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# A new genus for the Blackfin Sucker, *Thoburnia atripinnis* (Cypriniformes: Catostomidae)

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## Abstract

*Thoburnia atripinnis* is more closely related to *Hypentelium* (hogsuckers) than it is to other *Thoburnia,* and its presence in the Barren River of Kentucky is disjunct from that of true *Thoburnia.* Its unique morphology is unlike that of the easily recognized hogsuckers, making placement of the species within *Hypentelium* untenable; thus, a new genus is described. The new genus can be separated from all other catostomids by the presence of thin, black, prominent stripes on the body, a large black mark on the anterodist al portion of the dorsal fin, presence of pads ventrally on the leading portion of the pectoral fin, lateral laminae of the dermethmoid angled anteriorly, and the base of the lateral ethmoid narrow.

**Key words:** *Hypentelium, Moxostoma,* Thoburnini, Taxonomy

## Introduction

Suckers (Catostomidae) are a largely North American family with 85 species currently considered valid. Most species are large and have a subterminal mouth with which they feed from the substrate (Harris *et al.* 2014). One of the more unusual species, due to its very distinctive color pattern and small adult size, is *Thoburnia atripinnis* (Bailey 1959) (Figs. 1–2), which is located only in the Barren River system of Kentucky and Tennessee (Fig. 3; Harris *et al.* 2014).

The genus *Thoburnia* was described for Wilbur W. Thoburn, a professor at Stanford University by Jordan and Snyder (in Jordan 1917) for the species *Catostomus rhothoecus* (Thoburn 1896, in Jordan & Evermann 1896; now recognized as *T. rhothoeca*). A second species, *T. hamiltoni*, was described by Raney and Lachner (1946). *Thoburnia rhothoeca* is known from upland portions of the Potomac and Roanoke River basins in Virginia and West Virginia and *T. hamiltoni* is from the upper Dan River (Roanoke River basin) in Virginia and North Carolina (Page & Burr 2011).

Bailey (1959) placed *Thoburnia* as a subgenus of *Moxostoma* Rafinesque 1820 based on the perceived relationship stated in Robins and Raney (1956) to the subgenus *Scartomyzon* Fowler 1913 of *Moxostoma* (*Scartomyzon* is now recognized as non-monophyletic and all species are recognized as *Moxostoma*; Clements *et al.* 2012, Harris *et al.* 2014, Bagley *et al.* 2018). Bailey further described a new species, *M.* (*Thoburnia*) *atripinne*. Bailey based his decision to place *Thoburnia* as a subgenus of *Moxostoma* in part, on the reduction of the swim bladder. *Moxostoma* have a large, three-chambered swim bladder that occupies the entire length of the body cavity while *T. atripinnis* has a two chambered swim bladder that ranges from near the entire length of the abdominal cavity to nearly the very reduced state in *T. hamiltoni* and *T. rhothoeca*. In addition, Bailey suggested that the border between the frontal and parietal is at a perpendicular to the main body axis in *Thoburnia* (Fig. 4B–C; apparently Bailey was referring to the section from the midline or cranial fontanelle to the supraoccipital crest) but angled posteriorly in *Moxostoma* (as well as *Hypentelium*). The use of this character is discussed below.

*Thoburnia* was recognized either as a genus or subgenus of *Moxostoma* after Bailey (1959) and Jenkins (1970) recognized its intermediate morphology and similarity to the Jumprocks (subgenus *Scartomyzon*). Jenkins added to the characters that separated *T. atripinnis* from *Thoburnia* sensu stricto and suggested that the states in *T. atripinnis* represented plesiomorphic conditions.

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Ferris and Whitt (1978) used allozymes and found that *Thoburnia* (as *Moxostoma rhothoecum*) was sister to *Hypentelium* Rafinesque 1818, and *Moxostoma* was paraphyletic with respect to *Thoburnia* + *Hypentelium.* Buth (1979) used allozymes of just the three species of *Thoburnia* and showed nearly every possible combination of relationships between James and Roanoke *T. rhothoeca*, *T. hamiltoni*, and *T. atripinnis* depending on the types of analysis performed. Buth suggested that there were uniquely derived alleles for *Thoburnia* and that they share a synapomorphy of diploidization of one locus (catostomids are otherwise tetraploid).

Smith (1992) used morphological characters and found *Moxostoma* to be paraphyletic with respect to *Scartomyzon, Thoburnia,* and *Hypentelium* (all then considered valid genera) with *Thoburnia* as the monophyletic sister group to *Hypentelium*. Ten characters supported the sister group relationship of *Thoburnia* and *Hypentelium* and 16 characters supported *Thoburnia* as monophyletic; however, character distribution is suspect given that the non-monophyly of *Moxostoma* with respect to *Thoburnia* and *Hypentelium* has not been found in subsequent studies. As an example of an error, Smith (1992) describes the frontoparietal fenestra as being absent in all *Thoburnia*, it is always present, although its extent is variable, in *T. atripinnis* (Bailey 1959) (Fig. 4C).

