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

Robert E. Jenkins[1], Scott D. Favrot[2], Byron J. Freeman[3], Brett Albanese[4], and Jonathan W. Armbruster[5]

Like the pine trees linin' the windin' road
I've got a name, I've got a name.
Like the singin' bird and the croakin' toad
I've got a name, I've got a name.
And I carry it with me like my daddy did,
But I'm livin' the dream that he kept hid.

—"I Got a Name," lyrics by Norman Gimbel,
music by Charles Fox, sung by Jim Croce

We are presenting the first of a series of new redhorse species discovered by Dr. Robert E. Jenkins over the last several decades. Bob contacted the last author in 2022 saying that he was running out of time, and he wanted to see the description of several species published. He wanted to lead this manuscript into publication, but Bob died on 12 July 2023.

As we finished up this work, we were reminded of the classic Jim Croce song "I Got a Name," as the Sicklefin Redhorse will finally have a name after it had been hidden for so long. Jim Croce died the day before the song was released, and he never got to see his own legacy. The same is true of Bob. Bob left us a great wealth of information as his legacy, and it is up to those interested in redhorse to see that his legacy is fulfilled. A version of this description first appeared in a report in 1999 and then was revised for another report in 2010. The introduction, diagnosis, ecology section, and parts of the discussion are new, but the materials and methods and description are largely Bob's. Bob selected the species' common name Sicklefin Redhorse; however, we did change the scientific name from that Bob had chosen, "falcatus." We feel this new scientific name honors the species' southern Appalachian Mountain heritage.

The Sicklefin Redhorse is perhaps the largest truly new North American species discovered in the last century, and the species is herein described as *Moxostoma ugidatli*, new species. Sicklefin Redhorse differ from other red-tailed redhorse based on the presence of elongate first through third dorsal-fin rays, and from all other redhorse by having plicate lips with deep, branching grooves distally (vs. lips papillose or unbranching) and by having moderately molariform pharyngeal teeth (vs. molariform or chisel-like teeth). The Sicklefin Redhorse is found in the upper Tennessee River basin of North Carolina and Georgia in the Little Tennessee and Hiwassee River subbasins. Although the species is not federally protected, it is threatened in North Carolina and endangered in Georgia. The species is known to live to 22 years, with the largest preserved female 500 mm SL, 633 mm TL, 2.561 kg and the largest preserved male 463.2 mm SL, TL unknown, 2.024 kg.

SUCKERS are mostly large-bodied fishes found throughout North America with one species being shared with Asia (*Catostomus catostomus*) and another native to China (*Myxocyprinus asiaticus*; Smith, 1992; Harris et al., 2014). Suckers (Catostomidae) are thought to have originated in Asia as several fossil taxa have been found in China, and *Myxocyprinus* is frequently a sister species to the remaining suckers in phylogenetic analyses (Liu and Chang, 2009; Liu et al., 2016; Liu, 2021). In eastern North America, the most species-rich genus of suckers is *Moxostoma* (Redhorses and Jumprocks; Harris et al., 2014). Several undescribed species of *Moxostoma* have been identified over the course of the first author's career, and here we describe the Sicklefin Redhorse as a new species.

Moxostoma currently consists of 42 nominal species with 23 considered valid (Fricke et al., 2023). Of these, the Harelip Sucker (*Moxostoma lacerum*) is extinct and its relationship with other *Moxostoma* is unclear, with the species often referred to the genus *Lagochila* (Jenkins, 1970; Harris et al., 2014). At adult sizes exceeding 60 cm (TL), the Sicklefin Redhorse may be the largest newly described vertebrate (i.e., not split from another species) in continental North America (Figs. 1, 2).

Dr. Bob Jenkins became aware of the species when a drawing was sent to him by Edward Menhinick in 1992 (Menhinick, 1991: 114, 220, UNCC 81–14) that was ascribed to the River Redhorse (*Moxostoma carinatum*). The two specimens

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Fig. 1. Live specimen of male, 353 mm SL (A) and female, 350 mm SL (B) *Moxostoma ugidatli*, AUM 86445, by S. Fraley.

in the lot were taken from the upper Little Tennessee River of North Carolina in 1981 and were unusual in the shape of the enlarged, falcate dorsal fin and red caudal fin (Figs. 1, 2). The only two species in the southern portion of the Tennessee River with red caudal fins are *M. carinatum* and *M. breviceps* (Smallmouth Redhorse, formerly *M. macrolepidotum*). Further, the specimens had pharyngeal teeth (Fig. 3B) intermediate between *M. breviceps* (chisel-like teeth; Fig. 3A) and *M. carinatum* (molariform teeth; Fig. 3C), suggesting the two specimens could be hybrids of *M. carinatum* and *M. breviceps*. As of 1992, only 14 specimens had been collected and only two of those adults. The first specimen (UMMZ 233241) was collected in 1937 at the mouth of Forney Creek in the Tuckasegee River (Little Tennessee River basin; the location is now part of a reservoir) and identified as *M. duquesnei* (Black Redhorse).

Upon Dr. Bob Jenkins recognizing the distinctiveness of the specimens, more specimens were found in the Little Tennessee River basin, and the range expanded to include Brasstown Creek (Hiwassee River basin) of North Carolina and north Georgia. The species was only seen spawning with other Sicklefin Redhorse, suggesting that it did not represent a hybrid, but an undescribed species (Favrot and Kwak, 2018, 2024; REJ, pers. obs.). Recognition of the species led to a significant effort to examine the species' range and ecology as well as to assess its conservation status (Stowe, 2012; USFWS, 2016; Favrot and Kwak, 2018, 2024).

The Sicklefin Redhorse has been examined in several phylogenetic studies. Harris et al. (2002) using the mitochondrial cytochrome *b* gene found that the Sicklefin Redhorse (as *M.* sp. *cf. macrolepidotum*) was strongly supported as sister to *M. carinatum*. This relationship has held through most studies, including Doosey et al. (2010, as *M.* sp. "Sicklefin Redhorse") using mitochondrial ND4/ND5, Clements et al. (2012, as *M.* sp. "Sicklefin Redhorse") using cytochrome *b* and the nuclear Growth Hormone Intron 1, and most of the analyses in Bagley et al. (2018, as *M.* sp. *cf. macrolepidotum*) using a combination of morphology and three mitochondrial and three nuclear genes (although no morphological data were available for the Sicklefin Redhorse). Analyses of nuclear genes alone in Bagley et al. (2018) instead found the Sicklefin Redhorse to be sister to a clade of *M. macrolepidotum* and the undescribed Brassy Jumprock (as *M.* sp. *cf. lachneri*); however, branches are short and not strongly supported in much of the nuclear tree. The time-calibrated

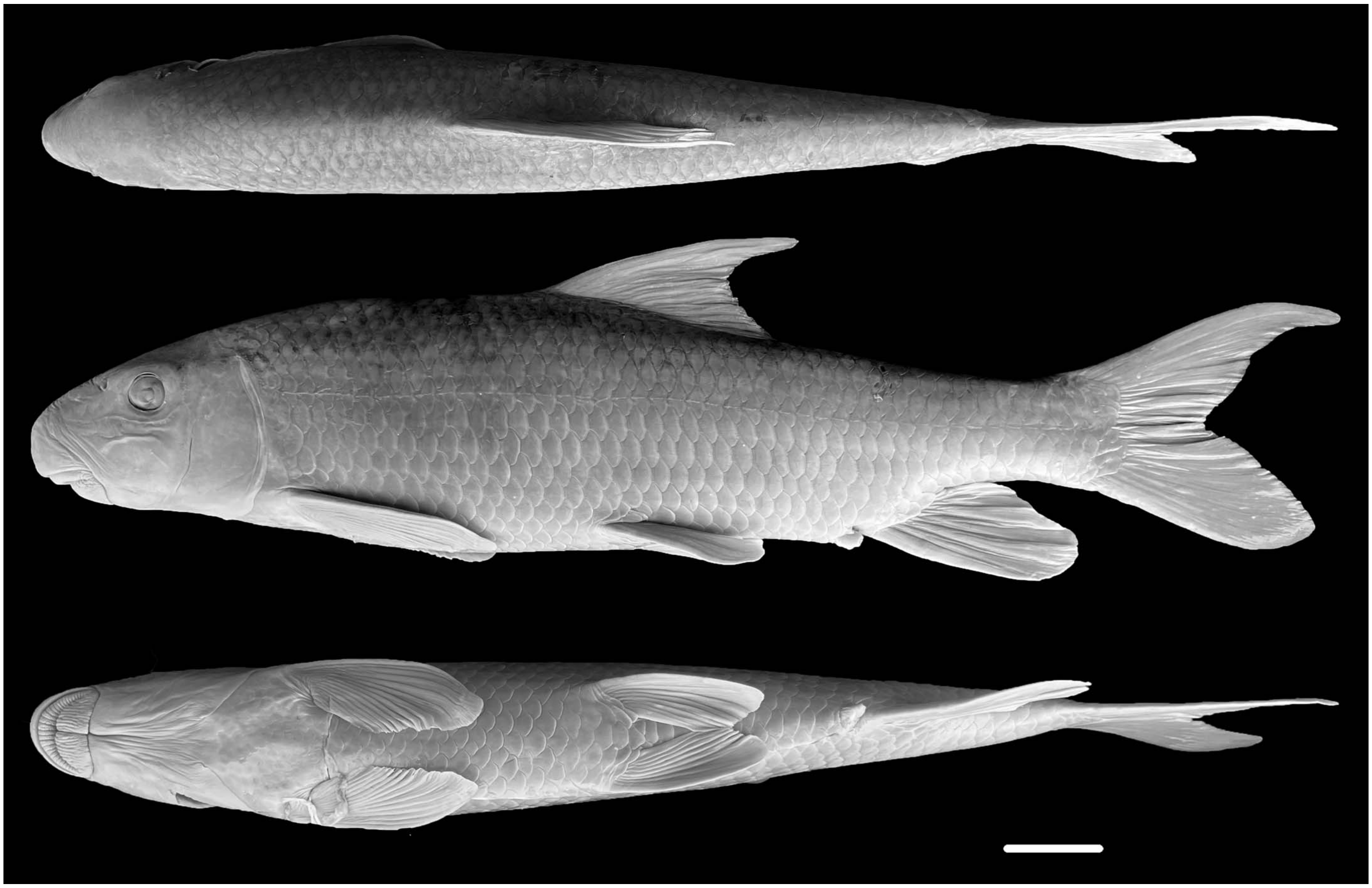

Fig. 2. Holotype of *Moxostoma ugidatli*, AUM 86444, female, 446.8 mm SL, North Carolina, Cherokee County, Hiwassee–Tennessee river basin, Valley River, river mile 19.0–19.1, just below rest stop, Andrews, 35.2049°, –83.8586°. Scale = 5 cm. Photos by J. W. Armbruster.

phylogeny in Bagley et al. (2018) placed the Sicklefin Redhorse as sister to *M. macrolepidotum* and *M. pisolabrum*, with the Sicklefin Redhorse and *M. carinatum* separated from one another by ~11 million years (my; 14–5 my). Differing relationships between the nuclear and mitochondrial markers in Bagley et al. (2018) could suggest that the Sicklefin is of hybrid origin, but the deep divergence suggests that any hybridization would be old. All phylogenies of *Moxostoma* so far have largely had weak support, and the relationships of the taxa need further examination. Moyer et al. (2019) examined genetic differentiation within Sicklefin Redhorse using microsatellites and found differentiation between the Hiwassee and Little Tennessee and moderate differentiation between two populations within the Little Tennessee.

