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SHORT COMMUNICATION

OCCURRENCE OF A COLORFUL PREJUVENILE MOUNTAIN MULLET (*AGONOSTOMUS MONTICOLA*) IN BRACKISH WATER OF MONTSERRAT, LESSER ANTILLES

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KEY WORDS: Mugilidae, Caribbean, Amphidromy

INTRODUCTION

Two freshwater mullets (Mugilidae) have been recorded in the Caribbean, Bobo Mullet, *Joturus pichardi* Poey 1860 and Mountain Mullet, *Agonostomus monticola* (Bancroft 1834). McMahan et al. (2013) found 4 distinct lineages within the Mountain Mullet, roughly corresponding to ocean basins: an Eastern Mexico form, a Caribbean form, and 2 forms in the Pacific Ocean. Mountain Mullet has often been described as catadromous (e.g., Fievet et al. 2001), but its condition has been questioned (Gilbert and Kelso 1971, Loftus et al. 1984, Cruz 1987). In Puerto Rico, it has been considered amphidromous as determined by Sr:Ca ratios and passive integrated transponder (PIT) and radio-telemetry tagging (Smith and Kwak 2014). Regardless of the categorization of migratory behavior of Mountain Mullet, early larval stages through small juveniles are marine. Although the marine stages have been described, the taxonomy of these early life history stages is confusing (Anderson 1957, Ditty et al. 2006).

Mugilid juveniles are silvery, but Robins et al. (1986) found Mountain Mullet juveniles with a "Bright red stripe on side on front half of body" (their emphasis). The objective of the present work is to describe the morphology and color pattern of small prejuvenile Mountain Mullet from brackish/freshwater in Montserrat, Lesser Antilles.

MATERIALS AND METHODS

Montserrat is a small volcanic island on the northern end of the Lesser Antilles (Figure 1). The Nantes River, located on the western side of the island (Figure 1), is the first intact drainage north of pyroclastic flows and subsequent 'lahars' that buried the island's largest freshwater stream, the Belham River, during eruptions of 1995–2012 (Barclay et al. 2007). The Nantes River is 3 km long, drops about 550 m in altitude (Montserrat Tourist Board 1983), and has many boulders and large cobble in the stream bed. In 2015, this spring-fed river was very shallow (although flowing) and was no more than 1 m wide. Pools (up to 2.5 m wide, at most 1 m deep) alternated with very shallow riffles and vertical drops up to 2 m. Its mouth was a shallow pool separated from the

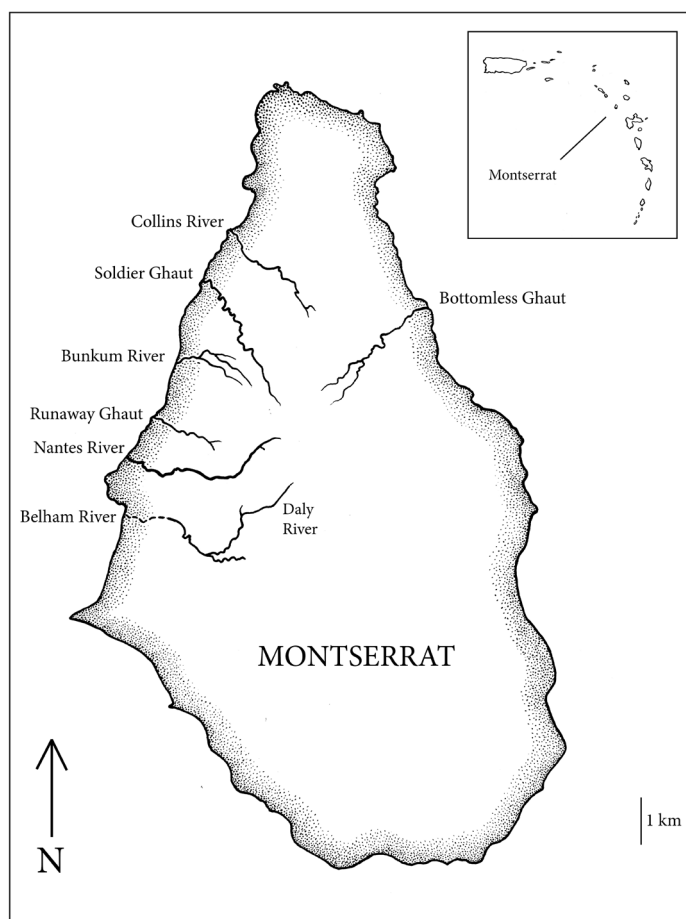


FIGURE 1. Study area showing major river drainages. The Belham River is indicated by dashed lines because it was buried by pyroclastic flows and subsequent lahars to a depth of >10 m.