The early 2000's brought a series of molecular phylogenies on suckers with genes used including mitochondrial l2s and 16s (Harris and Mayden (2001), mitochondrial cytochrome b (cytb, Harris et al. 2002), mitochondrial ND4 and ND5 and intervening t-RNA (Doosey *et al.* 2010), cytb and the nuclear Growth Hormone 1 intron 3 (GH1, Clements *et al.* 2012), and the near complete nuclear interphotoreceptor retinoid-binding protein 2 gene (IRBP2, Chen & Mayden 2012). Although they varied in relationships, these molecular phylogenies have consistently found that *Thoburnia* is a non-monophyletic sister to *Hypentelium* and that *Scartomyzon* is part of a monophyletic *Moxostoma* that is sister to *Thoburnia* + *Hypentelium*.

Bagley *et al.* (2018) provides a total evidence hypothesis of relationships based on mitochondrial genes (cytb, ND2, and cytochrome c oxidase I), nuclear genes (IRBP2, GH1, and ribosomal protein S7 intron 1), and morphology (Smith 1992) as well as analyses of each partition. The combined analysis found a monophyletic Thoburniini Hubbs 1930 including *Thoburnia* + (*T. atripinnis* + *Hypentelium*) as sister to a monophyletic Moxostomatini Bleeker 1863 (*Moxostoma*), and this was true for the mitochondrial partition and the mitochondrial + nuclear partition. The nuclear IRBP2 suggested instead that *Thoburnia s.s.* was sister to *Hypentelium* and that *T. atripinnis, Thoburnia s.s.* + *Hypentelium*, and *Moxostoma* formed a polytomy (also see Chen & Mayden 2012). The total nuclear dataset suggested non-monophyly of *T. hamiltoni* with one specimen sister to *Hypentelium* (with *T. atripinnis* sister to this clade) and the other *T. hamiltoni* sister to *T. rhothoeca* and embedded within *Moxostoma*. *Thoburnia* was only monophyletic under the morphological partition and the four-locus partition (mitochondrial DNA plus nuclear genes). In the four-locus dataset, the monophyly of *Thoburnia* had a Bayesian posterior probability of 0.58 meaning that the monophyly is not supported, and none of the individual partitions presented showed a monophyletic *Thoburnia*.

Stout *et al.* (2016) examined 11 catostomid species in an Anchored Phylogenomic dataset that was subsequently expanded in an unpublished master's thesis (Sperstad 2018) to include 43 of 85 species of suckers. *Thoburnia* was once again non-monophyletic with *T. atripinnis* sister to *Hypentelium*. Based on the preponderance of evidence, *Thoburnia* is not monophyletic leaving three possibilities: recognizing an expanded *Hypentelium* to include *T. atripinnis*, including all *Thoburnia* in *Hypentelium*, or recognizing a new genus for *T. atripinnis*. The latter is favored as the hogsuckers of *Hypentelium* are very distinctive and a clear monophyletic group. Sinking the also distinctive *Thoburnia* s.s. and/or *T. atripinnis* into *Hypentelium* would make a genus not readily recognizable by external characteristics. Thus, a new genus is described herein for *T. atripinnis*.

## Methods

Counts and measurements are per the traditional morphometrics presented in Armbruster (2012). Measurements were made to the nearest 0.1 mm with digital calipers and can be found in supplementary table 1 (available at Armbruster 2024); the 24 specimens (12 male, 12 female) measured were presumed adults or older juveniles 71.6–131.2 mm SL. Pharyngeal teeth were counted on the left and right jaws of the single dry specimen available (AUM 86412) and included alveoli of lost teeth. Given only one skeletal specimen available, a brief search for potentially diagnostic features was made with comparison across Catostomidae (see Skeletal Specimens Examined section below). Locality information is from GBIF (2023). Color patterns for the diagnosis were based on examination of specimens at the Auburn University Museum of Natural History, personal observations, and published information (mainly Jenkins and Burkhead 1994, Boschung and Mayden 2004, Etnier and Starnes 1993, Harris et al. 2014, Page and Burr 2011). The map (Fig. 3) was created in QGIS (v. 3.30.0, QGIS.org 2023). Rivers are from the HydroRIVERS version 1.0 (Lehner & Grill 2013), and river widths are represented as interpolated lines based on Strahler Number (ORD_STRA). Lakes are from the HydroLAKES version 1 (Messager *et al.* 2016). Digital Elevation Model and Hillshade from Mapzen (https://www.mapzen.com). Country borders are from NaturalEarth (1:10m, file ne_10m_admin_countires, version 5.1.1, naturalearthdata.com). Museum acronyms are per Sabaj (2020).

