MORPHOLOGY AND A LARGE GAP IN THE DISTRIBUTION OF THE BRONZESTRIPE GRUNT (LUTJANIFORMES: HAEMULIDAE) HINTS AT A NEW SUBSPECIES IN THE GULF OF MEXICO

Arturo Acero P.[1] & José Tavera[2]

[1]*Instituto para el Estudio de las Ciencias del Mar (Cecimar), Universidad Nacional de Colombia sede Caribe, El Rodadero, Santa Marta, Colombia* aacerop@unal.edu.co. *https://orcid.org/0000-0002-6637-9901*

[2]*Departamento de Biología, Universidad del Valle, Cali, Colombia* jose.tavera@correounivalle.edu.co *https://orcid.org/0000-0003-4517-9238*

ABSTRACT: A new subspecies of the bronzestripe grunt, *Haemulon boschmae castroaguirrei sub spec*. *nov.*, is described from the southern Gulf of Mexico. The new subspecies seems to be restricted to the Gulf of Mexico, being separated for more than 2,000 km from the typical subspecies, *H. boschmae boschmae*, which is endemic to the southern Caribbean and northern south America (Panamá to French Guiana). Meristic values, scaling pattern, and some morphometric features distinguish both subspecies.

Keywords: *Haemulon boschmae castroaguirrei n. ssp*., Haemulinae, western Atlantic, geographic isolation.

RESUMEN: Se describe una nueva subespecie del ronco ruyi-ruyi, *Haemulon boschmae castroaguirrei sub spec. nov*., de la porción sur del Golfo de México. La subespecie nueva se halla aparentemente restringida al Golfo de México, estando separada de la subespecie típica, *H. boschmae boschmae* endémica del Caribe sur y el norte de Suramérica (Panamá a la Guayana Francesa), por más de dos mil kilómetros. Las dos subespecies se distinguen por caracteres merísticos, patrón de escamación y aspectos morfométricos.

Palabras clave: *Haemulon boschmae castroaguirrei n. ssp*., Haemulinae, Atlántico occidental, aislamiento geográfico.

INTRODUCTION

The genus *Haemulon* Cuvier, 1829 is the richest lineage of the New World grunts (family Haemulidae); however, no agreement exists on the number of valid species, especially due to their complex taxonomic history. The first modern review of the western Atlantic members of the genus recognized 13 species (Courtenay 1961); an additional species, endemic to northern South America, was later added (Courtenay 1965). Lindeman & Toxey (2002) recognized 14 western Atlantic species, excluding the Brazilian yellow grunt described by Rocha & Rosa (1999).

Carvalho *et al.* (2020) described the western Atlantic Latin grunt as a new species, *Haemulon atlanticus* Carvalho, Marceniuk, Oliveira & Wosiacki, 2020. The five tropical Eastern Pacific species were surveyed by McKay & Schneider (1995). A molecular phylogeny for this genus was proposed by Rocha *et al.* (2008), which recognized 19 nominal species and included the previously monotypic genus *Inermia*. A molecular phylogenetic study on the family Haemulidae

(Tavera *et al*. 2018) divided *Haemulon* into two genera by resurrecting *Brachygenys* Poey, 1868 to include species under the genera *Xenocys* and *Xenistius* and the smallmouth grunt *B. chrysargyrea* (Günther, 1859), formerly *Haemulon chrysargyrea*. On the other hand, Froese & Pauly (2022) reported 20 valid species, including the enigmatic Brazilian *H. schrankii* Agassiz, 1831. A recent study (Cerqueira *et al.* 2021) on molecular identification of species in the genera *Brachygenys* and *Haemulon* identified single lineages in *B. chrysargyreum, H. melanurum* (Linnaeus, 1758), *H. parra* (Desmarest, 1823), and *H. squamipinna* Rocha & Rosa, 1999, but more than one molecular operational taxonomic unit in *H. atlanticus, H. aurolineatum* Cuvier, 1830 and *H. plumierii* (Lacepède, 1801). All these studies concur in a lack of consensus on the real species diversity included under these lineages.