Caribbean Sea by a 4 m cobble and boulder beach. Storm surges inundated its mouth at least up to the first waterfall, a 1.5 m drop about 40 m inland.

Mountain Mullet were collected on 8 January 2015 with dip nets from shallow pools at the mouth of the Nantes River and kept alive in an aquarium to be digitally photographed. Morphology and coloration of Mountain Mullet prejuveniles were taken from digital photographs of living individuals in the aquarium. Meristic and morphometric characters were

recorded by measuring each preserved specimen with a pair of dividers following Harrison et al. (2007). These current data were compared to previous morphometrics recorded for small mugilids (Anderson 1957) by physically drawing lines parallel to the axes on the published regression graphs to obtain the previous values. The right pelvic fin was removed and fixed in 95% ethanol for DNA analysis and the rest of each fish was preserved in 10% formalin. Collected specimens were transferred to 70% ethanol within three weeks and stored in the New York State Museum (NYSM 71909). Genomic DNA from one specimen was extracted to amplify the mitochondrial COI gene following Shoobs et al. (2016).

RESULTS AND DISCUSSION

The meristics and morphometrics of the 6 specimens (29–33 mm SL) from the Nantes River were consistent with prejuveniles of Mountain Mullet (Table 1; Anderson 1957, Ditty et al. 2000, 2006) and they lacked an adipose eyelid,

TABLE 1. Meristics and morphometrics of 6 prejuvenile Mountain Mullet, *Agonostomus monticola*, collected in fresh/brackish water in Montserrat in January 2015. Specimens deposited in the New York State Museum (NYSM 71909). Roman numerals indicate number of spines in a given fin. Body proportions represent the number of times a given measurement is contained in head length or standard length. Fin origin measurements are distances from the snout.

Meristic or Metric	Mean	Variation
Standard Length (mm)	31.4	29.0–33.0
Total Length (mm)	39.2	37.0–42.5
First Dorsal Spines	4.2	IV (5), V (1)
Second Dorsal Rays	8.3	8 (4), 9 (2)
Anal Fin Elements	1–10	–
Pectoral Fin Rays	13.5	13 (3), 14 (3)
Pelvic Fin Elements	1–6	1–5 (3), 1–7 (3)
Lateral Scale Rows	32.7	32–34
In Head Length:		
Eye Diameter	2.9	2.5–3.0
Snout Length	4.0	3.0–5.2
D1–D2 Distance	2.0	1.7–2.6
In Standard Length:		
Head Length	3.4	3.1–3.7
First Dorsal Origin	2.2	2.0–2.3
Second Dorsal Origin	1.5	1.4–1.5
Pelvic Fin Origin	2.3	2.1–2.4
Anal Fin Origin	1.5	1.4–1.5

showed one large anal spine, and lacked the black fin bars typical of Bobo Mullet (Greenfield and Thomerson 1997). A visually striking red band evident on these individuals (Figure 2) is a very unusual character for mugilids and has been briefly mentioned by Robins et al. (1986). The resulting COI sequence from the Montserrat mullet was identical to



FIGURE 2. Prejuvenile Mountain Mullet, *Agonostomus monticola*, collected in the Nantes River, Montserrat on 8 January 2015. Specimen deposited in the New York State Museum (NYSM 71909). Size is about 31 mm SL.

3 Mountain Mullet sequences available in Genbank (Cuba: FN545593 and FN545594, and Guadeloupe: JQ060146). Consequently, this latter finding confirms that the Montserrat specimen belongs to the Caribbean clade as defined by McMahan et al. (2013) and as expected from the geographic location of the island.

