9.0–10.4% vs 7.8–8.5%); from *M. poecilurum* by having longer skulls (Skull L/SL 17.8–21.2% vs. 15.8–17.2%); and from *M. duquesnei*, *M. erythrurum*, *M. lachneri*, and *M. poecilurum* by having a relatively shorter premaxilla ascending processes (Premaxilla Ascending Process L/Premaxilla Oral Surface L 61.6–76.1% vs. 76.2–90.6).

Description. Lips. Posterior margin forming a slightly to moderately obtuse angle. Surfaces deeply plicate, occasionally with a slightly wrinkled appearance in adults, but not deeply, transversely cut. Lip width moderate (4.1)4.4–5.9(6.3)% SL in juveniles, (4.6)5.0–6.6(7.7)% SL in adults; upper lip length short, (2.9)3.1–4.5(5.1)% SL in juveniles, (3.4)3.8–5.2(6.1)% SL in adults.

Meristics. Lateral line scales (42)43–46(47); circumbody scales 30–33(37); scales above lateral line (6)7(8); scales below lateral line (4)5(7); circumpeduncle scales (11)12(13); predorsal scales (14)15–17(18), postdorsal scales (17)19–22(24); breast scalation 95–100%. Postweberian vertebrae 38–40. Dorsal rays (11)12–13; caudal rays (17)18; pectoral rays (15)16–18(19); pelvic rays (8)9(10); anal rays (6)7(8).

Body moderately compressed to almost terete, elongate to moderately stout, wider and stouter in larger specimens; greatest depth in advance of dorsal fin in some adults due to slight, smoothly-elevated predorsal hump.

Head moderate, head dimensions nearly isometric to standard length, body depth and width positively allometric, resulting in blocky head for compressed-bodied juveniles compared to thicker-bodied adults. Body depth (19.0)20.3–24.3(26.8)% SL in juveniles, (20.8)21.8–27.0(29.8)% SL in adults; head depth at the nape (14.9)15.5–17.3(18.2)% SL in juveniles, (15.6)16.0–18.3(19.3)% SL in adults; head depth through the eye (12.7)13.0–14.7(15.9)% SL in juveniles, (13.0)13.3–15.4(16.1)% SL in adults; head width (11.3)12.1–13.6(14.6)% SL in juveniles, (7.3)12.2–14.2(15)% in adults; head length (20.2)22.0–24.7(25.9)% SL in juveniles, (19.7)21.4–23.5(25.2)% SL in adults. Snout tip profile truncate or slightly rounded, tip little or not at all exceeding upper lip, snout length (8.8)9.2–10.9(12.2)% SL in juveniles, (9.0)9.8–11.9(12.5)% SL in adults; postorbital length (7.5)8.0–10.0(11.0)% SL in juveniles, (6.9)7.7–9.7(11.3)% SL in adults. Eye moderate in size, orbit diameter (4.2)4.6–6.7(7.1)% SL in juveniles, (3.3)3.5–4.5(4.8)% SL in adults. Caudal peduncle elongate, moderate in depth, length (14.8)16.2–18.8(20.8)% SL, depth (7.9)8.8–10.0(10.6)% SL.

Fins. Dorsal-fin margin usually slightly concave, occasionally moderately concave or straight. Pectoral fin in adults somewhat pointed, tip slightly rounded, rays 3 or 4 or 4 or 5 longest; (12.6)15.6–19.9(21.1)% SL. Anal fin margin slightly to well-rounded, its tip usually not exceeding posteriormost caudal peduncle scales. Caudal fin in adults with lobes equal in length or upper or lower slightly longer; upper lobe tip pointed, margin approximately straight; lower lobe with slightly rounded tip, margin slightly to moderately, convexly rounded; notch shallow and rounded.

Gill rakers increase in number from 17–25 (modally 20 and 21, $n = 31$) in small specimens under 100 mm to 22–27 (modally 25, $n = 26$) in medium specimens between 100 mm and 180 mm to 22–29 (modally 25, $n = 46$) in adult specimens. Raker length moderate, longest raker on first arch 0.90–1.90% SL ($n = 17$; 132–389 mm SL).

Pharyngeal arch light, lower teeth well-compressed. Pharyngeal teeth 60–77 ($n = 10$ specimens, 20 jaws). Scales lack lateral radii. Intestine highly coiled, longitudinal section 1 crossed 12 times in two specimens, 184 and 253 mm SL; crossed eight times in two species, 115 and 133 mm SL; crossed four times in seven specimens, 33–64 mm SL. Peritoneum silvery. Air bladder usually with three chambers and a slightly to well-developed fourth chamber in three specimens, 184–249 mm SL, of the 17 examined, 33–306 mm SL; third chamber, when fourth absent, usually with a slightly to well-tapered posterior end.

Tuberculation. *Male*: Caudal fin with all or only lower rays tuberculate, tubercles generally small, particularly on upper lobe. Anal fin with almost entire length of all rays tuberculate, largest tubercles moderate in size. Paired fins with minute tubercles, slightly larger on pelvic fins. Dorsal fin lacking tubercles or with few minute tubercles on its anterodistal portion. Head with scattered minute tubercles on all surfaces. Body with most or all scales with minute tubercles scattered over all exposed scale fields. Skin not evidently thickened (TU 22899, 5, 305–368, not well-tuberculated [but most were spawning at time of capture, *vide* Yerger & Suttkus, 1962:325]; TU 24473, 3, 292–329; TU 29878, 1, 345).



