



Halichoeres sazimai, a new species of wrasse (Perciformes: Labridae) from the Western South Atlantic

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Abstract

Halichoeres sazimai, n. sp. is described from the Western South Atlantic. During many years it was misidentified as *H. bathyphilus* from the Northwestern Atlantic, but it can be distinguished from the latter by striking color differences between the two species, with *H. sazimai* being characterized by a white body with a midline, zigzag patterned stripe on body, black and brownish in terminal males and yellow or golden in females and juveniles. Preserved specimens can also be distinguished by the visible mid-body stripe in *H. sazimai*, which disappears in *H. bathyphilus*. Diagnostic differences in the mitochondrial DNA cytochrome *b* gene separate *H. sazimai* from all other Western Atlantic labrids, with *H. bathyphilus* being its sister species. Individuals of *H. sazimai* were observed living on the deeper parts (20-40 m) of rocky reefs and sand bottoms, apparently associated with water temperatures lower than 18°C. This species is currently known from the southeastern and southern coasts of Brazil, from Espírito Santo to Santa Catarina States.

Key words: Taxonomy, Endemic Species, Brazilian Province, Rocky Reefs

Introduction

Reef fishes of the genus *Halichoeres* occur throughout tropical and subtropical reefs of the world from shallow to deep reefs (Parenti & Randall 2000). Randall and Böhlke (1965) recognized nine species occurring in the Northwestern Atlantic, five of which ranging south to Brazil: *Halichoeres bivittatus*, *H. poeyi*, *H. cyanocephalus*, *H. maculipinna*, and *H. radiatus*. More recently, the latter three species had their Southern Atlantic populations revalidated as *H. dimidiatus*, *H. penrosei* and *H. brasiliensis* respectively and considered endemics to the Brazilian Province (Rocha & Rosa 2001; Rocha 2004) with the notable exception of *H. radiatus* from Fernando de Noronha Archipelago, Atol das Rocas and St. Paul's Rocks whose population remain genetically linked with that of the Caribbean (Rocha *et al.* 2005). Additionally, two new species from the Northwestern Atlantic were described (Randall & Lobel 2003; Weaver & Rocha 2007), resulting in a total of fourteen species of *Halichoeres* in the Atlantic Ocean.

The deep-reef *Halichoeres bathyphilus* was described from Bermuda, caught in depths over 150 meters (Beebe & Tee-Van 1932) and since then it was rarely collected or observed (Smith-Vaniz *et al.* 1999). It was further recorded in the Northwestern Atlantic from North Carolina, Florida, the Gulf of Mexico, Yucatan Peninsula and off Venezuela's coast, in depths of 27 to 118 meters (Randall & Böhlke 1965; Cervigón 1993). For nearly two decades, a wrasse from the subtropical coast of Brazil (from 20°S to 27°S) has been identified as *H. bathyphilus* (Menezes & Figueiredo 1985; Moura *et al.* 1999; Carvalho-Filho 1999). Despite its morphological similarity, striking color differences noted during underwater observations and photographs

lead us to suspect that the wrasse from the rocky reefs off the Southeastern Brazilian coast was a new species of *Halichoeres*. Color patterns are usually a useful character for diagnosing reef fish species (Moura & Castro 2002), however, as Rocha *et al.* (2007) pointed out, species diagnosis based on color differences alone should be taken with caution, as they may represent within-species phenotypic variation. We therefore conducted a molecular mtDNA analysis of specimens of *H. bathyphilus* from populations in the North and South Western Atlantic, and re-analyzed their morphological characters and color patterns in order to determine the distinctiveness of the Brazilian species.

Materials and methods

Morphology. Measurements follow Randall and Böhlke (1965) and Randall and Lobel (2003) and are expressed as percent standard length (SL) (Table 1). Measurements were done with dial calipers to the nearest 0.1 mm. Counts and measurements in the description are for the holotype followed, in parentheses, by the range of paratypes when different. Ratios of proportional measurements are rounded to the nearest 0.1. Institutional abbreviations follow Leviton *et al.* (1985) and Leviton and Gibbs (1988).