**TABLE 1.** Morphometrics of *Vexillichthys* **n. gen.** *atripinnis*. N=24.

| | Average | SD | Minimum | Maximum |
|---|---|---|---|---|
| SL (mm) | 110.8 | | 71.6 | 133.7 |
| *%SL* | | | | |
| Body Depth | 18.8 | 1.8 | 16.1 | 26.1 |
| Caudal Peduncle Depth | 9.5 | 0.8 | 8.5 | 12.4 |
| Caudal Peduncle Length | 18.4 | 1.6 | 16.1 | 24.0 |
| Predorsal Length | 46.5 | 3.2 | 43.6 | 60.6 |
| Dorsal-fin Base Length | 13.5 | 1.7 | 11.7 | 19.1 |
| Anal-fin Base Length | 8.9 | 1.4 | 7.3 | 13.8 |
| Dorsal Fin Height | 16.7 | 1.7 | 14.2 | 21.1 |
| Anal Fin Height | 22.5 | 2.9 | 19.3 | 33.7 |
| Depressed Dorsal Fin Length | 23.2 | 2.9 | 20.0 | 33.4 |
| Longest Anal Ray Length | 19.2 | 2.1 | 16.6 | 27.2 |
| Head Length (HL) | 20.1 | 1.4 | 18.9 | 26.0 |
| *%HL* | | | | |
| Head Depth | 69.6 | 3.1 | 64.8 | 77.7 |
| Snout Length | 46.1 | 2.6 | 41.9 | 52.4 |
| Postorbital Head Length | 37.5 | 4.0 | 29.7 | 46.7 |
| Orbit to Angle of Preopercle Length | 43.7 | 3.5 | 40.1 | 54.4 |
| Interorbital Width | 45.6 | 3.0 | 39.6 | 52.2 |
| Orbit Length | 29.8 | 1.8 | 25.7 | 33.2 |
| Upper Jaw Length | 30.9 | 2.8 | 27.1 | 40.2 |
| Mandible Length | 19.1 | 1.8 | 15.6 | 22.4 |
| Gape Width | 32.0 | 1.9 | 27.7 | 35.9 |

## *Vexillichthys* Armbruster, new genus

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Figs 1–2

**Type species.** *Moxostoma* (*Thoburnia*) *atripinne* Bailey 1959.

**Included species.** *Moxostoma* (*Thoburnia*) *atripinne* Bailey 1959:7, Pls. 1–2; Figs.1B–D, 2C, 3A–B Salt Lick Creek, at state highway 52 bridge, Red Boiling Springs, Macon County, Tennessee, U.S.A., elevation 765 feet. Holotype: UMMZ 169506 (image examined). Paratypes: UMMZ 165370 (6). Valid as *Vexillichthys atripinnis*.

**Specimens examined.** Specimens used for morphometrics in supplementary table 1 and those for the map (Fig. 3) in supplementary table 2 available at Armbruster (2024) (AUM specimens were additionally used for morphological comparisons). Skeletal specimen examined AUM 86412.

**FIGURE 1.** Live specimens of *Vexillichthys* **n. gen.** *atripinnis*. A. young in typical coloration (90 mm SL, Salt Lick Creek at Bugtussle Road crossing, Monroe Co., KY, 36.65654°, -85.92124°) and B. nuptial specimen, probably female (147 mm SL, Long Hungry Creek, at KY 1333 crossing, Allen Co., KY, 36.67412°, -86.04397°). Specimens uncataloged. Photos by M. Thomas.

**Diagnosis**. *Vexillichthys* can be separated from all other Catostomids by the presence of well-developed, thin, black stripes on the body and a large, black mark on the anterodistal portion of the dorsal fin. Members of *Hypentelium* and *Thoburnia* may have stripes, but the stripes are faint, and the dorsal saddles are darker than the stripes (vs. the stripes darker than the saddles in *Vexillichthys*). *Hypentelium* does have dark marks in the dorsal fin, but the fin has bands or blotches instead of a single, large, black area at the anterodistal portion of the fin and the remainder of the fin hyaline. *Vexillichthys* can be further separated from *Thoburnia* by lacking a rust-colored, wide lateral stripe. *Minytrema* also has dark stripes, but these are composed of distinct spots (vs. continuous lines). Some of the species of *Moxostoma* formerly ascribed to *Scartomyzon*, also may have stripes, but they are not as intense as that of *Vexillichthys* and there is maximally some black just at the anterodistal edge of the dorsal fin (vs. a large area). *Vexillichthys* may also be unique in the development of pads on the distal ends of the anterior unbranched rays of the pectoral fin as well as the anterior portion of the first branched ray and occasionally the second branched ray (other suckers may have thickened skin in these regions, but not distinct pads; Fig. 5).