FIGURE 2. Photographs of the holotype of *Moxostoma antelunare*, AUM 88125 (338 mm SL). Photographs by J. W. Armbruster

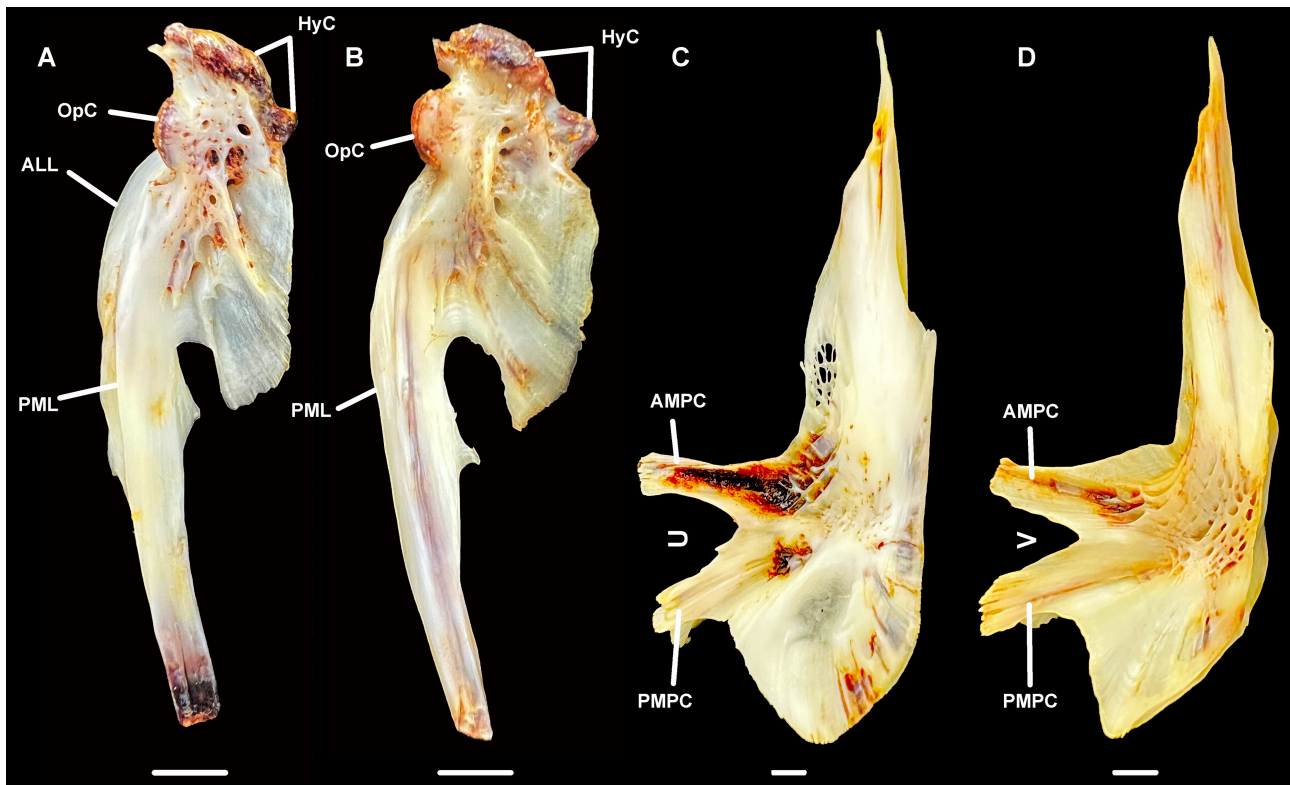


FIGURE 3. Posteromedial view of left hyomandibulae (A–B) and roughly anterior view of left cleithra (C–D) of *Moxostoma duquesnei*, AUM 86386, 445.0 mm SL (A, C) and *M. antelunare*, AUM 86402, 415 mm SL (B, D). Dorsal is towards the top of the figure. ALL—anterolateral lamina of hyomandibula (not visible in B); AMPC—anteromedial process of cleithrum; DPC—dorsal process of cleithrum (runs dorsally just posterior to head); HyC—double hyomandibula condyle to neurocranium; OpC—opercular condyle of hyomandibula; PML—posteromedial lamina of hyomandibula; PMPC—posteromedial process of cleithrum. The shapes of the spaces between the anteromedial and posteromedial processes indicated by U and V. Individual scale bars = 5 mm. Photographs by J. W. Armbruster.

Female: Caudal-fin rays lack tubercles or with very low non-pointed cornifications on lower lobe. Anal-fin rays with slightly to well-developed cornifications, effecting rounded condition to rays in latter case; in other specimens low, very bluntly-tipped and basally-separated cornifications occur. Paired and dorsal fins lack tubercles. Head dorsally and laterally, or only dorsally, with few minute tubercles. Body with minute tubercles only on nape. Lower urosome scales overlaid with slightly to well-developed cornifications; in latter case some of the cornifications form ridge-like striae that radiate from approximately the focal area of scales; cornified ridges occur on the dorsal aspect of the caudal peduncle in some specimens. (TU 22899, 4, 331–377; TU 24473, 1, 333; TU 29878, 1, 350).

Coloration in life. (Figure 4). Head dorsum olive; opercular and suborbital areas brassy to yellow-olive; lower cheek white to off-white; lower edge of snout, lips, gular area, and isthmus white or off-white. Iris dusky and golden orange dorsally, most of remainder brassy or coppery; narrow inner ring pale gold.