In this paper, we describe the Sicklefin Redhorse as new to science. Even though it has taken over 30 years for science to describe the species after its discovery, the Sicklefin Redhorse has been known by the Eastern Band of Cherokee Indians as unique for centuries, and it probably served as an important resource (Altman, 2006; USFWS, 2015). We name the species in accordance with the Cherokee name. We also discuss age and growth, morphometry, and pharyngeal jaw morphology.

MATERIALS AND METHODS

Institutional codes follow Sabaj (2020). Counts and measurements follow Hubbs and Lagler (1958) except as indicated below and are presented in Supplementary File 1 (see Data Accessibility), which has separate sheets for different data forms (data are parsed by field number instead of catalog number as the specimens were split among several institutions and were not individually tagged as to individual; field number is included along with catalog numbers in the specimens examined sections). Measurements less than ~120 mm were taken with dial calipers and recorded to the nearest 0.01 mm (rounded here to 0.1 mm). Those measurements greater than 120 mm were made with a needlepoint beam compass and read to the nearest 0.5 mm from a metal ruler. Slightly curved specimens were straightened, but badly curved specimens were not measured. The end of the caudal peduncle for standard length (SL) and caudal peduncle length was determined by probing the end of the caudal peduncle with fine point forceps until the end of the hypural was found. Total length (TL) is the maximum length, measured by holding the tip of the longest caudal lobe (the upper) to the longitudinal midline of the body (lateral line level). Head length and postorbital length exclude the opercular membrane. Orbit diameter was measured as the horizontal distance between the fleshy orbital rims. Snout length and postorbital length were taken from the bony orbital rim. Lip width is the greatest distance between the outer, lateral edges of the lips. Lip length was measured along the midline from the anterior edge of the upper lip to the posterior edge of the lower lip. Caudal-fin lobes were measured from the caudal base to the tip of the caudal lobes after they were moderately spread. Measurements are presented as percent SL.

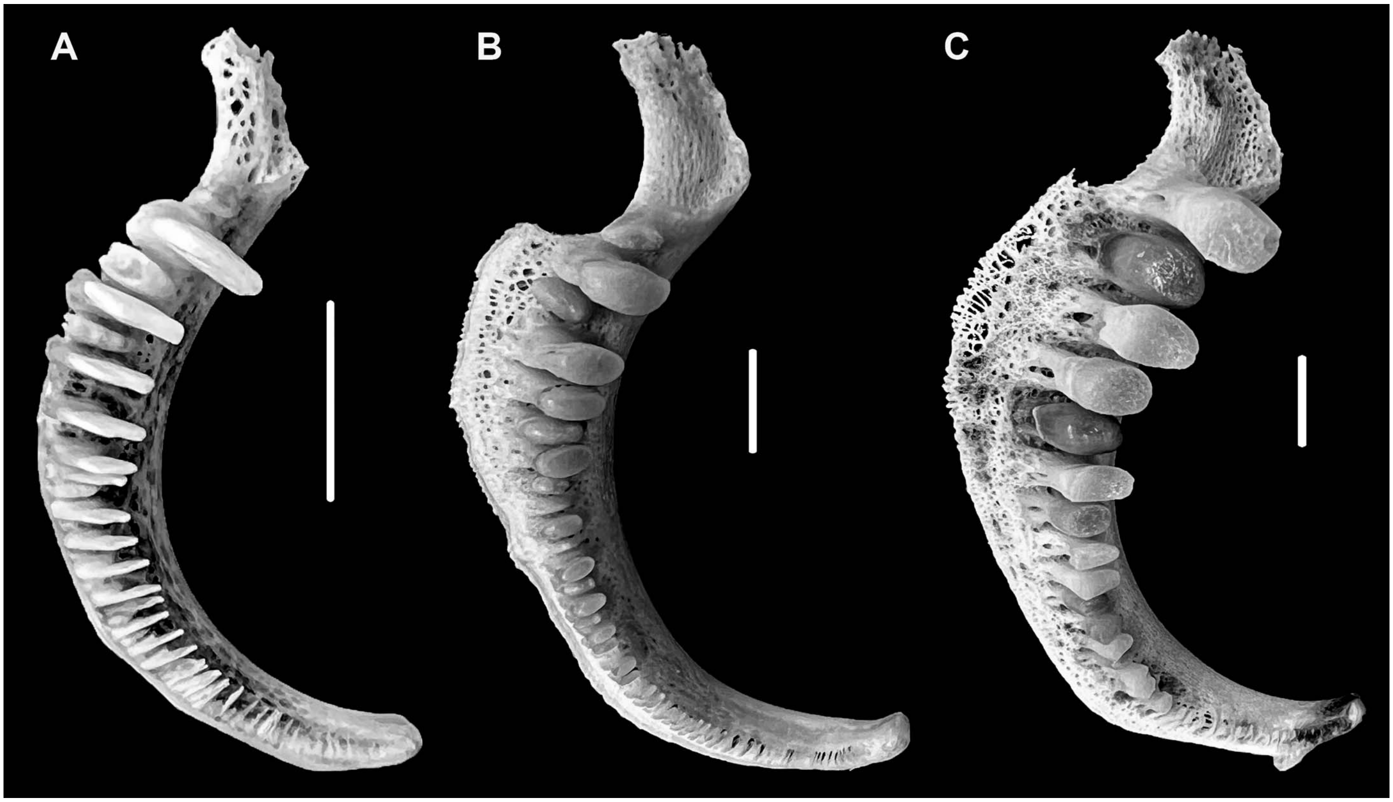

Fig. 3. Left pharyngeal arch and teeth of (A) *Moxostoma breviceps* (uncataloged, Swain Co., NC), slender (light) arch, chisel-like teeth; (B) *M. ugidatli* (REJ 1933), moderately stout (heavy) arch and moderately molariform teeth; (C) *Moxostoma carinatum* (REJ 1313), stout (heavy) arch and molariform teeth. Ventral is top of figure. Scale = 1 cm.

Breast scalation is the percentage of scale coverage of the area bounded by the distal edge of the branchiostegal membranes (anteriorly as far as their attachment to the isthmus) and the pectoral-fin bases. Coverage was estimated to the nearest 10% and is reported categorically, e.g., the 90% category includes 90–99% coverage. Embedded scales were discerned by scraping with a needlepoint. Breast scalation was rarely determined for specimens less than 100 mm SL owing to relative difficulty of detecting scales.

Caudal-fin rays were counted as the branched fin rays plus the two principal unbranched rays. The last ray of the dorsal and anal fins is divided to the base and so the last two elements were counted as one. Pelvic-fin rays were counted on both sides and expressed as #left–#right (i.e., 9–10). Pelvic-fin rays may be fused and were counted only when the number of rays that were fused was clear.

Post-Weberian vertebral counts were made from radiographs with the caudal complex included as one. Gill rakers were counted on the lateral (or anterior) surface of the first, right arch; counting was facilitated by cutting the upper and lower opercular muscles to rotate the opercle out of the way. Cephalic lateralis pores were counted by revealing them with compressed air. Counts often were repeated for specimens having minute pores and canals obscured by thick skin; precision was enhanced by sometimes marking each pore with an ink dot next to it. The pore count of the postocular commissure (POC, or lateral canal) was ended posteriorly at the junction of the supratemporal (ST) canal; a common pore was included only in the POC count. The POC count was ended anteriorly when the canal dipped distinctly, continuing as the infraorbital (IO) canal. A common pore at the junction of the IO with the supraorbital canal (SO) or preopercular-mandibular (PM) canal was counted only as an IO pore. Pores on atypical canal branches were not counted.

Pharyngeal arches and teeth were studied from skeletonized specimens or arches dissected and cleaned under a dissecting microscope or immersion in chlorine bleach. Teeth were counted under a dissecting microscope with all bases and alveoli included. Teeth were not counted when several of the fine, uppermost teeth were missing as they leave no base or alveolus. A distinction between heavy and light pharyngeal arches was made by examining the distance between the arch and the cleithrum with a sharp probe (heavy arched species have the arch and cleithrum very close and light arch species have them distant). Measurements of the arch included pharyngeal arch length (PAL; the greatest length of the arch), pharyngeal arch width (the maximum width of the arch), pharyngeal arch base width (the widest portion of the untoothed, ventral portion of the arch), pharyngeal arch base length (the length of the untoothed, ventral section of the arch), and pharyngeal tooth row length (the length of the toothed section of the arch). Tooth measurements include cusp width (greatest pharyngeal tooth width), cusp length (greatest pharyngeal tooth length), tooth height (greatest pharyngeal tooth height), and base width (greatest pharyngeal tooth base width) of the largest of the three lowermost pharyngeal teeth (the largest tooth was always one of these three; width and length are relative to the tooth with width the smaller dimension and length the greatest).

Scale morphology (distribution of radii) was examined from scales taken from the dorsolateral body about the level of dorsal-fin insertion. Lip plicae counts include primary plicae and not secondary plicae that are shallow and branch from primary plicae. Lip angles were measured with a small, clear plastic protractor and straightedge by placing their edge over the posterior end of the lower lip, intersecting the middle of the lower edge of the protractor with a straightedge (intersection placed over the apex of the lip angle) and reading degrees from where the straightedge intersected the upper edge of the protractor.

Intestines were measured after cutting the alimentary tract just posterior to the heart and at the anus and removing, cleaning, uncoiling, and slightly stretching them (stretching was done to compensate for the slight kinking in the intestines left from the intestinal coils). Abdominal cavity length was measured by opening the abdominal cavity with scissors just lateral to the vent. Gas bladder length and lengths of the chambers were measured *in situ* or with the bladder removed and while avoiding stretching the short canals between the chambers. The length excluded the posterior extension of the third chamber, if any was present, unless the extension was much wider than a narrow tube and appearing as a small fourth chamber.

Skeletons examined were found in a dry state at institutions or prepared by Dr. Bob Jenkins by heating and removing flesh. Crania were not disarticulated.

Counts are presented as a range of about 80% of the specimens with outliers indicated in parentheses. For example, (11)12–14(15) indicates that about 80% of specimens have a count of 12–14 and 11 and 15 represent outliers. Following Jenkins (1970) and Jenkins and Burkhead (1994), the frequency of states of numerous characters are denoted by the following relative terms: rarely—the state is present (or absent) in about 1–5% of the specimens studied; occasionally—6–20%; often—21–50%; usually—51–95%; almost always—96–99%. Many characters had their states recorded by a code string system ranging 0–6: 0—structure or state absent; 2—slightly developed; 4—moderately developed; 6—very or strongly developed. Codes 1, 3, and 5 were recorded for intermediate states or conditions not clearly assignable to the former codes and were used in essentially equal frequency as their adjacent codes.

Nuptial tuberculation was described from specimens with well-developed tubercles. Tubercle buds (Lachner and Jenkins, 1971) of prenuptial males indicated sex incipient tubercle patterns; postnuptial males had raised remnants or flat pale scars of former tubercles. Buds and scars were discernible (without sectioning) only for medium and large tubercles on the head and the anal and caudal fins. Scars appeared absent in relatively few, clearly adult-size, well-preserved postnuptial males. For describing the annual cycle of development of tuberculation, the degree of development was scored by the 0–6 scale of coding above.