Osteologically, *Vexillichthys* can be diagnosed by two characteristics of the skull: lateral laminae of the dermethmoid angled anteriorly (Fig. 4C; vs. laterally in *Thoburnia rhothoeca*, Fig. 4B, or posteriorly as in *Hypentelium* and most *Moxostoma*, Fig. 4A); narrowest portion of lateral ethmoid when viewed ventrally much less than length of anterolateral processes (vs. approximately equal in *T. rhothoeca* and *Hypentelium*, area of base shown in Fig. 4).

**Description.** Morphometrics in table 1. Body long and low, flattened ventrally to anal fin and then rising to caudal peduncle. Dorsal surface forms gentle arc from snout to dorsal fin and then slowly lowering to caudal peduncle. Head small and roughly conical. Eye large. Mouth inferior. Upper lip plicate, about half width of lower lip; lower lip plicate proximally and with cross furrows distally; lower lip with distal split between left and right lobes.

Dorsal fin roughly triangular in juveniles and females, becoming almost rectangular in nuptial males; located approximately mid body; ii,8–10 (usually 9). Anal fin rounded, broader in nuptial males; ii,6–7 (usually 6). Caudal fin emarginate with rounded lobes, i,8,8,i. Pectoral fin short and rounded with leading unbranched rays and anterior margin of first branched ray with fleshy pad; located at ventral margin of body; ii,12,i. Pelvic fins rounded, originating below middle of dorsal fin; i,6–8 (usually 7),i.

**FIGURE 2.** Preserved nuptial male specimen of *Vexillichthys* **n. gen.** *atripinnis* in dorsal, lateral, and ventral views. AUM 12812, 71.6 mm SL. Photos by J.W. Armbruster. Scale = 1 cm.

Lateral line complete. Scales small, 46–50 in lateral line, 16–20 predorsal scale rows, 9 caudal peduncle scale rows, 16 circumpeduncular scale rows, 31–32 circumferential scales. Scales of breast and nape deeply embedded. Vertebrae 43–45. 35 right and 39 left pharyngeal teeth; ventral most teeth with *U*-shaped cusps (shallowest in middle, longest edge medial) and dorsal most teeth thin and filelike; pharyngeal arch narrow, not much wider than teeth; single tooth present on neck of arch (portion of arch ventral to widened section).

**Coloration.** Body distinctly dark above (base color tan with overlying dark markings) and white below. Head with thick, diffuse stripe from tip of snout, through eye, to dorsal margin of opercle. Body with approximately seven black stripes running entire length separated by tan to cream interspaces. Faint dorsal saddles present below stripes, first behind head, second below origin of dorsal fin (slanted anteroventrally), third behind dorsal fin (slanted posteroventrally), fourth at middle of caudal peduncle (wedge-shaped, narrowest dorsally), and fifth at base of caudal fin; second and fourth saddles darkest. Dorsal fin clear to hyaline with large, black spot anterodistally on first five to six rays with spot continuing only on extreme distal portion of remaining rays. Other fins hyaline with caudal darker; caudal also with broad, dark stripe down middle and sometimes with dark edge. Nuptial specimens darker often with a dark mark over the pectoral girdle that extends medially behind opercular opening and interradial membranes of pectoral and/or anal fins pigmented (mainly in center third of length of fin). Color in life similar, but pectoral fins and dorsal and ventral margins of caudal fin rust-colored with lighter yellow to rust coloring on pelvic and anal fins.