Body dark olive or olive dorsally to lighter brassy or golden sheen laterally to silver or white ventrally with colors transitioning gradually dorsoventrally. Scale hues consistent with general body coloration. Individual scales with slightly darker hues at scale pockets and dimmer brightness at thin posterior margins and thick dorsal and ventral margins. Faint, dusky lateral stripes along body from overlaid dorsal and ventral margins of individual scales alternating with lighter stripes from brighter middle portions of sequential scales.

Caudal fin typically light gray to dark gray almost black, occasionally with some peach or orange tint in lowermost ray and membranes near the peduncle, diffusing distally to solid gray covering the posterior one-third of caudal fin when color present. In smaller fish, lowermost ray and adjacent membrane white or lighter than remaining rays.



FIGURE 4. Photograph of *Moxostoma antelunare* (327 mm SL, uncatalogued) from the lower Apalachicola River in life. Photograph by D. C. Werneke.

Dorsal-fin membranes olive to dark gray almost black, diffuse distally. Rays lighter than membranes, olive to gray, darker basally.

Pectoral and pelvic fins variable in color from peach or orange to dark gray almost black. Membranes basally dusky peach or gray diffusing to washed-out or white distal margins. First ray lighter from dusky peach to white; remaining rays lighter than membranes, grading darker basally to lighter distally. Pelvic fins similar to pectoral fins.

Anal-fin membranes variable in color from dusky peach or light orange to dark gray almost black; light gray or white at distal margin. Anterior membranes darker than posterior membranes. Rays lighter than membranes, grayish, grading darker basally to lighter distally.

Coloration in alcohol. Scale bases: scale pockets slightly to well-excised (usually moderately excised), moderately to well-darkened in larger juveniles and adults; scale bases in young anteriorly, slightly or not at all darkened; posteriorly slightly to moderately darkened; posterior scale margins usually moderately darkened in most specimens, pale in young. Posteriormost scales over caudal fin almost always moderately to very dark-margined, rarely pale-margined, except in young which lack dark margin. Alternating dark and light horizontal body stripes almost always well-developed in juveniles and adults; stripes in young moderately developed to, in smallest specimens, absent. Lateral blotch-saddle pattern well developed in larger young and smaller juveniles, typically three lateral blotches connecting over dorsum as saddles near origin and insertion of dorsal fin and origin of anal fin with fourth lateral blotch near caudal peduncle not connecting as a saddle (Figure 5).

Caudal fin with lowermost ray and adjacent membrane white in larger young and juveniles until about 140 mm SL, becoming progressively darkened to the intensity of other caudal rays in larger specimens due to melanophoric deposition; rays 2–18 equally dark; small young have the lowermost ray and membrane lightly dappled with melanophores, about equal in concentration to that of the other fins; larger young and small juveniles occasionally have slight amount of melanophores in or along lowermost ray, but the ray appears basically white to the naked eye; the caudal in adults is generally darker than in juveniles.

All melanophoric color patterns are intense in two adults (TU 41298, UF 3164) from dark-stained Chipola River system waters, whereas the young and an adult in two other TU series from white-colored Chipola River waters have lighter color patterns, as in specimens from farther upstream in the Apalachicola drainage.

Distribution. Found throughout the Apalachicola, Chattahoochee, and Flint River systems in Florida, Alabama, and Georgia and in Econfin Creek of the St. Andrew's Bay drainage in northwestern Florida, United States of America (USA) (Figure 6).

Ecology. *Moxostoma antelunare* lives in small streams to large rivers. Numerous records are from lower Chattahoochee River and larger Apalachicola River, particularly from tailwaters of Jim Woodruff Dam, Florida USA to about five kilometers downstream. A large series of juveniles and adults was also taken (by rotenone) in the

extreme upper Chattahoochee River. Adults have been taken in the Lake Eufaula impoundment (Walter F. George Reservoir) on the Chattahoochee River, Alabama-Georgia border USA.

The Apalachicola Redhorse appears to be a fairly common species in the upper and lower Chattahoochee River system and upper Flint River system. There are few records of the Apalachicola Redhorse in the lower Flint River system, but this may be due to sampling bias as indicated by the presence of Apalachicola Redhorse both upstream in the upper Flint River and further downstream in the Apalachicola River. When sampling the sloughs of the lower Apalachicola, D. R. Akin never encountered any individuals when seining in wadable habitat, but only when boat-electrofishing near where the mouth of the sloughs opened into the main stem Chipola River and Apalachicola River. The relative abundance of *M. antelunare* (and its preferred habitat) is not known.



FIGURE 5. Photograph of a juvenile *Moxostoma antelunare*, AUM 86400 (81.1 mm SL; scale bar = 1 cm). Note the faint saddles and blotches. Photograph by J. W. Armbruster.