In total, 231 Sicklefin Redhorse specimens were examined. Some of the specimens could not be located and most of these are listed as "Non-types (uncataloged, likely destroyed)." Dr. Bob Jenkins examined comparative material from throughout the range of *Moxostoma*, but that presented herein is mainly from coexisting congeners present in the Sicklefin Redhorse's range. Specimen lists are sorted by basin, state, county, field number, 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: nf = not found and refers to specimens that were not located and are not considered part of the type series, nm = not measured, sk = skeletonized (these were measured prior to skeletonization in most cases).

Age was estimated by counting primary rings on opercles (validated for the catostomid *Chasmistes cujus* in Scoppettone et al., 1986; Scoppettone, 1988). Annuli one and two are occasionally obscured on opercles, and age was checked with scale age when this occurred. The age was given in a proportion of the year that was calculated by determining the day the specimen was collected out of 365 divided by 365. The age/growth curve was fitted with the fishmethods package of R with the size data from the "size" sheet in Supplementary File 1 (see Data Accessibility) imported as a csv file as "data" and the following code: growthmultifit(len=data$sl,age=data$age,group=as.character(data$sex),model=1,fixed=c(2,1,1),error=1,select=1,Linf=NULL,K=NULL,t0=NULL,plot=TRUE,control=list(maxiter=10000,minFactor=1/1024,tol=1e-5,pch=40)). For specimen ages, the year age is provided with days; a plus sign indicates that a specimen was between that age and the next.

***Moxostoma ugidatli*, new species**

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Sicklefin Redhorse or Ugidatli (ᎤᎩᏓᏟ)

Figures 1, 2, 3B, 4C, 5, 6; Tables 1–2; Supplementary Figure 1

Moxostoma carinatum (in part, misidentifications).—Simbeck, 1990 (one collection in the Great Smoky Mountains National Park); Menhinick, 1991: 114, 115, 198, 220 (in key, illustrated specimen laterally, illustrated pharyngeal arch, certain NC records mapped).

Moxostoma duquesnei (in part, misidentification [UMMZ 233241]).—Menhinick, 1991: 115 (Forney Cr. record mapped).

Moxostoma macrolepidotum (in part, misidentifications [not key and illustrations]).—Menhinick, 1991: 114, 115, 198, 220 (certain NC records mapped).

Moxostoma sp. *cf. macrolepidotum*.—Bagley et al., 2018 (phylogenetic relationships).

Moxostoma sp., Sicklefin Redhorse.—Jenkins and Freeman, 1997: 89 (brief account: description, range, habitat, conservation status); Doosey et al., 2010 and Clements et al., 2012 (phylogenetic relationships); Page and Burr, 2011 (brief description, distribution map); Favrot and Kwak, 2018 (behavior and reproductive ecology); Moyer et al., 2019 (population genetics); Tracy et al., 2020 (distribution map and discussion of restocking efforts); Favrot and Kwak, 2024 (habitat niche dynamics).

Holotype.—AUM 86444 (REJ 1946), female, 446.8 mm SL, North Carolina, Cherokee County, Hiwassee–Tennessee River basin, Valley River, river mile 19.0–19.1, just below rest stop,

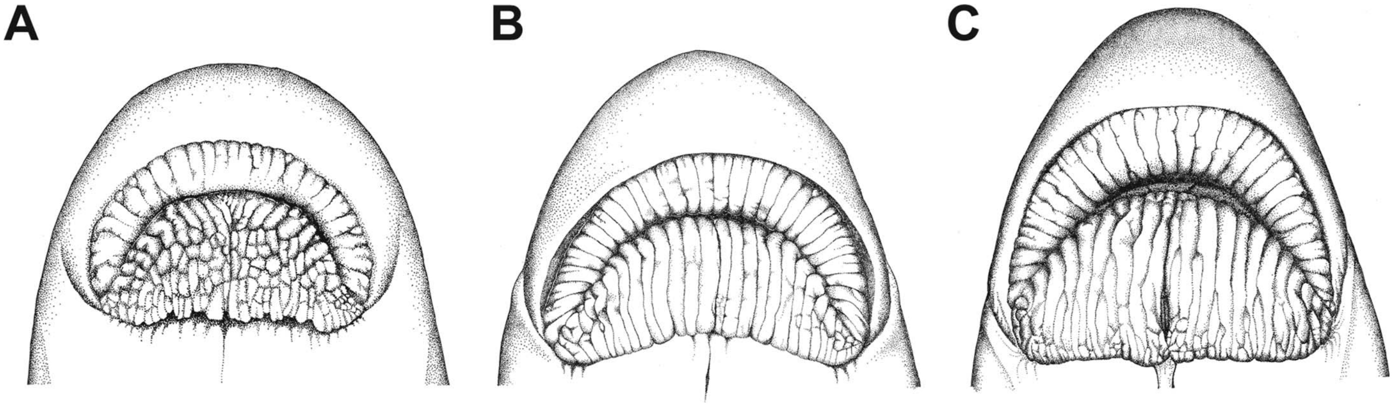

Fig. 4. (A) Papillose lips, *M. breviceps*, 306 mm SL, Duck River, TN; (B) plicate lips, *M. carinatum*, 315 mm SL, Kentucky River, KY; (C) distally branching plicate lips, *Moxostoma ugidatli*, 426 mm SL, Valley River, NC. Illustration by D. Etter.

Andrews, 35.2049, −83.8586, R. E. Jenkins, B. W. Albanese, S. J. Fraley, and J. W. Mays, 12 August 2003.

Paratopotype.—NCSM 114519 (REJ 1946), 1, male, 395.4 mm SL, 8 yrs., collected with holotype.

Paratypes.—All from Hiwassee–Tennessee River basin. Georgia, Towns Co.: AUM 86443 (REJ 1485), 1, 395 mm SL, 15 yrs., Towns Co., Brasstown Creek at junction of routes 66 and 339, 1.8 air miles SSE Warne, river mile 10.2–10.5, 34.97234, −83.88059, R. E. Jenkins, B. J. Freeman, and D. M. Walters, 15 April 1996; GMNH 2595, 1, 360 mm SL, 10 yrs., Brasstown Creek at junction of routes 66 and 339, 1.8 air miles SSE Warne [North Carolina], river mile 10.2–10.5, 34.97234, −83.88059, B. J. Freeman, L. M. Hartle, T. E. Jones, and R. O. Hall, 14 April 1993; GMNH 3107, 1, 348 mm SL, 6+ yrs., Brasstown Creek at junction of routes 66 and 339, 1.8 air miles SSE Warne [North Carolina], river mile 10.2–10.5, 34.97234, −83.88059, P. T. Frizzelle and D. M. Walters, 20 June 1995.

North Carolina, Cherokee Co.: AUM 86394 (RC-TVA 230594-S), 2 (sk, 1 sb), 381.5–392.0 mm SL, 10–13 yrs., Valley River, river mile 12.5, Hyatt Creek mouth, 35.17410, −83.91610, D. C. Matthews, R. Pickett, Tennessee Valley Authority, 23 May 1994; AUM 86395 (REJ 1799-S), 1 (sk), 398.7 mm SL, 9 yrs., Hiwassee River, river mile 96.8, route 64 bridge, 35.07850, −84.02620, A. Fivemere, 23 April 2000; AUM 86409 (RC-FWA 140601-S), 1 (sk), 326 mm SL, 6+ yrs., Hiwassee River, river mile 101.6, 35.05310, −83.96980, Fish and Wildlife Associates, 14 June 2001; AUM 86432 (RC-TVA 230993), 1, 247.5 mm SL, 3+ yrs., Hiwassee Lake, river mile 77 in forebay (lower reservoir), ca. 9.8 air miles WNW center Murphy, 35.16610, −84.17810, Tennessee Valley Authority, 23 September 1993; AUM 86433 (1), VIMS 48136 (2), (REJ 1789), 4 (1 nf), 306.2–334.1 mm SL, 5–9 yrs., Hiwassee River, at Murphy (lower of 2 bridges at NC boat ramp), river mile 96.3–96.4, 35.08490, −84.03670, R. E. Jenkins, D. C. Matthews, E. Scott, and R. Butler, 10 March 2000; AUM 86434 (2), VIMS 48144 (1), (RC-TVA 160797), 3, 292.8–379.8 mm SL, 4–13+ yrs., Hiwassee River, river mile 96.4–96.7, Murphy boat ramp, 35.08490, −84.03670, Tennessee Valley Authority, 16 July 1997; AUM 86436 (2), NCSM 114518 (1), VIMS 48142 (2), (RC-TVA 191196), 5, 232.6–306.0 mm SL, 2–4+ yrs., Hiwassee Lake, river mile 77, forebay (lower reservoir), 35.1661, −84.1781, D. C. Matthews, 19 November 1996; AUM 86440 (3), NCSM 114511 (1), VIMS 48134 (2), (REJ 1782), 6 (1 nm), 316.0–425.9 mm SL, 6–15 yrs., Hiwassee River, river mile 101.6–101.7, 1.9 air miles NW Brasstown under powerline, McCombs Road, 35.05310, −83.96980, R. E. Jenkins, W. C. Starnes, E. Scott, M. Cantrell, and D. C. Matthews, 6 March 2000; AUM 86442 (3), NCSM 114515 (1), VIMS 48135 (2), (REJ 1788), 6, 355.3–436.1 mm SL, 7–19 yrs., Valley River, river mile 0.7–0.8, Murphy, park and tennis courts, 35.09110, −84.02910, R. E. Jenkins, D. C. Matthews, and E. Scott, 9 March 2000; AUM 86445 (REJ 1934), 10 (1 nm), 296.8–430.5 mm SL, 5–13 yrs., Hiwassee River, river mile 96.3–96.6, Murphy boat ramp, 35.08490, −84.03670, R. E. Jenkins, E. Scott, S. Fraley, B. Porter, and C. Storey, 19 April 2003; AUM 86446 (REJ 2012), 2, 274.6–283.3 mm SL, 4+ yrs., Hiwassee Lake, Grape Creek arm, T-4, downlake shore, river mile 0.0–0.8, 35.11820, −84.11730, R. E. Jenkins, D. L. Yow, S. J. Fraley, S. Favrot, L. Henebry, J. Simmons, M. Cantrell, 6 June 2006; AUM 86447 (REJ 2015), 12, 164.0–363.8 mm SL, 4–8+ yrs., Hiwassee Lake, between Bearpaw Creek and Beaverdam Creek arms, 35.16800, −84.16740, R. E. Jenkins, D. L. Yow, S. J. Fraley, J. Simmons, S. Favrot, Shively, L. Henebry, M. Cantrell, and A. J. Rodgers, 7 June 2006; AUM 86448 (33), VIMS 48137 (2), (REJ 1857, 1859, 1861), 36 (1 nf), 157.7–351.0 mm SL, 3–6+ yrs., Hiwassee Lake across all 3 main divisions, most

Fig. 5. Age-0 *Moxostoma ugidatli* propagated and photographed at Conservation Fisheries Incorporated. Most specimens were 45–60 mm total length.