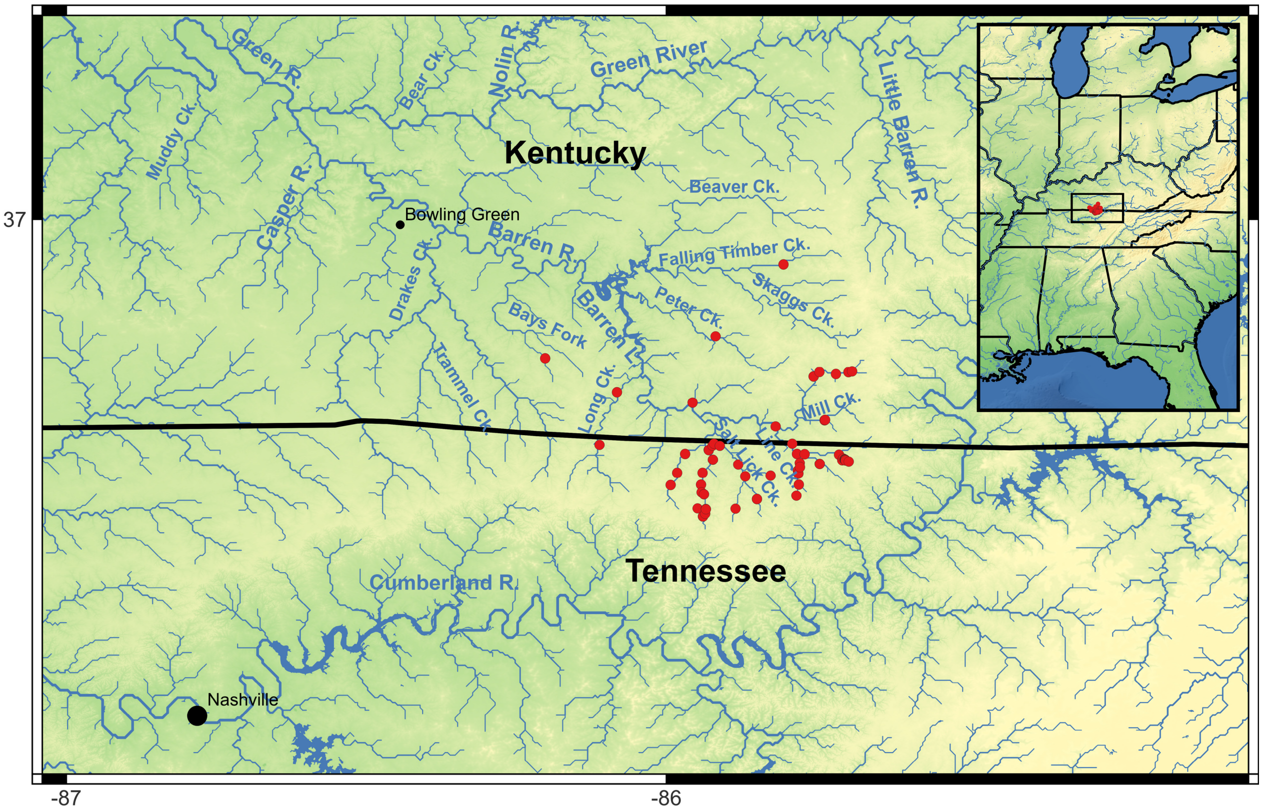

**FIGURE 3.** Distribution of *Vexillichthys* **n. gen.** *atripinnis*.

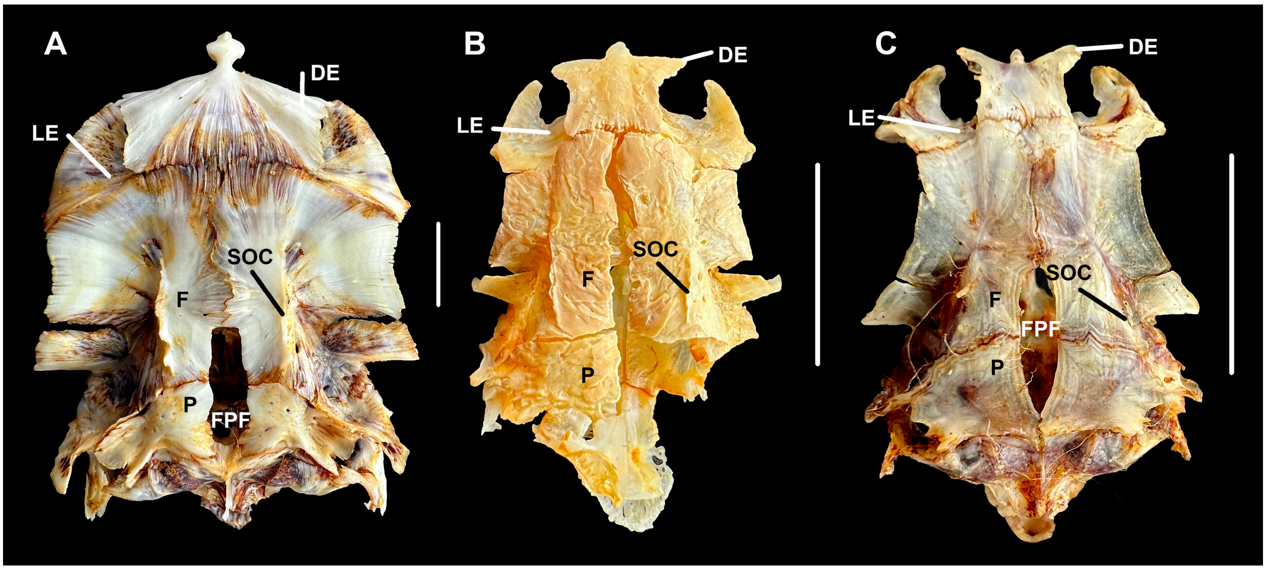

**FIGURE 4.** Dorsal view of crania of A. *Hypentelium nigricans*, AUM 86410, 259.5 mm SL, B. *Thoburnia rhothoecum*, AUM 86411, and C. *Vexillichthys* **n. gen.** *atripinnis*, AUM 86412. 109.7 mm SL. DE—dermethmoid (lines are to a lateral lamina), F—frontal, FPF—frontoparietal fenestra, LE—lateral ethmoid (lines are to the base of the bone), and SOC—supraorbital crest (lines are to a lateral lamina). Photos by J.W. Armbruster. Scale = 1 cm.