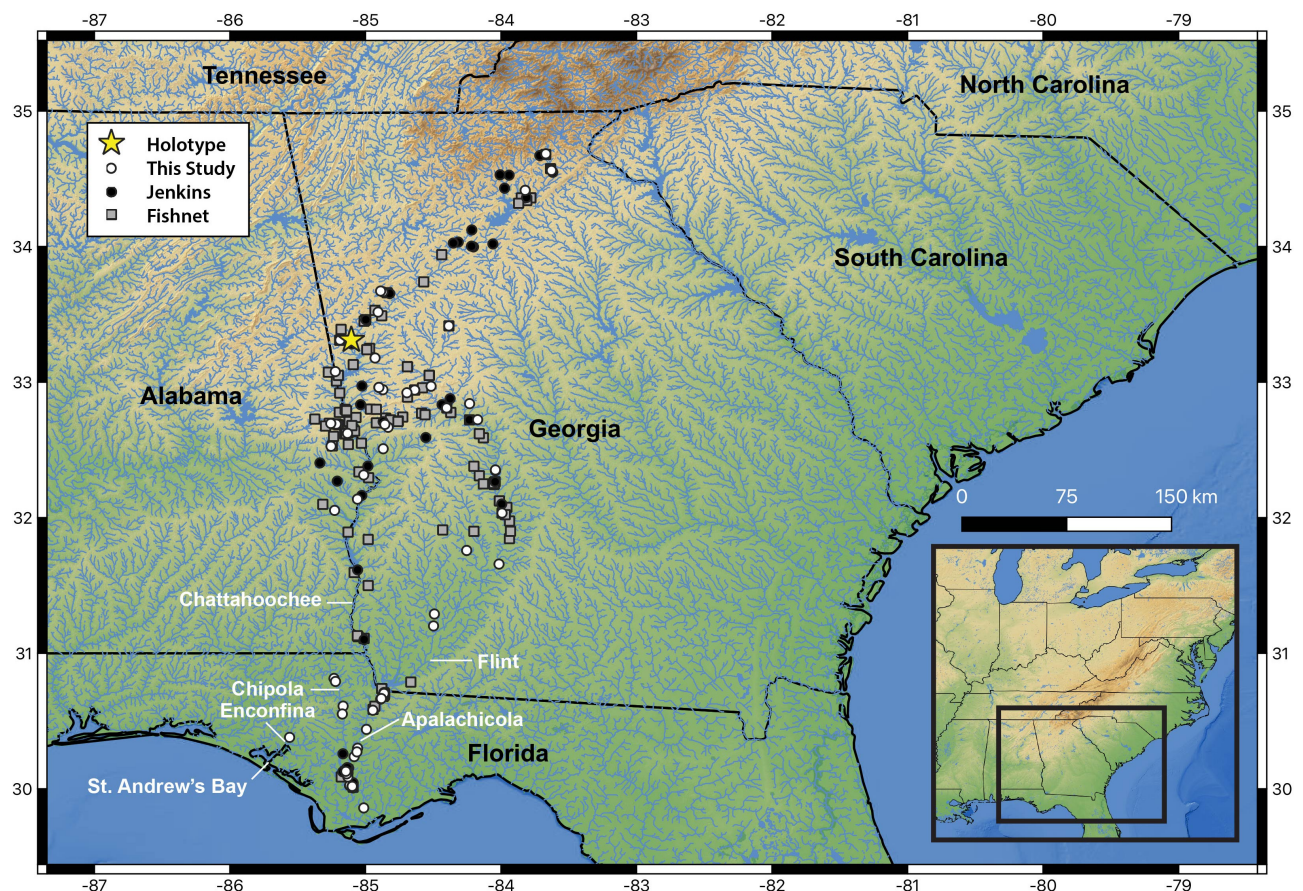


FIGURE 6. Distribution map of *Moxostoma antelunare*. Holotype denoted by a star, paratypes by white circles, non-types in black circles, and occurrences from Fishnet and GA DNR in squares.

TABLE 1 a–c. Meristics and measurements of all type specimens **a)** all adult specimens **b)** and all juvenile specimens **c)** of *Moxostoma antelunare*.

a.	All Types (n=157)			
	MIN	10th Percentile	90th Percentile	MAX
Meristics				
Predorsal Scale Count	14	15	17	18
Postdorsal Scale Count	17	19	22	24
Postanal Scale Count	5	6	8	9
Lateral Line Scale Count	42	43	46	47
Circumferential Scale Count	30	30	33	37
Scale Count Above Lateral Line	6	7	7	8
Scale Count Below Lateral Line	4	5	5	7
Circumpeduncular Scale Count	11	12	12	13
Simple Pectoral-fin Rays	2	2	2	2
Branched Pectoral-fin Rays	13	14	16	17
Simple Pelvic-fin Rays	1	1	1	1
Branched Pelvic-fin Rays	7	8	8	9
Simple Dorsal-fin Rays	1	1	1	1
Branched Dorsal-fin Rays	10	11	12	12
Simple Anal-fin Rays	1	1	1	2
Branched Anal-fin Rays	5	6	6	7
Principle Caudal-fin Rays	17	18	18	18
Standard Length (mm)	46.4	68.8	343.0	417.0
Measurements (%SL)				
Head Length from the Occipitum	17.0%	18.1%	21.1%	22.9%
Head Length from the Opercle	19.7%	21.4%	24.2%	25.9%
Head Depth through the Eye	12.7%	13.2%	15.1%	16.1%
Head Depth at the Occipitum	14.9%	15.7%	18.0%	19.3%
Head Width	7.3%	12.1%	14.0%	15.0%
Snout Length	8.8%	9.4%	11.7%	12.5%
Postorbital Head Length	6.9%	7.8%	10.0%	11.3%
Cheek Height	4.6%	5.4%	7.2%	12.4%
Orbit-Preopercle	6.6%	7.6%	9.3%	10.2%
Interorbital	7.8%	8.6%	10.9%	11.7%
Orbit Diameter	3.3%	3.6%	6.0%	7.1%
Lip Width	4.1%	4.7%	6.4%	7.7%
Upper Lip	2.9%	3.4%	5.1%	6.1%
Pectoral Fin Length	12.6%	15.6%	19.9%	21.1%
Pelvic Fin Length	11.4%	12.7%	15.5%	16.5%
Base of the Dorsal Fin	13.2%	14.3%	17.0%	18.1%
Dorsal-Fin Origin to Longest Ray	14.9%	16.7%	21.0%	22.6%
Dorsal Fin Depressed Length	20.0%	22.2%	25.5%	26.4%
Base of Anal Fin	4.9%	6.1%	8.0%	9.2%
Anal-Fin Origin to Longest Ray	15.0%	16.1%	22.1%	26.2%
Caudal Peduncle Depth	7.9%	8.8%	10.0%	10.6%
Caudal Peduncle Length	14.8%	16.2%	18.8%	20.8%
Body Depth	19.0%	20.9%	26.4%	29.8%
Predorsal Length	43.8%	45.1%	49.0%	51.0%