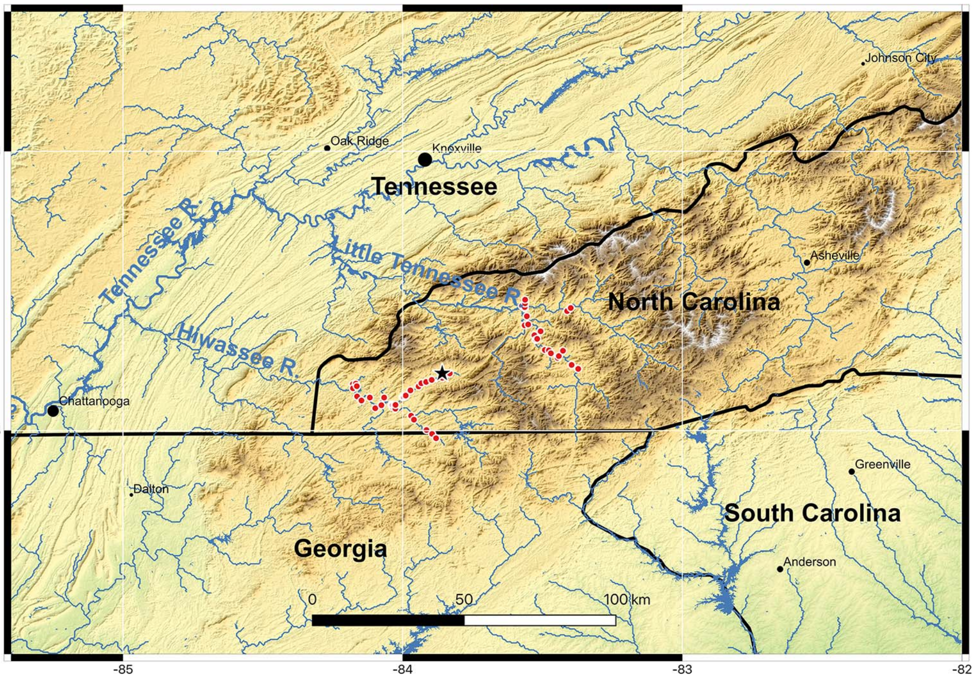

Fig. 6. Distribution of specimens examined of *Moxostoma ugidatli*. Star indicates type locality.

major arms (different field numbers denote upper, middle, and lower thirds), 35.15890, −84.16390, R. E. Jenkins, D. L. Yow, S. Loftis, W. S. Poore, and T. A. Dickey, 1 May 2001; AUM 86498 (REJ 1925), 1, 78.5 mm SL, 1+ yrs., Valley River, Lundsford Farm, river mile 11.1–11.3, ca. 0.6 air miles SW Marble center, 35.16950, −83.93300, R. E. Jenkins and J. Winesett, 25 July 2002; AUM 86500 (REJ 1774), 1, 97.8 mm SL, 1+ yrs., Valley River, river mile 15.9–16.6, off route 74, across from tanks to airport hangars, 2.1 air miles WSW center Andrews, 35.18910, −83.85860, R. E. Jenkins, J. D. Riley, E. M. Scott, and A. K. Wales, 22 October 1999; AUM 86501 (RC-TVA 050899), 1, 100.2 mm SL, 1+ yrs., Valley River, river mile 4.3, end of road from Armory, 35.12000, −83.99540, A. K. Wales, E. Crews, A. Harris, C. Paxton, and D. Pipes, Tennessee Valley Authority, 5 August 1999; AUM 86502 (REJ 1617), 2, 43.5–92.2 mm SL, 0–1+ yrs., Valley River, river mile 4.8–5.2, at Riverbend Campground, 3.5 air miles NE center Murphy, 35.12280, −83.98970, R. E. Jenkins, R. Bronchaud, A. G. Genderons, A. A. Coons, and W. C. Starnes, 11 October 1997; AUM 86503 (REJ 1924), 1, 70.9 mm SL, 1+ yrs., Valley River, Swinging Bridge to Powerline, river mile 5.2–5.5, ca. 1.0 air miles SSW Tomotla, upper end of campground, 35.12530, −83.98930, R. E. Jenkins and J. Winesett, 25 July 2002; AUM 86505 (RC-NCSU 090507), 1, 65.5 mm SL, 1+ yrs., Valley River, river mile 7.25, 35.1439, −83.9722, S. D. Favrot et al., 9 May 2007; AUM 86506 (REJ 1917), 1, 126.1 mm SL, 2+ yrs., Hiwassee River and Valley River at their confluence, Murphy, 35.09330, −84.03970, R. E. Jenkins, J. Winesett, T. Kwak, and E. G. Malindzak, 11 June 2002; NCSM 114513 (2), VIMS 48139 (3), (REJ 1922), 5 (2 nm), 335.4–358.0 mm SL, 6+ yrs., Hiwassee River, river mile 96.4–96.7, Murphy boat ramp, 35.08490, −84.03670, R. E. Jenkins, J. Winesett, T. Kwak, and E. G. Malindzak, 24 July 2002; NCSM 114516 (RC-TVA 010793), 2, 393.0–412.0 mm SL, 10–13+ yrs., Valley River, river mile 4.0, Marble Creek mouth, 35.11980, −84.00040, R. Wallus, Tennessee Valley Authority, 1 July 1993; NCSM 23745 (RC-TVA 071106), 1, 363.0 mm SL, 7+ yrs., Hiwassee Lake, river mile 85.0 transition zone (upper reservoir), ca. 6.5 air miles WNW center Murphy, 35.10760, −84.14730, D. C. Matthews, Tennessee Valley Authority, 7 November 2006; NCSM 23746 (RC-TVA 081106), 3, 294.2–371.5 mm SL, 4–6+ yrs., Hiwassee Lake, river mile 77 in forebay (lower reservoir), ca. 9.8 air miles WNW center Murphy, 35.16610, −84.17810, D. C. Matthews, Tennessee Valley Authority, 8 November 2006; NCSM 23747 (RC-NCWRC 111006), 1, 321.4 mm SL, 5+ yrs., Hiwassee Lake, uplake point of mouth of Nottely River arm, river mile 91.85, ca. 2.4 air miles WNW center Murphy, 35.09090, −84.07600, North Carolina Wildlife Resources Commission, 11 October 2006; NCSM 23748 (RC-NCWRC 051006), 1, 299.7 mm SL, 4+ yrs., Hiwassee Lake, uplake at outer point of Nottely River arm, river mile 91.9, ca. 2.4 air miles WNW center Murphy, 35.09090, −84.07600, North Carolina Wildlife Resources Commission, 5 October 2006; NCSM 23749 (RC-NCWRC 300906), 3, 158.2–317.2 mm SL, 2–5+ yrs., Hiwassee Lake, Beech Creek cove, E side, 0.5 air miles from lake mid-channel at river mile 90.2, ca. 3.5 air miles W center Murphy, 35.0800, −84.0980, North Carolina Wildlife Resources Commission, 30 September 2006; NCSM 32309 (RC-TVA 201000), 2, 188.7–343.3 mm SL, 2–5+ yrs., Hiwassee Lake, river mile 85.0 transition zone (upper reservoir), ca. 7.6 air miles WNW center Murphy, 35.10760, −84.14730, D. C. Matthews, Tennessee Valley Authority, 20 October 2000; NCSM 32310 (RC-TVA 211100), 3, 272.0–340.3 mm SL, 4–5+ yrs., Hiwassee Lake, river mile 77, forebay (lower reservoir), rock bluff shore area, ca. 9.3 air miles NW Murphy, 35.15140, −84.17770, D. C. Matthews, Tennessee Valley Authority, 21 November 2000; NCSM 32311 (RC-NCWRC 020500), 20, 133.2–364.6 mm SL, 3–7+ yrs., Hiwassee Lake (upper, middle, and lower part of reservoir), ca. 7.6 air miles WNW Murphy, 35.12230, −84.16300, D. L. Yow, S. Loftis, C. Willard, and T. Dickey (USDA Forest Service), 1 May 2000; NCSM 32312 (RC-NCWRC 110400), 1, 186.8 mm SL, 3 yrs., Hiwassee Lake, Beech Creek arm, in mouth near river mile 90, 6.1 air miles W center Murphy, 35.08000,

Table 1. Morphometrics for *Moxostoma ugidatli*.

	n	Average	SD	Min	Max
Standard length (SL, mm)	231	299.9		43.5	500.0
%HL					
Snout length	115	49.3	2.9	39.1	54.5
Postorbital length	115	36.1	1.7	32.0	40.2
Orbit length	115	20.0	3.7	15.3	32.1
Interorbital width	115	41.7	3.2	32.6	46.6
Lip width	110	30.6	3.0	22.2	37.8
Lip length	110	20.3	3.8	10.5	28.7
Upper lip width	110	6.2	1.6	1.3	10.1
%SL					
Head length (HL)	115	22.7	1.1	20.5	25.6
Caudal-peduncle length	113	14.3	1.0	12.3	17.5
Caudal-peduncle depth	113	10.8	0.6	9.4	12.2
Body depth	150	26.8	1.7	22.2	30.6
Head depth	115	17.9	0.6	16.3	19.3
Body width	115	16.0	1.0	14.1	18.6
Head width	152	14.3	0.5	13.0	16.0
Dorsal-fin height	117	30.4	3.9	22.8	40.3
6th dorsal-ray length	114	13.2	1.7	10.2	17.2
Dorsal-fin-base length	115	18.8	1.2	15.5	21.9
Last dorsal-ray length	114	8.5	1.5	6.3	22.8
Upper caudal length	98	31.2	2.4	25.6	36.7
Lower caudal length	98	27.2	2.5	20.9	33.1
Pectoral-fin length	118	20.3	1.7	16.5	25.5
Pelvic-fin length	118	16.8	1.2	14.8	20.6
Anal-fin length	118	22.6	2.0	18.2	27.0
Pharyngeal arch length (PAL)	49	8.4	0.5	7.3	9.9
%PAL					
Pharyngeal arch width	49	22.7	1.8	17.7	26.5
Pharyngeal base width	49	15.0	1.4	11.4	18.4
Pharyngeal base length	49	35.5	2.0	30.3	40.7
Pharyngeal tooth row length	49	71.5	2.7	64.9	77.9
Greatest tooth height	49	21.2	2.4	15.8	27.3
Greatest tooth crown length	49	10.4	1.7	7.4	16.5
Greatest tooth crown width	49	21.2	2.4	15.8	27.3
Greatest tooth base	49	7.0	1.3	4.7	11.3

Table 2. Meristics for *Moxostoma ugidatli*.

Count	*n*	Mode	Range
Post-Weberian vertebrae	12	39	39–41
Lateral line scales	129	45	43–48
Circumbody scales	124	32	30–37
Scales above LL	124	13	12–15
Scales below LL	124	17	15–20
Caudal peduncle scales	126	12	11–16
Pectoral rays	131	17	15–19
Pelvic rays	131	9	8–10
Dorsal rays	132	13	12–14
Caudal rays	111	18	18
Anal rays	111	7	7
Gill rakers	94	31	23–37

−84.09800, D. L. Yow, S. Loftis, C. Willard, and T. Eller (USDA Forest Service), 11 April 2000; NCSM 44982 (NCSU 310306), 2, 366.1–377.7 mm SL, 6–8 yrs., Valley River, river mile 0.0–0.4, Murphy, 35.09110, −84.03540, R. E. Jenkins, T. J. Kwak, S. D. Favrot et al., 31 March 2006; UMMZ 241054 (RC-TVA 021002-A), 7 (2 sk), 199.6–325.7 mm SL, 2–6+ yrs., Hiwassee Lake, river mile 77 in forebay (lower reservoir) and 85 in transition zone (upper reservoir), between 35.16610 and 35.10760, between –84.17810 and –84.14740, Tennessee Valley Authority, 2 October 2002; UT 45.1756 (UT 45.1756), 1, 60.9 mm SL, 1+ yrs., Valley River, river mile 17.7, just below Andrews at Quality Discount Furniture store, 35.1971, −83.8494, Wales et al., Tennessee Valley Authority, 27 May 1999; VIMS 48132 (REJ 1484), 1, 397.5 mm SL, 11 yrs., Hiwassee River, at Murphy (lower of 2 bridges at NC ramp), river mile 96.3–96.4, 35.08490, −84.03670, R. E. Jenkins, B. J. Freeman, and D. M. Walters, 14 April 1996; VIMS 48138 (REJ 1919), 1, 366 mm SL, 9 yrs., Valley River, river mile 0.6–1.2, Murphy, Konahete Park, 35.09190, −84.02570, R. E. Jenkins, J. Winesett, D. C. Matthews, and W. J. Stephens, 12 June 2002; VIMS 48141 (RC-TVA 031096), 2, 283.7–311.4 mm SL, 3–4+ yrs., Hiwassee Lake, river mile 77, forebay (lower reservoir), 35.16610, −84.17810, Tennessee Valley Authority, 3 October 1996.