The dense scaling pattern that covers the entire portion of the second dorsal and anal fins and the bright red-orange color present in the inner portion of the mouth, have been traditionally used to identify *Haemulon*. The number of dorsal-fin spines (12 vs. 13) has been previously used to subjectively separate Atlantic *Haemulon* species into two different groups. Lindeman & Toxey (2002) recognized three species with 13 dorsal-fin spines: the tomtate *H. aurolineatum*, the striped grunt *H. striatum* (Linnaeus, 1758) , and the bronzestripe grunt *H. boschmae* (Metzelaar, 1919). The tomtate and the striped grunt are haemulids widely distributed in the tropical and subtropical western Atlantic Ocean (Courtenay 1961; Randall 1968; Cervigón 1993; Lindeman & Toxey 2002; McEachran & Fechhelm 2005; Robertson & Van Tassell 2019). The bronze striped grunt, on the other hand, was generally considered endemic to the southern Caribbean and northern South America, from Panamá to French Guiana (Courtenay 1965; Randall 1968; Uyeno *et al*. 1983; Cervigón 1993; Lindeman & Toxey 2002); however, more recently, the bronzestripe grunt has also been detected in the southern Gulf of México, separated from the southern Caribbean by more than 2,000 km (Castro-Aguirre & Márquez-Espinoza 1981; McEachran & Fechhelm 2005; Robertson & Van Tassell 2019).

How species diverge is a very active but controversial topic, especially in marine species. However, it is well known that geographic isolation plays an important role in the process (Miglietta *et al*. 2011). Vicariance is a prevalent speciation model in which biological populations become geographically isolated to an extent that prevents or interferes with gene flow (Mayr 1954). Hence, using morphological characters and geographical isolation we herewith describe the Gulf of Mexico *Haemulon boschmae* as a new subspecies of the bronzestriped grunt.

MATERIAL AND METHODS

A total of nine specimens were examined, six of them coming from the Colombian Caribbean and three from the Gulf of México. Material examined is deposited at the following collections: United States National Museum (USNM), Washington, D.C.; Colección Nacional de Peces, Instituto de Biología de la Universidad Nacional Autónoma de México (IBUNAM), Ciudad de México; and Instituto de Investigaciones Marina y Costeras (INVEMAR-P,), Santa Marta, Colombia. The descriptions and keys presented by Courtenay (1965), Uyeno *et al.* (1983), Cervigón (1993), Lindeman & Toxey (2002), McEachran & Fechhelm (2005), and Robertson & Van Tassell (2019) were used to identify and compare the material examined. Counts and

morphometrics followed those described by Courtenay (1961); measurements were taken with dial calipers recorded to the nearest 0.1 mm and presented as percentages of standard length (SL), head length (HL) and in some clearly mentioned instances snout length (SnL).

RESULTS AND DISCUSSION

Haemulon boschmae castroaguirrei new subspecies

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Figs. 1 and 2

Haemulon boschmae (Metzelaar, 1919): Castro-Aguirre & Márquez-Espinoza, 1981: six specimens (78-130 mm) from Isla Lobos (Veracruz, México), comments; McEachran & Fechhelm (2005): 370, description and comments; Robertson & Van Tassell (2019).

Holotype. CNPE-IBUNAM-9358: 101 mm SL. Continental shelf, Tamaulipas, México. 23º 41' 02'' N, 97º 39' 05'' W.

Paratypes. CNPE-IBUNAM-7291: 80 mm SL. Continental shelf, Campeche, México. 19º 35' 08'' N, 91º 59' 08´´ W. CNPE-IBUNAM-1721: 105 mm SL. Continental shelf, Yucatán, México. 21º 59' 04'' N, 91º 05' 09'' W.

Diagnosis. The southern Gulf of Mexico *Haemulon boschmae castroaguirrei* can be separated from the typical subspecies (from Panamá to French Guiana) in having 7 anal-fin soft rays, 17 pectoral-fin rays, a smaller eye (27.6-30.3% of HL), a shorter upper jaw (33.0-34.8% of HL), a shorter longest gill raker on the first gill arch (10.9-14.2% of HL), and in distribution, since its area of occurrence is considerably separated from the southern Caribbean, 3600 km following the coastline or 2100 km in a straight line across the tropical western Atlantic.

Description. *Haemulon boschmae castroaguirrei* is a small fish, the largest specimen measured is 130 mm SL. Fin ray counts and measurements for the holotype and two paratypes are given in Table 1. Dorsal rays XIII, 12 or 13; anal rays III, 7; pectoral rays 17; lateral line scales 54-55; scales above lateral line 6 or 7 rows; scales around caudal peduncle 22-24; total gill rakers on first arch 33-34. Body relatively slender. Mouth terminal and rather small, posterior margin of upper jaw barely reaching anterior border of eye. All teeth conical but none developed as prominent canines, no teeth on vomer or palatines. Opercle scaled; margin of preopercle serrate. Snout short, its length subequal to eye diameter. Scale rows below lateral line parallel to long axis of body.