Genetics. DNA extraction, polymerase chain reaction, and sequencing followed the methods described in detail by Rocha (2004). PCR products were sequenced in the forward and reverse directions, and resulting mtDNA cytochrome *b* sequences are deposited at Genbank with accession number FJ800096. Sequences were aligned and edited with Sequencer version 3.0 (Gene Codes Corp., Ann Arbor, MI). In order to estimate corrected genetic distances between *H. sazimai* and *H. bathyphilus* the computer program MODELTEST version 3.06 (Posada & Crandall 1998) was used to determine the substitution model that best fit the data through a hierarchical likelihood ratio test (HLRT). The Tamura-Nei model (Tamura & Nei 1983) with gamma distribution shape parameter of 0.17 was chosen. A molecular clock for *Halichoeres* as proposed by Barber & Bellwood (2005) was used to estimate the distance of separation between the species analyzed.

Comparative material examined. *Halichoeres bathyphilus*: Bermuda: ANSP 133442, 3; ANSP 133443, 3; Florida: UF 122049; UF 203925; UF 204525; UF 209822.

Halichoeres sazimai sp. n.

Figures 1, 2, 3; Table 1

Halichoeres bathyphilus, Menezes and Figueiredo 1985: 32, 92 fig. 32; Moura *et al.* 1999: 520; Carvalho-Filho 1999: 186, 314 fig. 164; Parenti and Randall 2000: 37; Joyeux *et al.* 2001: 832, 835; Rangel *et al.* 2007: 11.

Halichoeres sp., Moura & Sazima 2003: 482; Luiz Jr. *et al.* 2008: 9, 16 fig. 6a, 21 fig. 9e, 25.

Holotype: ZUEC 6323, male, 214 mm SL, Ilha de Cabo Frio, Arraial do Cabo, Rio de Janeiro State, South Eastern Brazil, 23°44'S, 42°00'W, interface rocky reef and sand bottom, 23 m, pole spear, 14 Jan 2002, C.E.L. Ferreira.

Paratypes: UF 172665, male, 192 mm SL, Laje de Santos, São Paulo State, South Eastern Brazil, 24°15'S, 46°10'W, interface rocky reef and sand bottom, 21 m, pole spear, 20 Feb 2004, O.J. Luiz Jr.; UF 171285, female, 155 mm SL, same locality as holotype, 30 Jan 2004, C.E.L. Ferreira; MZUSP 98973, 2, female, 150–176 mm SL, same data as holotype, C.E.L. Ferreira; ZUEC 6324, female, 171 mm SL, same locality as holotype, 06 Mar 2003, C.E.L. Ferreira.

Diagnosis. A species of *Halichoeres* as defined by Randall and Böhlke (1965) with the follow combination of characters: dorsal rays IX, 11; anal rays III, 12; pectoral rays 13; caudal rays 14; lateral line scales 27. Distinct from other Atlantic Ocean congeners by coloration as follows: body white with a distinctive stripe running on midline of the body from the snout, through the eye to tail. The stripe is straight, broadest and continuous from the snout to the shoulder, when it turns into a line of close-set spots in a zigzag

pattern on alternate scales of two adjoining rows. Terminal phase adults have the stripe entirely black or black at the first half becoming brownish, some with golden spots above and below scales, body darkened on the dorsum and the abdomen, becoming grayish or greenish in the area just above the mid-body stripe to the base of the dorsal fin. In initial phase adults the stripe is brown on the first third of its length and yellow to golden on the last two thirds.