**Sexual Dimorphism.** Males much smaller than females with larger anal fin (anal fin height to SL ratio 21.4–33.7% vs. 7.9–17.2%) and a more rectangular dorsal fin with a greater depressed dorsal fin length to SL ratio 22.3–33.4% (vs. 20.0–22.3%). Tubercles found in both males and females. Tubercles in females small and present on anal fin and caudal peduncle ventral to lateral line. Nuptial males with large tubercles on the anal and caudal fins and small tubercles on much of body (particularly caudal peduncle head and throat). Males also with some small tubercles occasionally on ventral side of pectoral fin and dorsal side of pelvic fin. Body tubercles of males best developed on caudal peduncle.

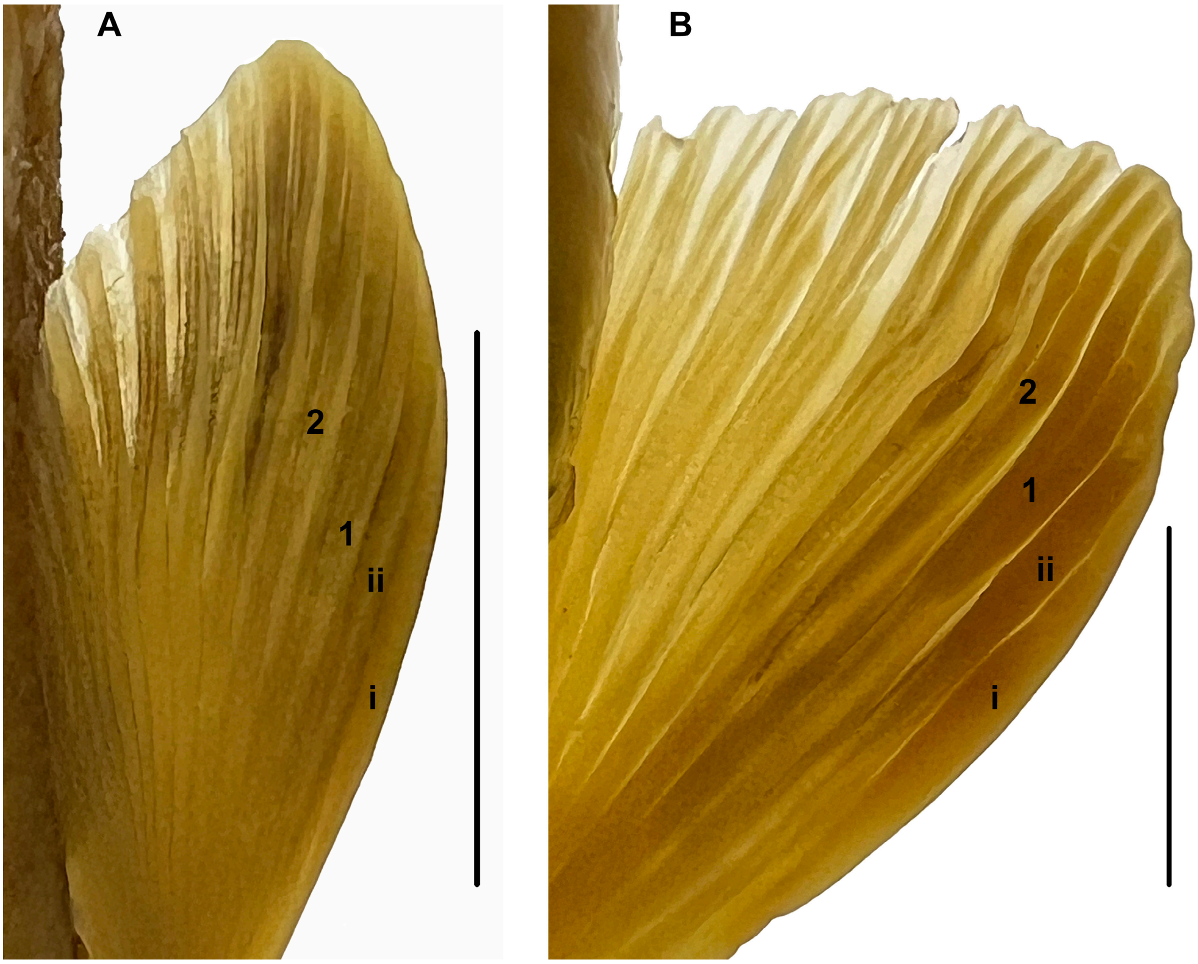

**FIGURE 5.** Ventral view of right pectoral fins of A. *Thoburnia rhothoeca*, AUM 61433, 94.7 mm SL and B. *Vexillichthys* **n. gen.** *atripinnis*, AUM 12812, 133.7 mm SL. Unbranched pectoral fin rays numbered with lowercase Roman numerals and first two branched rays numbered with Arabic numerals. The specimen in B is a large, nuptial female and pads are present on all four of the numbered rays with even some thickening on the third branched ray (numbers are approximately in the center of the pads). Photos by J.W. Armbruster. Scale = 1 cm.