Coloration in preservative. Mainly pale brown with a slight indication of a dark stripe running across middle body, and a faded but well defined, rather small, dark spot on caudal peduncle.

Coloration in life. Based on the three excellent photographs by Carlos Estape presented by Robertson & Van Tassell (2019) of specimens living in Veracruz (México) between 10 and 15 m: silvery grey, sides of body with narrow dark yellow-brown stripes along scale rows, oblique below lateral line, becoming horizontal above lateral line; an elongate blackish, sometimes faded, spot at base of caudal fin; caudal fin grey with yellow hinges.

Fig. 1. Preserved specimen (CNPE-IBUNAM-9358, holotype, 101 mm SL).

Fig. 2. Alive specimen, 10-15 m depth (General Vicente Palacio wreck, Veracruz, México; Allison Estape, carlosestape.photoshelter.com).

Table 1. Morphometric and meristic data of *Haemulon boschmae castroaguirrei* and *H. b. boschmae*, mode counts are given in parentheses.

	Haemulon boschmae castroaguirrei		***Haemulon boschmae boschmae***		
	CNPE-IBUNAM 9358 Holotype (n=1)	CNPE-IBU-NAM 7291; 1721 Paratypes (n=2)	USNM 396675 (n=1)	INVEMAR-PEC 6468 (n=1)	USNM 153917 (n=4)
Morphometrics		Range			Range
Total length (mm)	125	98-128	130.4	102.69	95.9-100.3
Standard length (mm)	101	80-105	108.2	84.74	76.7-84.6
Head length (mm)	28.8	24.1-29.4	29.9	24.98	22.2-24.6
Percentage of SL					
Body depth	30.99	27.1-31	28.74	27.59	26.5-29.6
Head length	28.51	28-30.1	27.63	29.48	27.3-31.6
Length of the upper jaw	9.41	9.6-10.5	10.72	10.66	10.7-11.7
Snout length	6.20	6.5-6.9	8.32	10.02	7.2-8.9
Eye diameter	8.22	7.7-9.1	9.15	-	9.4-10-0
Pre-anal length	65.74	63.6-67	67.28	64.67	62.9-67.8
Pectoral length	24.75	24.3-25.3	24.40	22.88	23.3-25.9
Head height	19.60	13.4-21.4	19.96	-	17.5-19.6
Inter-orbital distance	8.12	7.0-8.0	7.58	8.12	7.6-8.0
Fifth dorsal spine	16.34	14.3-14.9	-	-	15.1-15.8
Fourth dorsal spine	15.05	14.9-16.3	13.68	-	14.5-16.6
Caudal peduncle height	9.29	8.9-9.2	8.96	-	8.8-10.2
Percentage of HL					
Length of the upper jaw	32.99	34.4-34.9	38.80	36.15	36-39.2
Snout length	21.74	21.7-24.8	30.10	33.99	23.7-30.6
Eye diameter	28.82	27.6-30.3	33.11	-	29.8-36
Times snout in head	4.60	4.0-4.6	3.32	2.94	3.3-4.2

Times eye diameter in head	3.47	3.3-3.6	3.02	-	2.8-3.4
Longest gill raker	10.90	13.1-14.2	15.38	-	12.2-17.1
Fourth dorsal spine	1.89	1.90	2.02	-	1.8-2.0
Percentage of snout length					
Eye diameter	1.33	1.1-1.4	1.10	-	1.1-1.3
Length of the upper jaw	1.52	1.4-1.6	1.29	-	1.3-1.6
Meristics					
Dorsal fin elements	XIII, 12	XII+I-XIII, 13	XIII, 12	XIII, 13	XIII, 11-13 (13)
Anal fin elements	III, 7	III, 7	III, 7	III, 8	III, 7-8 (8)
Pectoral fin elements	17	17	18	18	18-19 (18)
Gill rakers on first arch	34	33-34	32	31	33-34 (34)
Rows of scales above lateral line	6	6-7	6	6	6-7 (6)
Lateral-line scales	55	50-55	51	53	50-55
Caudal-peduncle scales	-	22-24	22	-	-