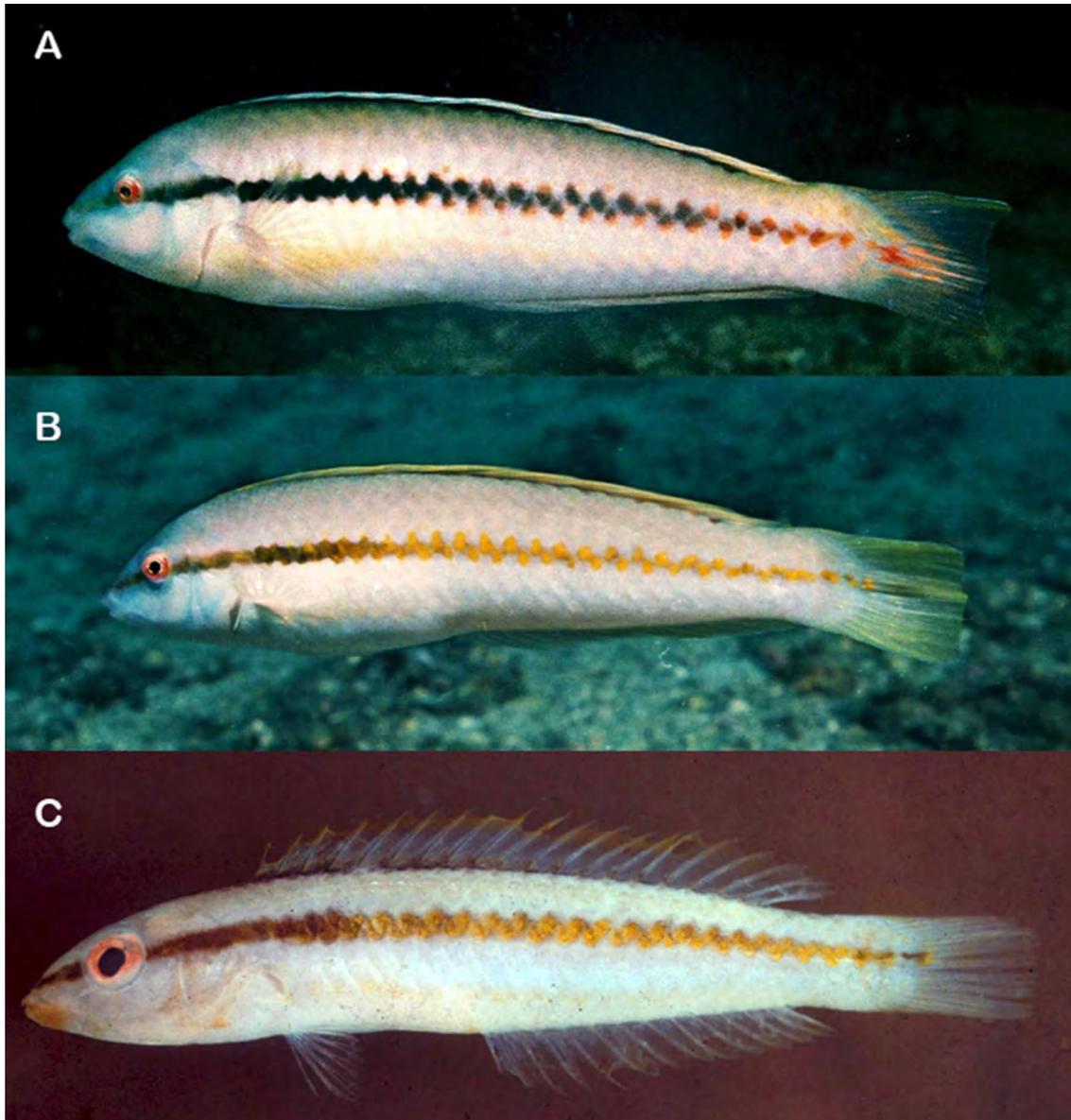


FIGURE 1. Underwater photographs of *Halichoeres sazimai*: (A) terminal phase male, (B) initial phase/female, and (C) newly collected recruit. Photographs by (A-B) O. J. Luiz Jr., and (C) A. Carvalho-Filho.

Description. Dorsal rays IX, 11; anal rays III,12; all dorsal and anal soft rays branched, the last to base; pectoral rays 13 (one individual 12) upper ray unbranched; pelvic rays I, 5; principal caudal rays 14, first and last unbranched; Lateral line scales 27 (one individual 26), each with a single pore opening dorsally; four scale rows above lateral line to origin of dorsal fin, two above anterior portion of lateral line to base of middle dorsal spines; eight scale rows below lateral line to origin of anal fin. Circumpeduncular scales 15-16. Gill rakers 17-18, 6 on the upper limb; Vertebrae 10+14. Proportional measures are listed in Table 1.

TABLE 1. Morphometrics of *Halichoeres sazimai* and its sister species *H. bathyphilus*. For *H. sazimai* the holotype is the first specimen listed, followed by the mean and range in the entire type series. For *H. bathyphilus*, mean and range of values are given, and number of species examined indicated in parentheses. Standard length is in mm, all other measurements are expressed as percentage of standard length. Characters that do not overlap are indicated with (*).