**Distribution.** Found only in headwaters of the Barren River System of Kentucky and Tennessee, USA.

**Ecology.** The trematode, *Dactylogyrus atripinnei* was described from the gills of *Vexillichthys* (Timmons & Rogers 1977). Life history was described in Timmons *et al.* (1983) with *V. atripinnis* found in headwater streams (1.5–9 m wide) with alternating pools and riffles. Streams were clear with a substrate of limestone, shale, and siltstone. Young were found in pools (0.3–1m deep) often in schools over gravel. Adults were collected along the shore or in pools (1.0–1.5 m deep) and would retreat into crevices in the bedrock. Adults are associated with bedrock ledges, boulders, slab rock, and rootwads (see also Stringfield 2013; Kentucky Ecological Services Field Office 2017). They feed mostly on chironomids but also on cladocerans, copepods, ostracods, simuliids, melgalopterans, and trichopterans. Males are tuberculate in year two, but Timmons *et al.* (1983) reported a young-of-the-year male that was emitting milt in December. Bailey (1959) reported spawning males in water eight centimeters deep from 6–10 April while Timmons *et al.* (1983) reported tuberculate males in March. Males gather in riffles weeks before spawning females arrive (females were normally in pools). Egg size is 1.7–2.5 mm and fecundity ranged from 1,070 to 1,755 eggs per female. Maximum reported age is five years.

**Etymology.** From the Latin *vexillum* for flag and the Greek *ichthys* for fish. The dorsal fin has a flaglike pattern and the approximately thirteen alternating dark and light stripes are like the flag of the United States of America. Gender masculine.

## Discussion

At 155 mm SL and five years maximum age, *Vexillichthys* is one of the smallest and shortest-lived suckers (Timmons *et al.* 1983). The striking color pattern of *Vexillichthys* seems like it would make the species easily seen; however, a picture in Warren *et al.* (2000) shows that the fish blends against its background with the light belly a similar color to the substrate, and the upper body blending with features of the rocks as well as dark interspaces between the rocks.

*Vexillichthys* has the two unbranched rays of the pectoral fin as well as at least the anterior edge of the first branched pectoral-fin ray (and sometimes the posterior edge of the first and the whole second branched ray; Fig. 5B) covered in a thick pad, particularly distally. Such pads are found throughout the Ostariophysi in rheophilic fishes and are thought to aid in maintaining contact with the substrate and providing protection for the fins (Conway *et al.* 2012, Lujan & Conway 2015, Armbruster *et al.* 2021). Although the flesh of the pectoral fin may be thickened in *Hypentelium* and *Thoburnia*, distinct pads are not present (Fig. 5A). The pads are better developed in nuptial individuals.

The Barren River is part of the Green River system, which is a tributary of the Ohio River, and it contains many endemics found nowhere else. Other than *Vexillichthys*, the endemic Green River species include the Bottlebrush Crayfish (*Barbicambarus cornutus* (Faxon)), several darters (*Etheostoma barbouri* Kuehne and Small*, E. barrenense* Burr & Page*, E. bellum* Zorach*, E. kantuckeense* Ceas & Page*, E. rafinesquei* Burr & Page*,* and *E. tecumsehi* Ceas & Page), the Kentucky Cave Shrimp (*Palaemonias ganteri* Hay), a pseudoscorpion (*Tyrannochthonius hypogeus* Muchmore), and the Kentucky Creekshell (*Villosa ortmanni* (Walker)). In addition, several imperiled species are also found within the watershed making the Green River a very important place for conservation (U.S. Army Corps of Engineers, Louisville District 2012).