Comparisons. The bronzestripe grunt, *H. boschmae*, characterized by having 13 dorsal-fin spines and more than 31 gill rakers in the first gill arch, has been considered endemic to the southern Caribbean and the northern part of South America to French Guiana (Uyeno *et al.* 1983; Cervigón 1993; Lindeman & Toxey 2002). Nevertheless, it was recorded from the Gulf of Mexico (Isla Lobos, Veracruz) by Castro-Aguirre & Márquez-Espinoza (1981); McEachran & Fechhelm (2005) and more recently Robertson & Van Tassell (2019) validated the record.

In the 80's decade, several exploratory surveys were carried out in the Gulf of Mexico and the collected material deposited in the IBUNAM collection at Mexico City. Three examined specimens of the Mexican bronzestripe grunt from that collection constitute the type series of the new taxon. The new subspecies consistently differs from the typical subspecies in anal-fin soft ray count (7 in *H. b. castroaguirrei*, 7-9, rarely 7, modally 8, in *H. b. boschmae*), pectoral-fin ray

count (17 in *H. b. castroaguirrei*, 17-19, generally 18, in *H. b. boschmae*), eye size (3.3-3.6 in HL in *H. b. castroaguirrei*, while 2.8- 3.2 in *H. b. boschmae*), upper jaw length (2.9-3.0 in HL in *H. b. castroaguirrei*, while 2.6-2.8 in *H. b. boschmae*), and length of the longest gill raker on the first gill arch (10.90-14.22%, mean 12.74%, in HL in *H. b. castroaguirrei*, 12.20-17.12%, mean 15.05%, in *H. b. boschmae*). The series of scales above the lateral line are inclined at a steep angle below the spinous and soft dorsal fins, which in *H. b. boschmae* become parallel with lateral line on caudal peduncle, while in *H. b. castroaguirrei* become parallel below the origin of the soft portion of dorsal fin. Additionally, the wide geographic gap (>2100 km) between the ranges of occurrence of both taxa may have led to genetic isolation. Considering available information on ecology and habitat preferences of the bronzestripe grunt (Cervigón 1993), and a whole body of volumes on the Caribbean fishes (Randall 1968; Human & Deloach 2014) we do not expect the species to be distributed in between the confirmed ranges.

Speciation is a continuous process that is not always straightforward and in consequence precise limits among populations are not always easily established. Yet, in this path into becoming separated species there may be stages in which isolated members may share morphological attributes but still can be distinguishable and capable of interbreeding successfully, if their range overlaps. The distinction among populations and subspecies can be subtle and subject to controversy. However, in our case the isolation herein reported among individuals (subspecies) is more than 2000 km with their ranges neither overlapping nor being immediately adjacent to each other, so having these entities named accordingly easy any management or conservation initiative that could be enforced in the future. Whether this extensive geographical gap has caused a complete genetic incompatibility among subspecies, still has to be tested.

Habitat. Nothing is known of the ecology of the new subspecies, beyond that it is a schooling grunt that occurs in the continental shelf. Allison and Carlos Estape (pers. com., 12 November 2022) reported and photographed specimens of a small group of less than ten bronzestripe grunts shoaling with a larger group of striped grunts between 10 and 15 m depth at General Vicente Palacio wreck in Veracruz; date of their sighting 20 May 2019.

Distribution. Known from the Mexican portion of the Gulf of Mexico, between the states of Tamaulipas and Yucatán. Robertson & Van Tassell (2019) extend its distribution to Quintana Roo state at the Caribbean side of the Yucatán peninsula.

Size. The largest specimen reported is 130 mm SL (Castro-Aguirre & Márquez-Espinoza 1981). Allison and Carlos Estape saw specimens between 15 and 20 cm total length (pers. com., 12 November 2022) in Veracruz.

Etymology. The subspecific epithet honors the Mexican ichthyologist José Luis Castro Aguirre, who passed away on January the 21st, 2011, and who discovered the presence of the bronzestripe grunt in the Gulf of Mexico.

Common name. We propose Mexican bronzestripe grunt for this variety of *H. boschmae*.

Additional material examined. *Haemulon boschmae boschmae* Colombia: USNM 396675 *Isaciops facis* holotype; USNM 153917; INVEMAR-PEC 6468.

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