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TABLE 1 a–c. (Continued)

b.	Adults (n=88)			
	MIN	10th Percentile	90th Percentile	MAX
Meristics				
Predorsal Scale Count	14	15	18	18
Postdorsal Scale Count	19	20	23	24
Postanal Scale Count	6	7	8	9
Lateral Line Scale Count	43	44	46	47
Circumferential Scale Count	30	30	33	37
Scale Count Above Lateral Line	6	7	7	8
Scale Count Below Lateral Line	4	5	5	7
Circumpeduncular Scale Count	11	12	12	13
Simple Pectoral-fin Rays	2	2	2	2
Branched Pectoral-fin Rays	14	14	16	17
Simple Pelvic-fin Rays	1	1	1	1
Branched Pelvic-fin Rays	8	8	8	9
Simple Dorsal-fin Rays	1	1	1	1
Branched Dorsal-fin Rays	10	11	12	12
Simple Anal-fin Rays	1	1	1	2
Branched Anal-fin Rays	6	6	6	7
Principle Caudal-fin Rays	18	18	18	18
Standard Length (mm)	182.7	196.1	368.0	417.0
Measurements (%SL)				
Head Length from the Occiput	17.0%	17.8%	20.5%	21.9%
Head Length from the Opercle	19.7%	21.4%	23.5%	25.2%
Head Depth through the Eye	13.0%	13.3%	15.4%	16.1%
Head Depth at the Occiput	15.6%	16.0%	18.3%	19.3%
Head Width	7.3%	12.2%	14.2%	15.0%
Snout Length	9.0%	9.8%	11.9%	12.5%
Postorbital Head Length	6.9%	7.7%	9.7%	11.3%
Cheek Height	5.1%	5.8%	7.3%	8.0%
Orbit-Preopercle	6.8%	7.5%	9.3%	10.2%
Interorbital	8.8%	9.3%	11.0%	11.7%
Orbit Diameter	3.3%	3.5%	4.5%	4.8%
Lip Width	4.6%	5.0%	6.6%	7.7%
Upper Lip	3.4%	3.8%	5.2%	6.1%
Pectoral Fin Length	14.9%	16.0%	19.3%	20.8%
Pelvic Fin Length	11.4%	12.5%	14.7%	15.4%
Base of the Dorsal Fin	13.2%	14.2%	16.6%	18.1%
Dorsal-Fin Origin to Longest Ray	14.9%	16.2%	19.3%	20.1%
Dorsal Fin Depressed Length	20.0%	21.8%	25.1%	25.8%
Base of Anal Fin	5.4%	6.1%	8.3%	9.2%
Anal-Fin Origin to Longest Ray	16.4%	17.6%	22.8%	26.2%
Caudal Peduncle Depth	8.5%	8.8%	9.9%	10.6%
Caudal Peduncle Length	14.8%	16.0%	18.1%	19.2%
Body Depth	20.8%	21.8%	27.0%	29.8%
Predorsal Length	43.9%	45.4%	49.2%	51.0%

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TABLE 1 a–c. (Continued)

c.	Juveniles (n=69)			
	MIN	10th Percentile	90th Percentile	MAX
Meristics				
Predorsal Scale Count	14	15	17	18
Postdorsal Scale Count	17	19	22	23
Postanal Scale Count	5	5	8	8
Lateral Line Scale Count	42	43	46	46
Circumferential Scale Count	30	30	33	34
Scale Count Above Lateral Line	6	7	7	7
Scale Count Below Lateral Line	5	5	5	6
Circumpeduncular Scale Count	11	12	12	13
Simple Pectoral-fin Rays	2	2	2	2
Branched Pectoral-fin Rays	13	14	16	17
Simple Pelvic-fin Rays	1	1	1	1
Branched Pelvic-fin Rays	7	8	9	9
Simple Dorsal-fin Rays	1	1	1	1
Branched Dorsal-fin Rays	10	11	12	12
Simple Anal-fin Rays	1	1	1	1
Branched Anal-fin Rays	5	6	6	6
Principle Caudal-fin Rays	17	18	18	18
Standard Length (mm)	46.4	62.0	167.6	179.5
Measurements (%SL)				
Head Length from the Occipitum	17.4%	18.3%	21.4%	22.9%
Head Length from the Opercle	20.2%	22.0%	24.7%	25.9%
Head Depth through the Eye	12.7%	13.0%	14.7%	15.9%
Head Depth at the Occipitum	14.9%	15.5%	17.3%	18.2%
Head Width	11.3%	12.1%	13.6%	14.6%
Snout Length	8.8%	9.2%	10.9%	12.2%
Postorbital Head Length	7.5%	8.0%	10.0%	11.0%
Cheek Height	4.6%	5.1%	7.0%	12.4%
Orbit-Preopercle	6.6%	7.7%	9.3%	10.1%
Interorbital	7.8%	8.2%	10.3%	11.6%
Orbit Diameter	4.2%	4.6%	6.7%	7.1%
Lip Width	4.1%	4.4%	5.9%	6.3%
Upper Lip	2.9%	3.1%	4.5%	5.1%
Pectoral Fin Length	12.6%	14.8%	20.1%	21.1%
Pelvic Fin Length	12.9%	13.5%	15.8%	16.5%
Base of the Dorsal Fin	13.3%	14.8%	17.0%	18.0%
Dorsal-Fin Origin to Longest Ray	18.4%	18.9%	21.5%	22.6%
Dorsal Fin Depressed Length	22.0%	22.6%	25.9%	26.4%
Base of Anal Fin	4.9%	6.1%	7.3%	8.1%
Anal-Fin Origin to Longest Ray	15.0%	15.8%	18.2%	20.6%
Caudal Peduncle Depth	7.9%	8.6%	10.0%	10.5%
Caudal Peduncle Length	15.2%	16.5%	19.0%	20.8%
Body Depth	19.0%	20.3%	24.3%	26.8%
Predorsal Length	43.8%	44.8%	48.5%	49.5%