*Vexillichthys* is currently considered Near Threatened (NT) in the IUCN Redlist (Natureserve 2014) while Warren *et al.* (2000) and Jelks *et al.* (2008) considered it Vulnerable (VU). The main issue leading to the imperiled status of *Vexillichthys* and other Barren River endemics is the size of the distribution (Etnier & Starnes 1993). Natureserve (2014) recognizes threats in the basin including the possibilities for increased stream siltation and eutrophication from agricultural sources and stream channelization. Stringfield (2013) found the species from most historic sites as well as a few new sites. The United States Fish and Wildlife Service (2017) found that *Vexillichthys* did not warrant threatened or endangered status under the US Endangered Species Act because the species distribution and numbers were stable and that threats within the Barren River system were predicted to decline in coming years. Further, the Kentucky Ecological Services Field Office (2017) found the species to be extant or likely extant across most of its distribution (27 of 29 streams where the species had been collected), there appeared to be no change in species abundance, and that it had a moderate to high level of resilience and redundancy. The streams in which *Vexillichthys* are found have become isolated by the creation of Barren Lake in 1964 leading to the potential for genetic isolation over time (Kentucky Ecological Services Field Office 2017). Several specimens examined had lateral line anomalies consisting of either small branches off the main lateral line or small sections in scale rows above or below the lateral line, some without any clear indication of injury in the area and all asymmetrical. Although these types of defects have not been examined, other lateral line defects and fluctuating asymmetry may be due to inbreeding, water conditions, pollution, stress, and parasites in other Cypriniformes (Almeida *et al.* 2008; Young *et al.* 2018, Lutfiyah & Budi 2023). With such defects, it is important that a genetic study be initiated to determine the interconnectivity of populations and whether there is sufficient genetic variability.

## Skeletal specimens examined

*Carpiodes cyprinus* AUM 86375-1; *Carpiodes velifer* AUM 86374-2; *Carpiodes* sp. AUM 86373-4; *Catostomus commersonii* AUM 86370-1, AUM 86371-1, AUM 86372-1; *Cycleptus elongatus* AUM 86366-1; *Cycleptus meridionalis* AUM 64106-1*,* AUM 86365-1; *Erimyzon oblongus* AUM 86376-1; AUM 86377-2; *Hypentelium nigricans* AUM 86364-1, AUM 86410-1; AUM 86592-1; *Ictiobus bubalus* AUM 86361-1, AUM 86362-1; *I. cyprinellus* AUM 86363-1; *Ictiobus* sp. AUM 86431-4; *Minytrema melanops* AUM 86367-1, AUM 86368-1, AUM 86369-1; *Moxostoma anisurum* AUM 86341-1, AUM 86342-1, AUM 86343-1, AUM 86344-1, AUM 86345-1, AUM 86346-1, AUM 86347-1; *Mo. ariommum* AUM 86352-3*,* AUM 86353-1*,* AUM 86354-1*,* AUM 86591-

10; *Mo. breviceps* AUM 86339-2, AUM 86340-3; *Mo. carinatum* AUM 86330-1, AUM 86332-3, AUM 86333-4, AUM 86334-3, AUM 86335-1, AUM 86336-1, AUM 86337-1, AUM 86338-1, AUM 86428-2, AUM 86456-4, AUM 86465-2, AUM 86471-1, AUM 86593-1; *Mo. cervinum* AUM 86378-1; *Mo. collapsum* AUM 86355-3, AUM 86356-4, AUM 86357-1, AUM 86358-1, AUM 86359-1, AUM 86360-2; *Mo. congestum* AUM 86379-3; *Mo. duquesnii* AUM 86380-1, AUM 86381-2, AUM 86382-1, AUM 86383-1, AUM 86384-1, AUM 86385-1, AUM 86386-2; *Mo. erythrurum* AUM 86387-3, AUM 86388-1, AUM 86389-2, AUM 86390-2; *Mo. hubbsi* AUM 86391-1, AUM 86392-1, AUM 86393-1; *Mo. lachneri* AUM 6891-1, AUM 86403-3; *Mo. macrolepidotum* AUM 86404-1, AUM 86405-1, AUM 86407-1, AUM 86408-1; *Mo. pappillosum* AUM 86414 2, *pappillosum* AUM 86416 1, AUM 86417-1, AUM 86418-1, AUM 86419-1; *Mo. pisolabrum* AUM 86406-1; *Mo. poecilurum* AUM 86413-3, AUM 86415-2; *Mo. robustum* AUM 86420-1, AUM 86421-1, AUM 86422-1, AUM 86423-1, AUM 86424-1, AUM 86425-1; *Mo. rupiscartes* AUM 86426-1, AUM 86427-2; *Mo. valenciennesi* AUM 86429-2, AUM 86430-2; *Moxostoma* sp. Sicklefin AUM 1455-10, AUM 86329-3, AUM 86331-3, AUM 86348-2, AUM 86349-1, AUM 86350-1, AUM 86351-2, AUM 86394-2, AUM 86395-1, AUM 86396-1, AUM 86397-1, AUM 86398-2, AUM 86399-1, AUM 86400-2, AUM 86401-2, AUM 86402-1, AUM 86409-1, AUM 86550-1; *Vexillichthys atripinnis* AUM 86412-1;

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