	<i>Halichoeres sazimai</i> (n=6)			<i>H. bathyphilus</i> (n= 8)	
	Holotype	Mean (range)			
Standard Length (mm)	214.0	176.3	(150.0–214.0)	128.0	(63.7–191.0)
Head length	27.57	29.0	(27.6–29.9)	32.2	(30.6–33.7)*
Eye diameter	3.93	4.2	(3.8–5.0)	5.6	(4.8–7.1)
Interorbital width	5.56	5.4	(5.2–5.7)	5.7	(4.7–5.8)
Body width	11.64	11.8	(10.4–13.0)	11.1	(9.9–12.8)
Body depth	25.14	23.7	(21.7–25.6)	24.6	(20.7–27.0)
Caudal ped. depth	12.06	12.0	(11.5–12.4)	11.8	(10.1–12.4)
Caudal ped. length	8.36	10.5	(8.4–11.7)	10.9	(8.3–14.3)
Snout length	8.93	9.24	(8.9–9.8)	10.2	(9.5–11.0)
Predorsal length	25.05	25.2	(24.4–26.4)	29.8	(27.9–31.9)*
Preanal length	53.18	51.7	(49.5–53.5)	54.0	(52.1–56.3)
First dorsal spine	5.42	5.9	(5.4–6.3)	5.1	(4.1–5.3)*
Longest dorsal ray	9.77	11.6	(9.8–12.8)	11.8	(10.0–13.3)
Length third anal spine	6.59	7.6	(6.6–8.5)	7.5	(5.8–8.7)
Longest anal ray	8.69	10.1	(8.7–11.1)	10.8	(10.0–11.9)
Middle caudal ray	17.71	18.8	(17.7–19.8)	20.0	(18.8–22.3)
Longest pectoral ray	15.37	16.0	(15.2–16.8)	18.0	(15.9–19.4)
Pelvic fin length	15.61	15.0	(13.0–16.1)	16.8	(12.2–20.1)

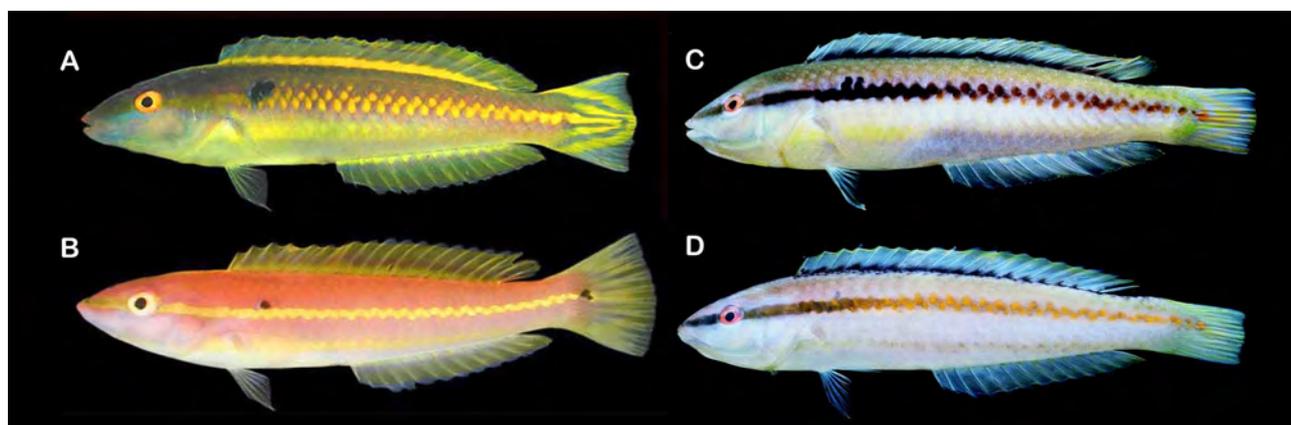


FIGURE 2. Comparison of color photographs of *Halichoeres bathyphilus* (A) terminal phase male, (B) initial phase/female and *H. sazimai* (C) terminal phase male, (D) initial phase/female. Photographs by (A-B) W. Smith-Vaniz and (C-D) A. Carvalho-Filho.