The habitat of six upper and middle Chattahoochee River system localities at which *M. antelunare* were captured usually ranged: width 4.6–46 m (15–150 feet); depth to 1.2 m (4 feet); current generally slow or pool and riffles present; bottom usually sand and gravel, but ranging from silt through rubble to bedrock; water colorless, clear or turbid; higher aquatic vegetation generally scant except *Podostemum* (Hornleaf Riverweed) common in riffles at some localities. Laurence & Yerger (1967) described upper Apalachicola River, below Jim Woodruff Dam, as having a sand and gravel bottom, and the lower Apalachicola River as including dark sloughs. The Chipola River was described by Laurence & Yerger (1967) as a clear, strongly flowing stream that originates from springs. Data for a Chipola River system collection (TU 34871) indicated that the bottom was shifting sand with silt in backwaters and the water was nonstained but turbid. At a site in Dead Lake, Chipola River system (TU 41298), the area was a swampy flowage with sand and silt substrate, water brownish and slightly turbid; one adult was taken by trammel net or gill net at 1.5–4.6 m (5–15 feet) depth.

Life history aspects of the Flint system population were studied by McSwain & Pasch (1973). Twenty-six mature males ranged 247–395 mm SL. The largest female examined was 389 mm SL, but fewer adult females than males were examined. Yerger & Suttkus (1962) reported a 417 mm SL specimen of unstated sex.

Spawning males and females were taken in upper Apalachicola River on 28–29 March 1960 (Yerger & Suttkus, 1962). Males running milt were collected on 26 March 1961 at the same locality (R. D. Suttkus, pers. com. with R. E. Jenkins; Jenkins (1970)). Reproductive adults were collected in a life history study by Grabowski *et al.* (2012) in February–April 2007 below Jim Woodruff Dam on the Apalachicola River (4 vouchers, NCSM 45829). Sex ratio of all collected Apalachicola Redhorse ($n=125$) was skewed 5:1 favoring males, and age at first maturity was estimated to be between 3 and 4 years with 3 year old fish being an average length of roughly 300 mm TL (Grabowski *et al.*, 2012), and the largest and the oldest individuals being 550 mm TL and 8 years old, respectively. This study found spawning aggregations of Apalachicola Redhorse arriving on gravel bars in late February and early March at water temperatures of 14°C, shortly after Spotted Sucker *Minytrema melanops* (Rafinesque 1820). At this site, spawning overlapped in space and time with Spotted Sucker continuing through late March and early April, but declining rapidly as water temperature increased from 18°C–20°C. Grabowski *et al.* (2012) also found the Apalachicola Redhorse to produce fewer, but larger eggs than Spotted Sucker. Detailed reproductive behavior is unknown throughout most of the remaining range.

Conservation Status. With an extent of occurrence of 50,905 km² and an approximate area of occurrence of 35,000 km², *M. antelunare* is considered Least Concern (LC) under IUCN criteria (IUCN 2012). The species is commonly encountered throughout its range and is found from small upland creeks to lowland main river channels. Water from the Apalachicola River system is extensively used for human activities, which can lead to a decrease in water quality, but such appears to be having no discernible effect on the distribution of *M. antelunare*. However, Grabowski *et al.* (2012) suggested that altered flow regimes may negatively affect populations near dams.

Note. Some non-type specimens exhibited the scale phenotype known in Common Carp (*Cyprinus carpio* Linnaeus) as “mirror” or “helix” or “scattered.” This appears to be exceedingly rare in *Moxostoma antelunare*, noted in only three specimens of over 300 museum specimens observed during data collection, and therefore considered not typical.

Etymology. A neuter adjective from the Latin *ante* for before, and *luna* for moon. This name is a reference to Bob recognizing this species one year prior to the moon landing in 1969. We believe this name is appropriate because it both represents the passage of time by referencing a monumental scientific event, and also reminds us that the Apalachicola Redhorse was still a species before description just as the moon existed before mankind set foot upon it or first recognized it in the sky.