North Carolina, Clay Co.: AUM 86439 (2), VIMS 48131 (1), (REJ 1380), 3, 380.4–400.8 mm SL, 11–14 yrs., Brasstown Creek at Route 1111 bridge, 0.4 air miles S Warne, 34.98810, −83.89470, R. E. Jenkins, J. S. Boyce, B. J. Freeman, M. Flood, and L. M. Hart, 17 May 1994; NCSM 114517 (RC-TVA 070493), 1, 410.5 mm SL, 15 yrs., Brasstown Creek, river mile 1.0, 35.03900, −83.95960, Tennessee Valley Authority, 7 April 1993.

Non-types (cataloged).—All from Little Tennessee–Tennessee River basin. North Carolina: Macon Co.: AUM 86396 (REJ 1404A), 2 (sk), 389.0–414.5 mm SL, 12–13+ yrs., Little Tennessee River, river mile 110.3–110.5, at Route 28 bridge at Iotla and lower 50 m of Iotla Creek, 34.23480, −83.39490, R. E. Jenkins and B. J. Freeman, 24 September 1994; AUM 86397 (REJ 1404B), 1 (sk), 416.5 mm SL, 11+ yrs., Iotla Creek, ~40 m upstream from mouth, at Route 28 bridge, at Iotla, 35.23440, −83.39620, R. E. Jenkins and B. J. Freeman, 24 September 1994; AUM 86437 (2), VIMS 48133 (2), (REJ 1519), 4, 403.7–444.6 mm SL, 17 yrs., Little Tennessee River, river mile 110.3–110.5, at route 28 bridge in Iotla, 34.23480, −83.39490, B. J. Freeman, D. M. Walters, and R. E. Jenkins, 24 March 1997; AUM 86499 (REJ 1354), 1, 119.4 mm SL, 1+ yrs., Little Tennessee River at mouth of Tellico Creek along route 1364, 0.6 air miles NNE Stiles, river mile 99.3, 35.28870, −83.491600, F. C. Rohde, M. L. Mosen, UNC Wilmington Class, and R. E. Jenkins, 25 September 1993; AUM 86504 (2), NCSM 23744, (REJ 1933), 14 (2 nm), 396.8–500.0 mm SL, 6–22 yrs., Little Tennessee River, just below Porters Bend Dam, down to first bend below mouth of Watauga Creek, river mile 112.8–113.1, ca. 4.4 kilometers N center Franklin, 35.22080, −83.37220, R. E. Jenkins, S. J. Fraley, E. M. Scott, C. M. Storey, and B. A. Porter, 18 April 2003; GMNH 2465, 2, 396.0–406.5 mm SL, 13–16 yrs., Little Tennessee River, river mile 110.3–110.5, Route 28 bridge in Iotla, 34.23480, −83.39490, R. O. Hall and UGA Ichthyology Class, 9 May 1993; GMNH 2822, 2, 360.0–412.0 mm SL, 8–12 yrs., Little Tennessee River, river mile 110.3–110.5, Route 28 bridge in Iotla, 35.23370, −83.39390, B. J. Freeman, L. M. Hartle, T. E. Jones, and R. O. Hall, 13 May 1993; GMNH 2934, 1, 404 mm SL, 11 yrs., Burningtown Creek, tributary of Little Tennessee River, Burningtown Road bridge, 35.28580, −83.42680, D. Jones and G. Helfman, 14 September 1995; NCSM 114511 (REJ 1425), 3, 393.0–406.0 mm SL, 9–13+ yrs., Little Tennessee River, across from McLarney House, river mile 104.6–104.9, 3.4 air miles NW Iotla, ca. 1.0 river mile above McCoy (county route 1456) bridge, Coggins Bend, 35.26010, −83.44580, R. E. Jenkins, B. J. Freeman, and C. Saylor, 18 October 1994; NCSM 23743 (REJ 1933), 1, 374.0 mm SL, 5 yrs., Little Tennessee River, just below Porters Bend Dam, down to first bend below mouth of Watauga Creek, river mile 112.8–113.1, ca. 4.4 kilometers N center Franklin, 35.22080, −83.37220, R. E. Jenkins, S. J. Fraley, E. M. Scott, C. M. Storey, and B. A. Porter, 18 April 2003; NCSM 28576 (REJ 1828), 1, 401.5 mm SL, 7+ yrs., Little Tennessee River at Coggins Bend off NC 28, 6.0 air miles NNW Franklin, river mile 104.3, Coggins Bend, 35.26680, −83.44150, W. C. Starnes, T. L. Fullbright, M. E. Raley, J. D. Fitzpatrick, R. E. Jenkins, and W. McClarney, 8 August 2000; NCSM 35918 (1), VIMS 48140 (1), (REJ 1938), 2, 387.5–394.9 mm SL, 8–11 yrs., Little Tennessee River, river mile 112.8–113.1, within 0.5 river km below Porters Bend Dam, north outskirts of Franklin, 35.2214, −83.373, R. E. Jenkins, D. C. Matthews, M. E. Raley, A. D. Gluth, and S. J. Fraley, 5 May 2003; UAIC 11643.01, 5, 357.0–422.3 mm SL, 7–12 yrs., Little Tennessee River just upstream of NC Hwy 28 at Iotla, 35.23580, −83.39610, B. R. Kuhajda and D. Neeley, 19 April 1997; UF 26420, 1, 116.3 mm SL, 2+ yrs., Little Tennessee River, river mile 100.4, at Lost Bridge, 1.8 mi from Swain County line just off State Route 28, 35.28710, −83.47700, C. Gilbert, D. A. Etnier, N. M. Burkhead, M. Ryan, J. Beets, and D. Nieland, 8 July 1977; UT 45.259 (UT 45.259), 1, 141.0 mm SL, 2+ yrs., Little Tennessee River, river mile 100.4, at Lost Bridge, 1.8 mi from Swain County line just off State Route 28, 35.28710, −83.47700, C. Gilbert, D. A. Etnier, N. M. Burkhead, M. Ryan, J. Beets, and D. Nieland, 8 July 1977.

North Carolina, Swain Co.: AUM 86435 (1), VIMS 48143, (RC-TVA 200795), 2, 298.5–425.0 mm SL, 5–13+ yrs., Tuckasegee River, river mile 15.0, just above Route 19, 35.4278, −83.4119, R. Pickett, Tennessee Valley Authority, 20 July 1995; AUM 86438 (RC-TVA 171193), 1, 257.0 mm SL, 3+ yrs., Fontana Lake, Tuckasegee River arm, Tuckasegee River mile 3.0, vicinity of mouth of Forney Creek Cove, 35.43960, −83.56410, Tennessee Valley Authority, 17 November 1993; AUM 86441 (RC-TVA 020693), 1, 383.0 mm SL, 7+ yrs., Little Tennessee River, river mile 94.3, at Needmore, 35.32830, −83.51890, C. A. Saylor and E. Scott, 2 June 1993; AUM 86507 (RC-TVA 071077), 1, 82.9 mm SL, 1+ yrs., Tuckasegee River, river mile 16.2, Ferguson Landing Field (was formerly located west of Governor's Island), 35.43900, −83.39900, J. C. Freeman et al., Tennessee Valley Authority, 7 October 1977; GMNH 3426 (GMNH 3426), 1, 303.9 mm SL, 3+ yrs., Little Tennessee River at river mile 94.3, Needmore, 35.32540, −83.52370, 27 June 2000; NCSM 114514 (RC-TVA 200694), 1, 253.0 mm SL, 4+ yrs., Little Tennessee River, river mile 94.3, at Needmore, 35.3283, −83.5189, E. M. Scott et al., 20 June 1994; NCSM 23742 (RC-TVA 291106), 1, 431.0 mm SL, 8+ yrs., Fontana Lake, Tuckasegee River arm, river mile 3.3, vicinity of the mouth of Forney Creek, ca. 6.6 air miles WNW center Bryson City, 35.44080, −83.56470, D. C. Matthews, Tennessee Valley Authority, 29 November 2006; NCSM 23866 (RC-NCWRC 181006), 1, 197.2 mm SL, 2+ yrs., Fontana Lake, Little Tennessee River arm, river mile 85.8, S. shore, 0.8 river miles above junction of mouth with the Nantahala River arm, ca. 6.8 air miles WSW center Bryson City, 35.38000, −85.55120, North Carolina Wildlife Resources Commission, 18 October 2006; NCSM 23867 (RC-NCWRC 191006), 3, 217.3–232.8 mm SL, 2+ yrs., Fontana Lake, Little Tennessee arm, E. shore at divider point of cove off of river mile 81.6, ca. 6.3 air miles WSW Bryson City, 35.40930, −83.55600, North Carolina Wildlife Resources Commission, 19 October 2006; NCSM 23868 (REJ 1947D), 1, 244.6 mm SL, 3+ yrs., Fontana Lake, upper Forney Creek arm, 70–80% of the length of the arm above mouth, ca. 6.7 air miles WNW Bryson City, 35.45550, −83.56240, R. E. Jenkins, S. J. Fraley, J. W. Mays, and D. L. Yow, 13 August 2003; NCSM 23869 (REJ 1947G), 1, 245.3 mm SL, 3+ yrs., Fontana Lake, Fork Cove off Tuckasegee River arm at river mile ca. 1.7, a double cove, second cove W. of Forney Creek, ca 7.2 air miles WNW center Bryson City, 35.44640, −85.57340, R. E. Jenkins, S. J. Fraley, J. W. Mays, and D. L. Yow, 14 August 2003; NCSM 32308 (RC-TVA 130700), 1, 357.7 mm SL, 8+ yrs., Tuckasegee River, river mile 15.0, just above Route 19, Bryson City, 35.4278, −83.4119, D. C. Matthews, Tennessee Valley Authority, 13 July 2000; UF 26387, 1, 135.5 mm SL, 2+ yrs., Little Tennessee River just off of County Route 1113, 6.0 mi above Swain Macon Co. line, 35.3412, −83.5290, C. Gilbert, D. A. Etnier, N. M. Burkhead, M. Ryan, J. Beets, and D. Nieland, 8 July 1977; UMMZ 233241, 1, 45.2 mm SL, 0 yrs., Forney Creek, at pre-impoundment mouth into Tuckasegee River, at village of Forney, near Bushnell, 35.4421, −83.5636, C. L. Hubbs and family, 8 September 1937; UT 45.258, 136.5 mm SL, 2+ yrs., Little Tennessee River just off of Co. Route 1113, 6.0 mi above Swain Macon Co. line, 35.3412, −83.5290, C. Gilbert, D. A. Etnier, N. M. Burkhead, M. Ryan, J. Beets, and D. Nieland, 8 July 1977; UT 45.262, 3, 122.8–178.0 mm SL, 1–2+ yrs., Little Tennessee River at end of Co. Route 1125 off Route 28, 6.2 air miles SW of center of Bryson City, 35.35540, −83.50670, J. P. Beets, N. M. Burkhead, S. DeKozlowski, and D. A. Etnier, 1 October 1977; UT 45.404, 1, 220.0 mm SL, 3+ yrs., Forney Creek at confluence with Fontana Lake and upstream, Great Smoky Mountains National Park, 35.46840, −83.56220, United States Fish and Wildlife Service, 6 August 1980; UT 45.66, 1, 135.0 mm SL, 2+ yrs., Fontana Lake above Almond Boat Dock, Little Tennessee River arm or lower Nantahala River arm, 35.37680, −83.56400, Tennessee Valley Authority, 13 September 1962.