Body slender, depth 4.0 (3.9–4.6) in SL, and moderately compressed, width 2.2 (1.97–2.08) in body depth; caudal peduncle depth greater than peduncle length, 2.3 (2.3–2.55) in head length; head length 3.6 (3.3–3.4) in SL; opercular flap extending slightly beyond the upper end of pectoral fin base but not beyond the lower end of pectoral fin base; dorsal profile of head uniformly convex; eye above the midlateral line of head, distance above eye to dorsal edge of head nearly half than distance below eye to ventral edge; eye relatively small, fleshy orbit diameter 7.0 (6.0–7.3) in head length.

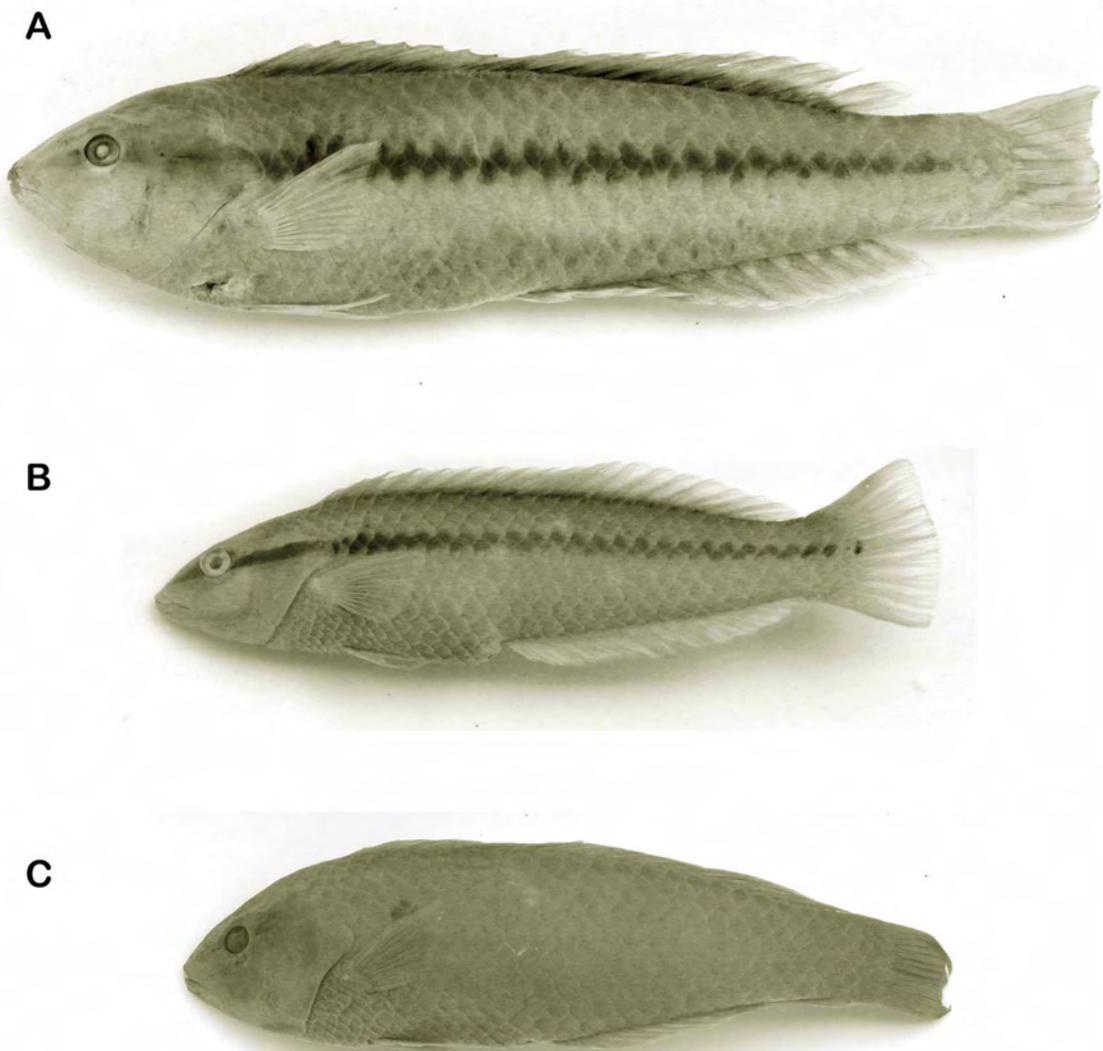


FIGURE 3. Lateral view of preserved specimens of *Halichoeres sazimai*, (A) holotype ZUEC 6323, (B) paratype MZUSP 98973, and *H. bathyphilus* UF 203925. Photographs by J.L. Gasparini and J.-C. Joyeux.