Discussion

Moxostoma antelunare began to puzzle ichthyologists in the 1950s and 1960s, with Robins & Raney (1956) being unsure of what to call some juvenile *Moxostoma* specimens from the Apalachicola River system—some were catalogued as *M. duquesnei* and some as *M. erythrurum*. Yerger & Suttkus (1962) compared specimens with both of those species and suggested that the Apalachicola Redhorse shared more affinities with *M. duquesnei*, but they also indicated the need for a closer taxonomic study. Jenkins (1970) proposed that *M. antelunare* was most closely related to *M. poecilurum*. All three of these potential sister species would be good candidates as allopatric sister species, given that each of these species can be found in complimentary drainages. Based on both morphological hypotheses

from Jenkins (1970) and molecular hypotheses from Bagley *et al.* (2018), it is unlikely that *M. erythrurum* is a close relative to *M. antelunare*. Based on the molecular phylogenies published by Bagley *et al.* (2018), *M. lachneri* and *M. congestum* join *M. duquesnei* and *M. poecilurum* as close relatives to *M. antelunare* with the remaining Southern Group *Moxostoma* also being members of this clade, as well as possibly *M. rupiscartes* and *M. valenciennesi* as early branches. However, the sister relationships are not yet resolved, and clade relationships will likely be subject to change as phylogenomic methods are applied to *Moxostoma*.

This potential clade (*Moxostoma lachneri*, *M. congestum*, *M. duquesnei*, *M. poecilurum*, *M. antelunare*, Southern Group, *M. rupiscartes*, and *M. valenciennesi*) is geographically intriguing. Based on molecular data, none of the three *Moxostoma* in the Apalachicola River are sister species. *Moxostoma lachneri* and *M. rupiscartes* have long been thought to be close relatives of the Southern Group, despite the closest drainage basins of their distributions being separated by many coastal drainages including the Alabama River and Mississippi River basins (Smith 1992; Clements *et al.*, 2012). The Southern Group appears to be monophyletic and the result of one ancestral dispersal event (Pérez-Rodríguez *et al.*, 2016). However, the remainder of this clade includes *M. poecilurum* distributed along coastal drainages of the northern Gulf of Mexico, *M. congestum* along coastal drainages of the western Gulf of Mexico, *M. duquesnei* throughout the middle Mississippi River basin, and *M. valenciennesi* in the Great Lakes. Although a thorough biogeographic study will be necessary to resolve this clade, we posit that the ancestor to this clade would have been distributed in the Proto-Mississippi River and species evolution has mostly occurred from peripheral dispersal events, e.g. *M. congestum* into the Brazos River, the Southern Group into the Proto-Bravo River, *M. rupiscartes*, *M. lachneri*, and *M. antelunare* all independently into the Apalachicola River, and *M. valenciennesi* into the Proto-St. Lawrence River. Rapid (relative to geologic timescales) range expansion and/or shifting following glacial retreat is evident in *Moxostoma hubbsi* (Armbruster & Jenkins, 2025), leading us to believe that dispersal played a large role in this clade's speciation. Conversely, *M. duquesnei* and *M. poecilurum* may have been partially separated ecologically (upland vs. lowland streams) from this common ancestor. One final piece to this puzzle is that the vagility and tetraploidy of this group may have resulted in varied levels of introgression between all species and common ancestors during any number of the dispersal events and/or range expansions/constrictions stemming from glaciation to the north and sea-level changes to the south. This very complex history may have produced a clade of morphologically constrained species with confusing sets of homoplastic traits and is a topic clearly in need of further study.

Moxostoma antelunare is mostly distributed within the Apalachicola basin, but it has also been recorded multiple times in Econfin Creek in the St. Andrew's Bay drainage of northwestern Florida. The first known record is UF 237850 (18 September 2007). Preserved specimens from this first-known collection were accessioned but are currently missing, however the associated photographs are still available. A collection was recently made and two of the collected specimens were accessioned at the Auburn Museum of Natural History (AUM 86814). Upon discussing this distribution with other researchers, the following hypotheses were proposed: i) a bait bucket release from people possibly bringing fish to the Florida Wildlife Commission (FWC) office in Panama City, FL for identification; or ii) a modern dispersal event from the Apalachicola River into Econfin Creek during a flooding event; or iii) a connected population during the last glacial maximum when sea-levels were lower. Prior extensive surveys (e.g. Crittenden 1958) of this stream may have missed this population because they have only been collected via electroshocking in a reach of stream that is difficult to sample with this equipment, but this locality is apparently quite consistent in having Redhorse (pers. comm. J. Knight). Because of the number of individuals that have been recorded and the apparent abundance in this locality, we don't believe a bait-bucket release to be likely. However, this cannot yet be ruled out as there is a precedent recorded by Tracy *et al.* (2013) in which stable, reproducing populations of *Moxostoma rupiscartes* represent three separate hypothesized bait bucket releases in the Yadkin Pee Dee River drainage of North Carolina and Virginia, USA.

Based on our rudimentary basin reconstruction at the last glacial maximum (Figure 6), we cannot rule out a past connection between the Apalachicola River and Econfin Creek. However, it should be noted that this model was constructed using a modern digital elevation model and makes very simple assumptions of hydrology while mostly ignoring geology. The rivers of our model approximate, but do not precisely match, today's rivers upstream of the modern coastline, and some basin connections in our reconstruction do not completely and precisely replicate other paleo-basin hypotheses that were constructed using more in-depth geologic and hydrologic methodologies, for example the paleo-Aucilla River detailed by Faught (2004). There does not appear to be any other freshwater fish distributions that would obviously suggest a modern dispersal from the Apalachicola River to Econfin Creek, but these remaining hypotheses could be tested against one another with a population-genetics study.