Non-types (uncataloged, likely destroyed).—Hiwassee–Tennessee River basin, North Carolina, Cherokee Co.: ASULAS 1462 (NCSU M-010607), 1, 372.1 mm SL, 10 yrs., ASULAS 1463 (NCSU M-040607), 1, 363.4 mm SL, 11 yrs., ASULAS 1463 (NCSU M-040607), 1, 363.4 mm SL, 11 yrs., ASULAS 1464 (NCSU M-080607), 1, 371.6 mm SL, 11 yrs., ASULAS 1459 (NCSU M-120407), 1, 377.5 mm SL, 7 yrs., ASULAS 1460 (NCSU M-170507), 1, 382.4 mm SL, 11 yrs., ASULAS 1461 (NCSU M-240507), 1, 348.7 mm SL, 9 yrs., Valley River, river mile 14, fish impinged on upstream side of weir, 35.18130, −83.89620, S. D. Favrot et al., 1–8 June and 17 and 24 May 2007; (RC-UNCC 81-921), 1, 77.0 mm SL, 1+ yrs., Hanging Dog Creek, 1.0 air miles above Hiwassee Lake, 35.11830, −84.06630, 21 July 1981.

Hiwassee–Tennessee River basin, North Carolina, Clay Co.: ASULAS 1458 (NCSU M-080407), 1, 360.9 mm SL, 8+ yrs., Brasstown Creek, river mile 6.5, near Beach Creek

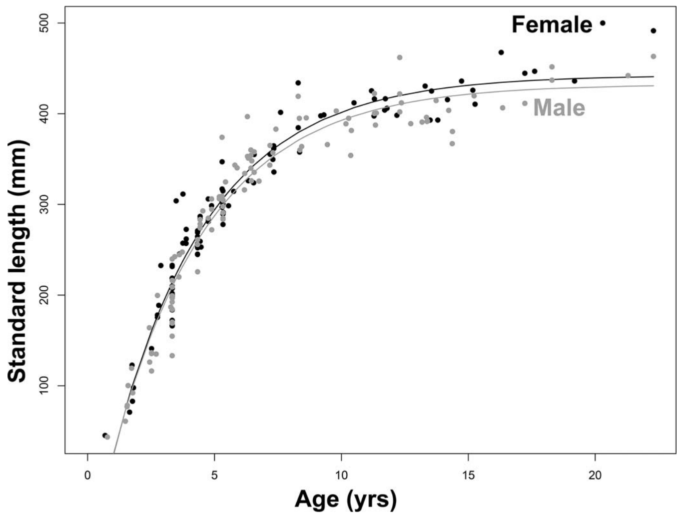

Fig. 7. Age/growth curve for males (gray) and females (black) of *Moxostoma ugidatli*.

mouth, fish dead in stream, 35.00200, −83.91480, S. D. Favrot et al., 8 April 2007.

Little Tennessee–Tennessee River basin, North Carolina, Macon Co.: (RC-UNCC 81-14), 1, 354.0 mm SL, 10 yrs., Little Tennessee River, river mile 110.3–110.5, Route 28 bridge, Iotla, 34.23480, −83.39490, 14 May 1981; (RC-UNCC 82-9), 1, 367.0 mm SL, 14 yrs., Little Tennessee River, river mile 110.3–110.5, Route 28 bridge Iotla, 34.23480, −83.39490, 14 May 1982; (REJ 1355-S), 1, 436.0 mm SL, 4+ yrs., Little Tennessee River, river mile 101.1, at Dean Island, 0.7–1.0 mile above county route 1455 bridge (Lost Bridge), 1.0 air miles E. Stiles, 35.27670, −83.46990, F. C. Rohde, M. L. Mosen, UNC Wilmington Class, and R. E. Jenkins, 25 September 1993.

Diagnosis.—*Moxostoma ugidatli* can be separated from all other *Moxostoma* by having a moderate to strongly falcate dorsal fin where the first 1–3 rays of the dorsal fin generally extend beyond the last dorsal-fin ray when adpressed (vs. straight to moderately curved dorsal fin with first dorsal rays not extending beyond last dorsal-fin ray when adpressed; Figs. 1, 2) and by having plicate lower lips that branch distally and exhibit deeply branched grooves and deeply transected ridges, particularly posteriorly (vs. papillose lips or plicae that do not branch; Fig. 4). In addition, *M. ugidatli* can be separated from all other *Moxostoma* by having moderately molariform teeth on the lower portion of a heavy pharyngeal arch (vs. chisel-like teeth on a light arch in most *Moxostoma* and highly molariform teeth on a heavy arch in *M. carinatum*, *M. hubbsi*, and *M. robustum*; Fig. 3). *Moxostoma ugidatli* can be further separated from *M. anisurum, M. ariommum, M. austrinum, M. cervinum, M. collapsum, M. congestum, M. duquesnei, M. erythrurum, M. hubbsi, M. lachneri, M. pappillosum, M. rupiscartes*, and the undescribed Apalachicola Redhorse, Brassy Jumprock, and Carolina Redhorse by having a red caudal fin (vs. gray to nearly black caudal fin with maybe a slight red or wine-colored tinge as in co-occurring populations of *M. duquesnei*).

Description.—Largest and heaviest specimen gravid female, 500.0 mm SL, 633.0 mm TL, 2.561 kg. Largest preserved male 463.2 mm SL (TL not measured), 2.024 kg. Oldest specimens one male and one gravid female of 22.3 years (Fig. 7).

Lateral line scales (43)44–46(48); circumbody scales (30)32–34(37); scales above lateral line (12)13–15; scales below lateral line (15)16–18(20); circumpeduncle scales (11)12–13(16); predorsal scales (14)15–17(18); breast scalation 80–100%. Post-Weberian vertebrae 39–41. Dorsal rays 12–14; caudal rays 18; pectoral rays (15)16–18(19); pelvic rays (8–8)9–9 to 10–9(10–10); anal rays 7. Lateral line complete.

Body elongate and shallow (low-backed) with small and medium juveniles higher-backed than adults. Head relatively long in young, decreases in proportion to length in small to medium juveniles, and increases in older, larger fish. Lip length and width increase proportionately with body size. Body terete to moderately compressed, often narrow; middorsal line almost ridged in some fish.

Snout tip moderately to much in advance of front of upper lip (Figs. 1, 2). Snout moderately rounded to almost pointed in young and small juveniles, becoming prominent, rounder, and bulbous in adults. Lower edge of snout often partly covering upper lip medially.

Height of first rays of dorsal fin similar in juveniles to other species but diverges rapidly after ∼100 mm SL (Fig. 8A). First rays of dorsal fin exceed last ray when fin adpressed. Caudal fin moderate or lunate in juveniles and adults; upper lobe longest, narrowest distally, often attenuate in adults (Figs. 1, 2). Paired fins in medium juveniles to adults usually with slightly concave distal margin, with rounded, often nearly pointed anterior tip almost falcate. Anal fin similar, except in adults much of distal margin straight or convex.

Lips plicate but unique among redhorses in large amount of deep branching of grooves and deep transecting of ridges of lower lip, particularly posteriorly (Fig. 4). Upper lip entirely plicate; its thickness nearly or fully uniform from side to side in young and small juveniles; with increase in fish size, upper lip becomes much thickened, medial half much more so than laterally; plicae strongly textured with small round to oval bumps. Lower lip of medium juveniles to adults often moderately indented posteromedially, with small, wide posterior extension next to indentation; plicae moderately textured with narrow, long oval bumps proximally and some small, round to wider oval bumps distally. Upper lip primary plicae 28–35, lower lip primary plicae 17–24, total plicae at posterior edge of lower lip 22–49 ($n = 60$). Posterior edge of lower lip forming moderately obtuse angle in young, 130–160°; usually very obtuse, straight-edged, or more extremely angled in medium juveniles to adults, 145–192° ($n = 52$). Lips increase in size proportional to fish length from medium in young and small juveniles to very large in adults.

Gill rakers increase in number from 23–24 in young to 30–36 in medium juveniles to adults ($n = 49$). Raker length moderate, longest raker on first arch 0.90–1.60% SL ($n = 45$).

Pharyngeal arches and lower teeth moderately stout and molariform (Figs. 3B, 8B). Tooth base and crown width moderate on lower portion of arch; tooth dimensions grade dorsally to tiny, very slender, comb-like teeth on upper arch. Total numbers of teeth per arch increase from 43–50 in small juveniles to 58–70 in adults; numbers on lower half of tooth row parallel increase of tooth number with fish size, 8–10 to 9–12 ($n = 23$). Newly replaced, round-