Mouth terminal, protusible, oblique, upper jaw forming angle of about 30° to horizontal axis of head and body; snout moderately pointed, its length 3.1 (3.0–3.3) in head length; pair of forward-projecting, slightly outcurved, canine teeth at front of upper jaw, two pairs in lower jaw, outer pair also curving laterally; Posterior canine sharp and well developed (Fig. 4). Conical teeth in upper jaw 11 to 14.

Sub-orbital pores five (five to seven). Nostrils with anterior short tube and posterior flap. Caudal fin truncate to slightly rounded in young, double emarginated in adults. Free vertical and horizontal margins of preopercle smooth. Scales end just above preopercle on nape, head naked. Scales on chest smaller than body, extending anteriorly to rear margin of isthmus. Single large, elongate scale between pelvic-fin bases. Three rows of scales on caudal fin, gradually decreasing in size to rear of lateral line. Lateral line continuous with an abrupt downward curve below last three dorsal rays, extending along midline to caudal peduncle.

Coloration in life. The body is white with a distinctive stripe running on midline of the body from the snout, through the eye to tail. The stripe is straight, broadest and continuous from the snout to the shoulder, when it turns into a line of close-set spots in a zigzag pattern on alternate scales of two adjoining rows. In juveniles and initial phase females the stripe is brown on the first third of its length and yellow to golden on the last two thirds; two dark blotches, linked to the central stripe, are present below the fourth and fifth dorsal spines, sometimes golden in very large terminal males. Terminal phase males have the stripe entirely black or

black at the first half becoming brownish, some with golden spots above and below scales; they also have a second stripe, lower and much less conspicuous, from the thorax through lower pectoral fin base to ventral