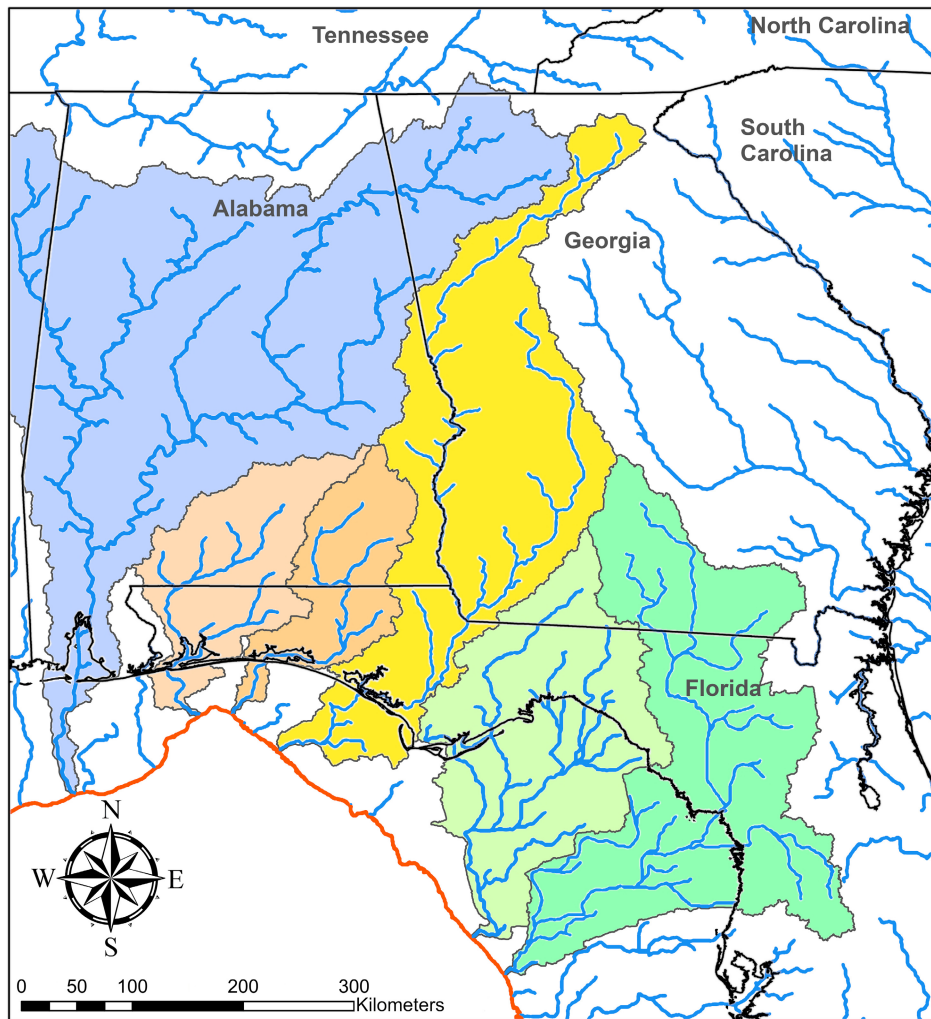


FIGURE 7. Drainage basin reconstruction during the last glacial maximum (LGM) (~20 kya). LGM coastline (red) approximated at 125 meters below current sea level. Constructed paleo-drainages in order from left to right, colors in parentheses: Mobile River (blue), Escambia+Yellow+Blackwater River (light orange), Choctawhatchee River (dark orange), Apalachicola+Econfina River (yellow), New+Steinhatchee+coastal River (light green), Waccasassa+Suwannee River (dark green).

Acknowledgments

D. R. Akin stumbled into the position to describe this species by collecting on the Apalachicola River with, and is thankful to, Dave Werneke, Mike Gangloff, Worth Pugh, and the retired Apalachicola Riverkeeper Dan Tonsmeire, as well FWC biologists Chelsea Myles-McBurney, Kallie Thornhill, and Lauren Patterson. We sent photographs of collected Redhorses to Bob, who was declining in health and invited us to finish this description. We would like to additionally thank Benjamin Allen, Steve Powers, Bryn Tracy, Gabriela Hogue, Rebecca Hawkins, Casey Dillman, Victor de Brito, Hernán López-Fernández, Benjamin Nicholas, Andy Bentley, Caleb McMahan, Susan Mochel, Diane Pitassy, Abigail Reft, Larry Page, Rob Robins, Bud Freeman, Mary Freeman, Nicole Pontzer, Mark Cantrell, and Jim Williams. We thank Bowen Bryant and Zach Abouhamdan of the Georgia Department of Natural Resources for sharing their collection records. We extend a special acknowledgement to John Knight for collecting in Econfina Creek and extending the range of the Apalachicola Redhorse. This paper is contribution no. 970 of the Auburn University Museum of Natural History.

From reading the many notecards and printed out emails that Bob left behind—we simply must acknowledge the entire North American ichthyological community, especially all members of Southeastern Fishes Council past and present. Bob's acknowledgements from a previous draft are included below, and were updated as little as possible:

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S1: Data collected by R. E. Jenkins. Not all abbreviations known, but known abbreviations listed in supplement 1a.

S2: Skull measurements recorded by J. W. Armbruster.

S3: ArcGIS model ran by D. R. Akin.