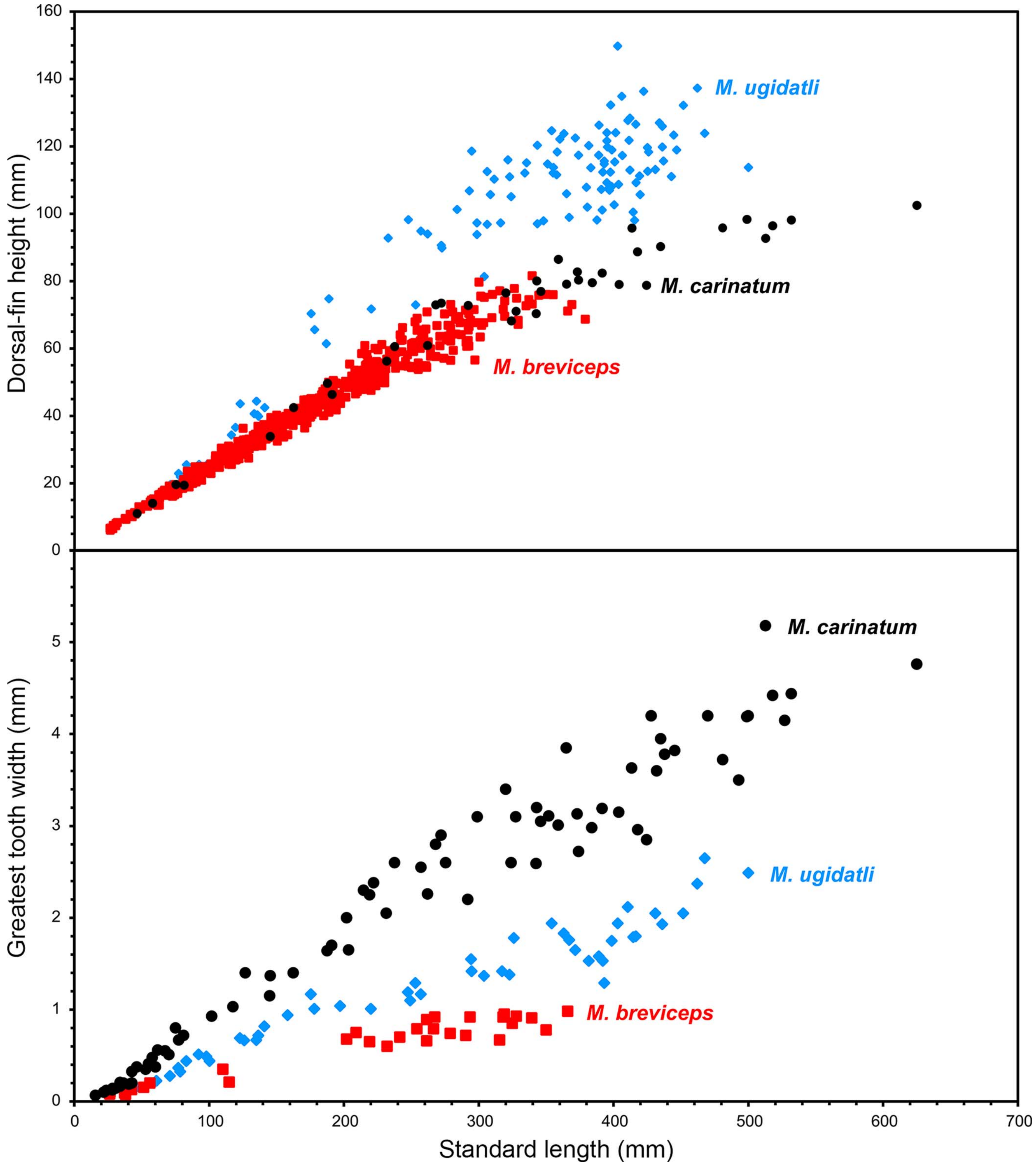

Fig. 8. (A) Dorsal fin height to standard length and (B) greatest pharyngeal tooth length to standard length of *M. breviceps* (red squares), *M. carinatum* (black dots), and *Moxostoma ugidatli* (blue diamonds).

topped crowns of lower teeth become flat to slightly concave by wear. Chewing pad hard; moderate in maximum longitudinal width, 1.23–1.45% SL, mean = 1.36, $n = 6$, and thickness, 0.51–0.71% SL, mean = 0.62.

Gut moderately long, 243–321% SL ($n = 4$); moderately coiled anteriorly and looped, 8–12 sections of coils cross first descending portion of gut ($n = 8$). Abdominal cavity length 46–50% SL ($n = 7$). Gas bladder with three chambers; large, total length 38–44% SL, $n = 7$ (excluding rarely present, tiny posterior nipple).

Tuberculation.—*Males*. Nuptial tuberculation prominent on anal and caudal fins, only slight roughening at most on all other parts. Fins with tubercles only on rays, with largest tubercles on anal fin. Anal fin tubercles, medium to large; largest tubercles submarginally on rays three to six, usually on ray five. Tubercles occur from near fin base in single column into submarginal area, and in some fish adjacent to edge of fin; apart from single column, rays three to four typically with cluster of small tubercles submarginally, and often small or medium tubercle adjacent to column. Tubercles usually straight but some slightly curved dorsally or posterodorsally.

Caudal fin next most tuberculate, largest tubercles medium size, on rays 16–17 (ray 18 being ventralmost); tubercle size and numbers diminish dorsally, upper rays having small to tiny, relatively sparse tubercles; small to medium tubercles mostly straight, some curved posterodorsally or ventrally.

Other fins very weakly tuberculate with tubercles only clearly discernible by magnification. Pectoral fin with minute sparse tubercles dorsally on rays one to 13 or fewer anterior rays, on distal half or more of ray length; ventrally about same or less tuberculate. Pelvic fin similarly weakly tuberculate. Dorsal fin usually lacks tubercles; one specimen with sparse minute tubercles on first unbranched ray and basal half of rays one to four.

Skin occasionally moderately thickened on caudal peduncle, along anal-fin base, and on belly; thickening best developed on caudal peduncle ventrally; or in some fish, thickening entirely slight and only on lower half of caudal peduncle and along anal-fin base. Thickenings firm, possibly cornified.

Head and body tubercles minute, except several small tubercles on lower third of caudal peduncle in area of one to five scales anterior to tail. Tubercles present on all areas of head except eye and lips, closely spaced dorsally, sparsest ventrally. Body with most or all scales tuberculate, more so dorsally; tubercles marginal to submarginal on most scales, except on nape they occur in all scale fields.

Females. Description from three specimens taken 7–19 April. Anal fin of one fish with all rays having a column of small, unhardened, round–tipped skin corrugations; another fish with corrugations on rays two to five; other with tiny tubercles on rays one to four; corrugation and tubercle column much less than length of rays. Caudal fin of one fish only with small corrugation basally on lower two rays. Tubercles absent elsewhere, except minute ones concentrated on head dorsum. Skin thickened on urosome ventrally to dorsally, and on belly and lower side posteriorly, to near head.

Coloration in life.—*Adults* (Fig. 1).: Head dorsum olive or olive-brown; opercular and suborbital areas dusky pale yellow-olive; lower cheek off-white to silvery; lower edge of snout, lips, gular area, and isthmus white, occasionally with very pale pink tint. Iris mostly dusky olive dorsally, most of remainder silvery, brassy, or coppery; narrow inner ring pale gold.

Body olive or olive-brown dorsally to pale olive or silvery ventrolaterally, mostly overlaid depending on lighting with iridescent coppery dominating dorsolaterally, brassy laterally, and silvery ventrolaterally; some fish mostly iridescent yellow-green laterally, some with vague purple tint laterally. Crescentic or subtriangular scale pockets grade from black or dark olive dorsally, medium olive midlaterally, to pale olive or pale yellow-olive ventrolaterally. Starting adjacent to scale pockets, individual dorsolateral scales typically grade dominantly coppery on most of scale to brassy posteriorly; lateral scales grade brassy to silvery; and ventrolateral scales grade pale brassy to mostly silvery. Breast and belly white or opalescent, some fish with pale yellow tint; caudal peduncle ventrally and along anal-fin base very slightly yellow or pearly.

Caudal fin with much to little medium red, dark red, or brown-red in membranes, brightest distally, red suffused over rays; red usually reduced in larger fish; red developed along entire distal margin and submargin, red usually suffused to fin base dorsally and ventrally. Rays basally dark olive, grading distally to yellow-olive, and often red-suffused.

Dorsal-fin membranes usually slightly reddened or dusky orange distally, or essentially all olive distally; pale to dark olive basally. Rays pale olive or slightly yellow- or red-tinged distally, grading basally to dusky olive.

Pectoral-fin membranes distally and posteriorly with whitish, or olive-yellow, or yellow-orange, or red tinge in narrow to moderately wide, submarginal to edge area, or relatively pale area restricted to anterior tip; mostly dusky to dark olive with yellow-orange tinge. Anterior rays grade clear pale olive distally to dusky yellow-olive basally; posterior rays grade dull white distally to very pale yellow basally. Pelvic fin like pectoral fin, except pale distal to posterior area usually wider.

Anal-fin membranes mostly gray or olive, with pale orange or pale red in some distal areas, some membranes dark red in some fish. Rays dull white distally, often tinted light olive or pale yellow-olive, to pale olive basally, or rays all dark except submarginally to tip; preprincipal ray dusky olive.

Nuptial males and females develop slightly to moderately dusky midlateral stripe about three to four scale rows wide from head to tail base; dorsolateral zone slightly to moderately paler than dorsum. Stripes ranked 0.5–2.0 on 0–3 scale, 3.0 being distinctly blackened; 2.0-stripe seen only on male; a female being courted had 2.0-stripe. Fish with 1.5- to 2.0-stripe had dusky stripe continued anteriorly through head, around snout. Some courting or spawning fish lacked lateral stripe. Nuptial tubercles on anal and caudal fins off-white.

Age-1 Juveniles. Head dark olive dorsally, opercle mixed dusky and silvery, cheek silvery and dark mottled; iris silvery; venter including lips white. Body with paler parts of scales olive or silvery olive dorsally; silvery and, in one fish, slight brassy iridescence midlaterally; silvery ventrolaterally; white ventrally; scale pockets black dorsally, grading dorsolaterally blackish olive to very pale olive ventrolaterally.

Fins dominantly red, in wider area than in adults. Caudal brightest red of fins, dominantly on rays; red suffuse in membranes; red brightest submarginally and well developed along length of most rays, gradually paling basally, but prominent to base of upper and lower two rays; red obscured in blackened distal margin.

Dorsal fin bright pinkish red most of height, pronounced in rays, suffuse in membranes, shading to pale olive in basal one-fourth to one-third; first ray slight red suffusion to base; red obscured by wide black distal margin. Pectoral fin anterodistally bright orange-red, grading to white in posterior rays, and to yellow olive anterobasally. Pelvic fin similar to pectoral, slightly paler orange-red. Anal fin palest of fins, pale orange-red or yellow-orange anterodistally.

Age-0 Specimens (Fig. 5). Back silvery olive, side silvery. Caudal fin red along entire upper and lower three rays and along entire distal margin; lobes dusky-tipped. Dorsal fin least reddened, slight suffusion anteriorly and distally. Lower fins with narrow reddened area anteriorly, most of fin length.

Coloration in alcohol.—*Adults*. Dorsum, snout, and suborbital dark, lower cheek and opercle dusky. Body moderately to heavily dusky over cleithrum; dorsum very dark, side grading dark dorsolaterally to moderately or slightly dusky ventrolaterally; dorsal-to-ventral gradation effected partly by width and darkness of scale pockets—horizontally wide dorsally, grading narrower and melanophores less concentrated ventrad. Lateral scales with unique pattern posterior to scale pockets; pigmentation on each of most scales grades posteriorly from relatively sparse to more concentrated in median area, then less concentrated and often with narrow curved pale line, posterior to which (along edge) scale darker as effected mainly by two partly underlying scale pockets. Vague lateral horizontal stripes traversing scale-row junctures in many specimens, stripes slightly darker than paler portions of scales.

Fins moderate to very dark, except pale distal margins of lower fins. Black edges of dorsal and caudal fins distinct or masked by general fin darkening. Caudal base often with dorsal-to-ventral *Z*-line of melanophores outlining posterior edges of posteriormost scales.

Age-0, Age-1 Specimens. Differ from adults by tending overall paler on body and fins, some individuals blotched and mottled; dark dorsal- and caudal-fin margins wider and/or bolder. 4–3 lateral blotch–saddle pattern vaguely to moderately discernible on one of two age-0 and three of five age-1 fish; four patterned fish with moderate to irregular mottling between blotches and saddles, partly obscuring pattern (presence or absence of mottling inconclusive for 1 of age-1 specimens owing to state of preservation). One age-0 and one age-1 fish with much mottling on head (perhaps related to preservation right after being held alive overnight in covered black bucket). Two largest age-1 fish with uniform gradations of basic scale patterns indicating natural loss of blotches and mottling around 120 mm SL and smaller age-2 fish (116–136 mm) without blotches or mottling. Some age-1 fish with 1–2 tiny spots basally on gill rakers in middle third of arch one.