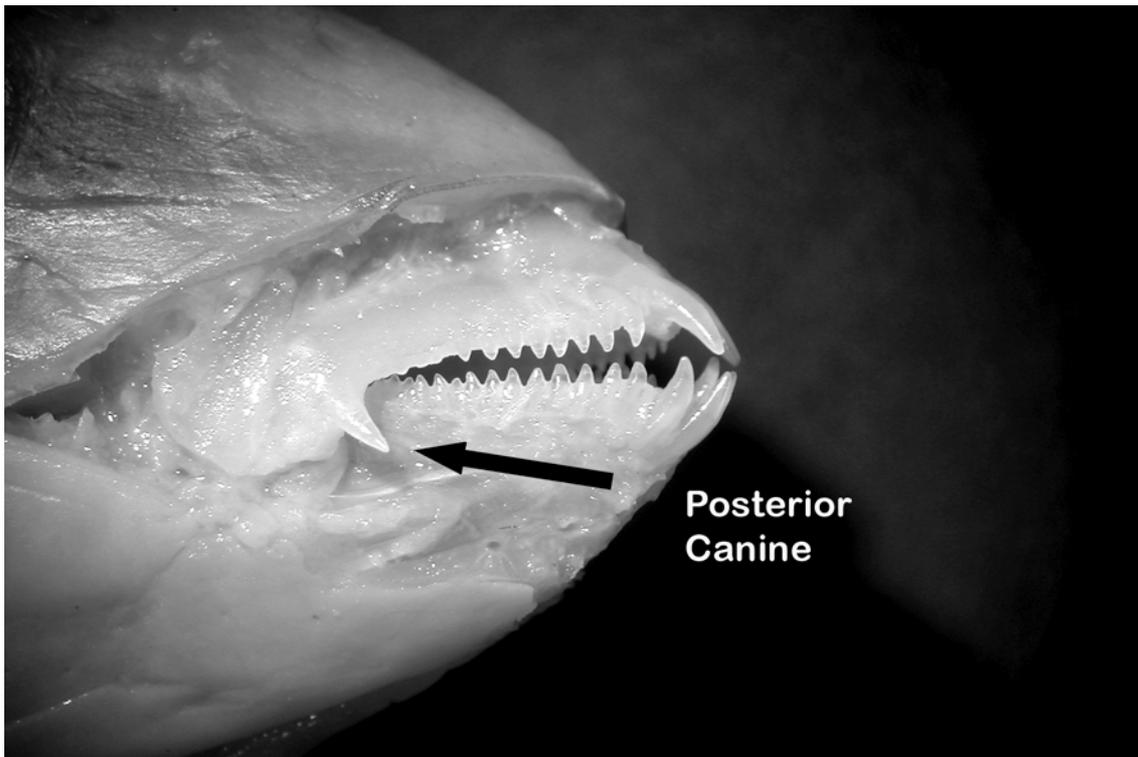


FIGURE 4. Mandibular apparatus of *Halichoeres sazimai*, showing the posterior canine (ZUEC 6324, female, 171 mm). Photograph by J.L. Gasparini and J.-C. Joyeux.

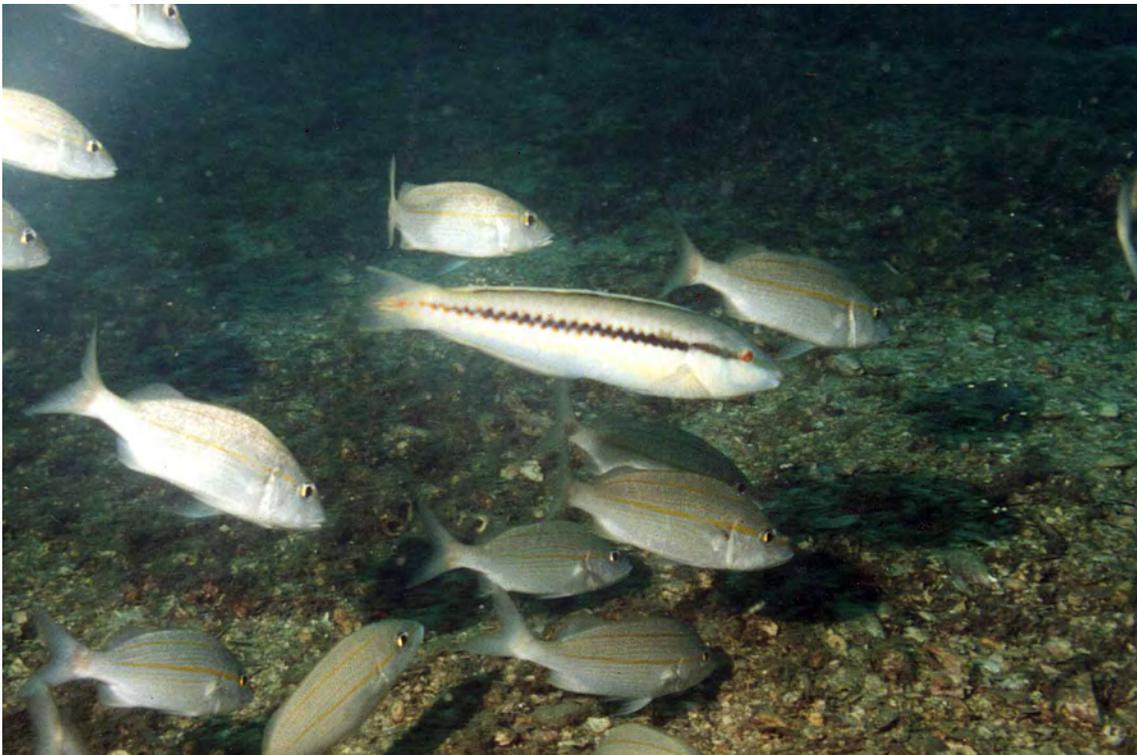


FIGURE 5. A terminal phase *Halichoeres sazimai* foraging while being followed by a *Haemulon aurolineatum* school at Laje de Santos Marine State Park. Photograph by O.J. Luiz Jr.