In live specimens (Figure 2), the dorsal surface of the Mountain Mullet shows a bright khaki green band, beginning above the anterior third of eye, touching the dorsal opercle, and continuing straight back to tail. A silver–white band oriented beneath the green band, beginning on the dorsal third of the eye and touching the dorsal base of the pectoral fins, continues straight back to the dorsal half of the caudal base. A dark red band is located beneath the silver–white band; it begins anterior to the eye on the snout, filling the central third (anterior) to half (posterior) of the iris, and extending back across the dorsal third of the operculum and onto the base of the pectoral fin but not onto the rays. The red band expands vertically until about as thick as eye diameter under the origin of the spiny dorsal, and then continues backward to the ventral half of the caudal base. The caudal base shows subtle bright green highlights, and the body is pale silver ventral to the red band. A dark spot is located at the base of tail, about half the depth of the peduncle.

In preservative, the specimens adopted a dark overall tone with a silvery abdomen. Melanophores are obscured by the coloration in live specimens but are evident in preserved specimens. Melanophores are more concentrated dorsolaterally and in the lateral band with a slightly higher concentration at the caudal base. Pectoral, pelvic, and anal fins are immaculate. Caudal and second dorsal rays are outlined with melanophores, more concentrated distally. The second dorsal base shows large stellate melanophores

on fin membranes, darker on the anterior. Melanophores on the first dorsal strongly outline the spines, but there are few melanophores on the membranes. A broad line of melanophores extends posteriorly on the ventral surface from the chin to about halfway past the eye. A patch of melanophores is dorsal to the mandible and melanophores cover most of the premaxillary and maxillary regions.

The color pattern shown by the Montserrat specimens differs from the brief description by Robins et al. (1986), the only published account for the species. Bright colors of the prejuvenile Mountain Mullet from Montserrat are likely transitory. Late larvae and prejuveniles in the marine environment are probably brightly colored but have gone unnoticed, partially because few larvae and prejuveniles have been collected and partially because those collected are observed after preservation. The bright colors disappear very quickly in preservative.

Bright colors tend to disappear soon after prejuveniles enter low salinity waters. Some individuals from the Nantes River showed brightly colored silvery bodies with a black lateral band, presumably having lost the dorsal and lateral pigmentation. Other collections of prejuvenile Mountain Mullet from brackish water on Montserrat (7 specimens 33–39 mm SL on 9 January 2014 from Bottomless Ghaut (NYSM 70098) and 9 specimens 24–49 mm SL on 6 January 2015 from the Collins River (NYSM 72071)) showed no color pattern other than silvery with a dark back. Like many shallow-water Caribbean marine fishes, bright colors may be advantageous to marine prejuvenile Mountain Mullet but a disadvantage once the fish move into brackish and

fresh waters.

Finally, another color pattern occurs in Mountain Mullet when the slightly larger juveniles show a dark lateral band fragmented anteriorly and a dark basicaudal spot with the bases of the median fins yellow. This pattern is common in adults and has been illustrated in most publications (Robins et al. 1986, Greenfield and Thomerson 1997, Schmidt and McMullin 2015).

Larvae and small juvenile Mountain mullet are pelagic (Debrot 2003) when collected from offshore waters (Anderson 1957). Many possible functions of bright colors are important in fishes (Price et al. 2008), most of which are not applicable to small pelagic individuals. In the Caribbean, other amphidromous fishes enter brackish and freshwaters as transparent larvae. Immigrating eleotrids display black markings and subtle yellow on a transparent body (Baldwin and Smith 2003, Maeda and Tachihara 2005). Sirajo gobies (*Sycidium* spp.) are transparent (Baldwin and Smith 2003) when harvested in river mouths and River Goby (*Awaous banana*) immigrants are transparent with some concentrations of melanophores.

Brightly colored marine stages could be characteristic in amphidromous Mugilidae since these fish have the unique prejuvenile stage and are marine at a much larger size than other amphidromous fishes. Comparisons with related species are not possible since color patterns of prejuveniles of Bobo Mullet are unknown (Cruz 1987, McLarney et al. 2010). Early stages of *Agonostomus* spp. from the western Indian Ocean have also not been described.

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