Narrow line, moderately dark to black, along anterior edge of first dorsal fin and upper edge to dorsalmost ray of caudal fin. Dorsal and caudal fins have narrow dusky or wide black distal margin.

Distribution.—Found in the Blue Ridge portions of the upper Hiwassee and Little Tennessee river systems of North Carolina and Georgia (Fig. 6). Major occupied streams include but are not limited to Brasstown Creek, the Hiwassee, Valley, and Nottely Rivers within the Hiwassee River system and the Little Tennessee, Tuckasegee, and Oconaluftee Rivers in the Little Tennessee River system.

Habitat.—*Adults*. Sicklefin Redhorse habitat occupancy varies seasonally and during spawning. Annually, nonspawning Sicklefin Redhorse occupy run and sheet habitat niches, while avoiding depositional edgewaters. In contrast, while spawning, run and pocket-water riffle habitat niches situated near depositional edgewaters are used (Favrot and Kwak, 2024). Specifically, from spring through fall, nonspawning occupied habitats exhibit swift midchannel currents, moderate depths, and coarse substrates supporting Hornleaf Riverweed (*Podostemum ceratophyllum*). Similar habitats are occupied during winter; however, a shift toward occupancy of deeper habitats does occur in winter. Coarse substrates (i.e., boulder and bedrock) hosting dense Hornleaf Riverweed coverage were the dominant foraging substrates. Annually, little affinity to cover is exhibited; however, spawning sites are frequently situated in close proximity to cover (e.g., logs and boulders). In addition, spawning sites are associated with slow currents, near-bank shallow depths, and intermediate-sized substrates (e.g., cobble) lacking Hornleaf Riverweed (Favrot and Kwak, 2024).

Juveniles. Little to no data exist pertaining to wild juvenile Sicklefin Redhorse habitat use; however, data are available from seven hatchery-reared juvenile Sicklefin Redhorse that were implanted with radio-transmitters and stocked into the Oconaluftee River (Stowe, 2012). During summer and fall, hatchery-reared juveniles occupy moderate to deep depths exhibiting slow currents and coarse substrates (e.g., boulders) lacking Hornleaf Riverweed. Hatchery-reared juveniles exhibit a strong affinity for boulder crevice cover. Habitat niches run and pool are most frequently occupied by hatchery-reared juvenile Sicklefin Redhorse (Stowe, 2012).

Ecology.—The Sicklefin Redhorse is a potamodromous species. During summer and fall, adult Sicklefin Redhorse occupy large, downstream river reaches, but avoid occupancy of lentic habitat (e.g., reservoirs). During winter, most adults exhibit downstream emigration to occupy large lotic reaches just upstream from reservoirs (e.g., Hiwassee Lake); however, some overwinter in impounded reaches (e.g., Fontana Lake). During spring (late March and April), adults conduct migrations into smaller spawning tributaries. Some adults will migrate downstream into impounded reaches to locate the mouth of an impounded spawning tributary prior to movement upstream to spawn. Tagging data has documented adult Sicklefin Redhorse returning to the same tributary to spawn during consecutive years. Females emigrate from spawning tributaries promptly following spawning, while some males will remain within a spawning tributary until migrating downstream to overwintering reaches. Following emigration from spawning tributaries, adults will exhibit extreme site fidelity by returning to previously occupied foraging reaches occupied during the previous summer (Favrot and Kwak, 2018).

Water temperature is associated with adult Sicklefin Redhorse spawning and winter migrations. Adults commence upstream spawning migrations at water temperatures 13.0–15.0°C and initiate post-spawning downstream migrations at water temperatures 18.0–19.0°C. Emigration to overwintering areas are associated with water temperatures 6.0–9.0°C. Cold water temperatures are not conducive to adult Sicklefin Redhorse spawning migrations; unseasonably cold water associated with meteorological cold fronts and hypolimnetic releases are associated with interrupted and abandoned spawning migrations (Favrot and Kwak, 2018).

Discharge is associated with adult Sicklefin Redhorse spawning migrations. Spawning tributary immigration and emigration are associated with discharge peaks. Low discharges, such as those associated with droughts, are associated with reduced spawning migration occurrence and spawning tributary occupancy time. Low discharges are also associated with decreased spawning migration distance, resulting in disproportional use of lower portions of spawning tributaries. Except during the spawning and winter seasons, adult Sicklefin Redhorse avoid lentic-like habitats (i.e., Hiwassee Lake) and impounded portions of spawning tributaries (e.g., Valley River; Favrot and Kwak, 2018).

Sicklefin Redhorse reproductive ecology is similar to that of other *Moxostoma* spp.; however, several unique divergences are also present. Courting behavior occurs in close proximity to spawning sites. Typically, a ripe female will position close to a spawning site prior to spawning, while males periodically approach and gently nudge a ripe female. Males do not conduct site preparation prior to spawning, and no agonistic behavior is exhibited by spawning males. Typically, a spawning trio (i.e., one female flanked by two males) is observed spawning; however, individuals engaged in spawning can range from a pair to supernumerary (>10). Frequently, a smaller presumed male will rapidly swim into and past a spawning troupe, ultimately terminating the spawning act. Occasionally following spawning, the larger presumed female will return to the quivering site to conduct additional postspawning digs. Following spawning and postspawning digs, males forage on unburied eggs (Favrot and Kwak, 2018).

Myxobolus naylori is a highly derived myxozoan cnidarian that was described from *Moxostoma ugidatli* (Ksepka et al., 2020). The myxospore stage infects the *stratum spongiosum* of the scales, and the species is currently considered to be host specific. *Moxostoma ugidatli* represents the intermediate host and the definitive host is unknown.

Conservation status.—The Sicklefin Redhorse was first considered a candidate for protection under the United States Endangered Species Act in 2005, due to population loss and fragmentation of remaining populations by reservoirs (USFWS, 2005). The species was removed from the candidate list in 2016 due to the existence of stable breeding populations, protection of over 40% of the species' range on state and federal conservation lands, and the ability to manage threats to the species through existing regulations and implementation of a candidate conservation agreement (USFWS, 2016). It is still protected by state law as a threatened species in North Carolina and an endangered species in Georgia. The Little Tennessee River population is considered currently stable, with annual population estimates exceeding 1,000 individuals for both the Tuckasegee and Little Tennessee Rivers during most years (Doll et al., 2023). Long-term monitoring efforts in the Hiwassee River system have focused on the Brasstown Creek population since 2016, but analyses are still ongoing (Albanese, 2020).

The Sicklefin Redhorse Conservation Committee, formed in 2016, is a partnership that works collaboratively to implement the candidate conservation agreement and conserve Sicklefin Redhorse populations through population augmentation, reintroduction into unoccupied habitats within its historic range, research, habitat protection, outreach, and population monitoring (USFWS, 2015). Current members include the Eastern Band of Cherokee Indians, the Georgia Department of Natural Resources, the North Carolina Wildlife Resources Commission, the Tennessee Valley Authority, and the U.S. Fish and Wildlife Service. Additional conservation organizations and academic institutions are actively engaged in Sicklefin Redhorse conservation and participate in annual meetings of the committee. The Warm Springs National Fish Hatchery, in Warm Springs, Georgia is currently propagating the species to support population augmentation and reintroduction efforts. Priority reintroduction sites include the Nottely River upstream of Lake Nottely and the Oconaluftee River upstream of the area currently impounded by Ela Dam (Davis et al., 2020).

Note.—Types were restricted to the Hiwassee River basin because *M. ugidatli* exhibits philopatry that could lead to the genetic differentiation between river basins that was shown by Moyer et al. (2019). We could not locate where some specimens were deposited and some are listed as destroyed; these specimens were also excluded from the type series. Live images of the holotype and paratype were available, but low resolution, and are included as Supplementary Figure 1 (includes a picture of Dr. Jenkins taken at the site; see Data Accessibility).

Etymology.—ᎤᎩᏓᏟ or ugidatli (pronounced ooh-gee-dacht'-lee) is the Cherokee word for the species and means *it wears a feather* in reference to this being the only species in the region where the dorsal fin is exposed above the water when spawning and its feather shape. Dr. Bob Jenkins had originally proposed a species name based on the falcate fin "falcatus" and used this in reports and correspondence; however, it is a *nomen nudum*. We felt it important to honor the Cherokee name as it occurs on the unceded territory of the Eastern Band of Cherokee Indians and it is right and proper to refer to the species using the name spoken by its true discoverers. Treated as a noun in apposition. Sicklefin refers to the moderately to extremely falcate shape of the dorsal fin.

DISCUSSION

Truly new species of vertebrates in terrestrial or freshwater habitats in North America are rare. Although new species are still being rapidly described, most new species are populations of already known species that are split from those species. What is remarkable about *Moxostoma ugidatli* is that not only is it a large species, but that it was only made known to science in 1992. That such a large species was discovered in a place as well sampled as the United States shows that the work of taxonomy is hardly complete.

Moxostoma ugidatli is restricted to the Blue Ridge geological province of the Great Smoky Mountains. Its distribution is similar to the southwestern portion of the distribution of the Greenfin Darter, *Nothonotus chlorobranchius*. Stokes et al. (2023) suggested that *N. chlorobranchius* became isolated in individual tributaries of the Blue Ridge by progressive erosion of the metamorphic rock of the Blue Ridge. As the rock eroded and the sedimentary Valley and Ridge province moved southeastward, the available habitat for *N. chlorobranchius* was pushed further upstream. *Moxostoma ugidatli* may have become isolated in the upper Hiwassee and Little Tennessee Rivers due to the same process as it also is not present in the Valley and Ridge province.

About 20 fish taxa are nearly or completely restricted to the Blue Ridge Geological Province of the Tennessee River drainage. Some of the Blue Ridge taxa probably are so confined by competition in western fringes of the province with sister taxa characteristic of the Ridge and Valley province (Jenkins et al., 1972; Starnes and Etnier, 1986; Jenkins and Burkhead, 1994). Some of these may prefer cool to cold water, certain water chemistries, and/or high gradients found only in the Blue Ridge (Gilbert and Seaman, 1973; Gilbert, 1980). The majority of Blue Ridge endemics are darters and minnows. *Moxostoma ugidatli* is the only described Blue Ridge endemic sucker; however, the Blue Ridge form of *Moxostoma duquesnei* may also be a separate species (REJ, pers. obs.).

The complex life history and dependence upon spatially discrete habitats for larval and juvenile rearing, adult breeding, and adult foraging/overwintering make the Sicklefin Redhorse vulnerable to a wide array of threats that impact habitat quality and connectivity between habitats. Continued efforts to conserve this species through enforcement of existing regulations and restoration of populations throughout its former range are warranted. Given the potential for migratory redhorse suckers to transport nutrients to upstream habitats (Hudson et al., 2023), the maintenance and restoration of Sicklefin Redhorse populations has important ecological implications. Further, Sicklefin Redhorse has cultural significance for the Eastern Band of the Cherokee Indians, who are actively engaged in the conservation of the species (USFWS, 2015).

DATA ACCESSIBILITY

Supplemental material is available at https://www.ichthyologyandherpetology.org/i2024049. ZooBank publication urn:lsid:zoobank.org:pub:236E3B7A-C8C1-4114-BC94-76BCE0E44954.

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