part of caudal peduncle; this lower stripe is yellow, has a faded appearance and is not clearly visible in live individuals. The coloration of terminal males is darkened on the dorsum and the abdomen, becoming grayish or greenish in the area just above the mid-body stripe to the base of the dorsal fin; head blue dorsally and whitish ventrally; cheeks often with a pink to orange area bordered by a bluish line; a broad dark blue area present in the belly from the pelvic fin base to the caudal peduncle, immediately below the lower yellow stripe. Dorsal fin grayish to dusky, often with a greenish hue in terminal males and yellowish in females and a dark base in both phases, the terminal males often with red spots in the soft portion base; the anal fin has its base colored as the belly, and the rest of the fin is dusky green in males and dusky yellow in females; ventral fins white in females light green in terminal males; pectoral fins translucent. Caudal fin with a translucent background, greenish in terminal males and yellowish in females. Terminal males have the upper and lower margins with thin yellow or reddish borders and patterned with a series of bands with the same color of the borders, which run diagonally from the base of the fin to the tip of the middle rays; the two outer bands starting at the upper and lower bases of the fin and meeting at the central tip of the tail; two similar inner bands running parallel inside these and meeting at tips; a central straight band of same color running directly from the mid caudal base to the tip of tail. Eye red to orange, the upper and lower parts sometimes paler in the young and females.



FIGURE 6. Southernmost record of *Halichoeres sazimai* at the Marine Biological Reserve of Arvoredo. Photograph by Banco de Imagens Rebiomar Arvoredo, Marcelo Kammers.

Coloration in alcohol. Body pale brown, fin membranes yellowish brown, lighter than body. Conspicuous brown stripe along the midline of body from snout to tail, corresponding to black and yellow stripes in life, for males and females respectively. Dorsal fin with a dark base. Males with the dorsal part of body darker, from immediately above the stripe to the base of dorsal fin and nape. Ventral side, from the thorax to the belly darkened but not more so than the dorsal side from the anus to the lower lateral of the body, not reaching the mid-body stripe, allowing two to three rows of scales from the end of the darkened ventral band to the stripe retain the background coloration. Females have a more homogenous pale brown body, being slightly darker on the dorsum, with the conspicuous brown midline body stripe (Fig. 3).

Comparisons with congeners. *Halichoeres sazimai* was previously misidentified as *H. bathyphilus* due to morphological similarities. However, they can be distinguished by coloration in live and preserved specimens (Fig. 2, 3). Despite similar patterns between *H. sazimai* and *H. bathyphilus* body textures as the mid-body zigzag patterned stripe, the diagonal bands on the caudal and colored base of dorsal fin separate those species. Terminal male *H. bathyphilus* has a green or bright yellow mid-body stripe vs. black and brownish in *H. sazimai*; the body color of the male *H. bathyphilus* is lilac on middle of sides, becoming dull at upper sides and yellow on lower sides, which contrast with the general white appearance with discrete green and blue tints respectively on the dorsal and ventral sides of the male *H. sazimai*. Males of *H. bathyphilus* also have a yellow base on dorsal and anal fin and a yellow dorsal fin outer margin while *H. sazimai* have black pigments on the base of the dorsal fin, and its outer margin is not yellow. Females of *H. bathyphilus* have a reddish-pink body color and a black spot at the base of caudal, whereas the females of *H. sazimai* have a body whitish without the spot at the base of caudal (Fig. 2). Preserved specimens could also be distinguished by its coloration, since in *H. bathyphilus* the mid-body stripe is lost with only the two black blotches above the pectoral fin remaining on homogenous body color, whereas in *H. sazimai* the stripe is retained and is very conspicuous (Fig. 3).

Sequence divergence at the mitochondrial DNA cytochrome b gene between *H. sazimai* and *H. bathyphilus* (its sister species) is 1.02%. Even though this distance is smaller than that observed in other sister species pairs of *Halichoeres* in the Atlantic (2.2 to 6% in other pairs; Rocha 2004; Weaver & Rocha 2007), we think that the genetic difference in combination with the color pattern differences presented herein warrant the recognition of this species. Using the molecular clock proposed for *Halichoeres* (Barber & Bellwood 2005; Weaver & Rocha 2007) this distance corresponds to a separation of approximately 300,000 years, however, this time frame must be taken as a rough estimate because of the error associated with the molecular clock.

Among other species of *Halichoeres* occurring in Brazil that resemble *H. sazimai* in color, juveniles of *H. bivittatus* and *H. penrosei* have a white body with a dark stripe running along the mid-body. *Halichoeres sazimai* could be distinguished from *H. bivittatus* by possessing a single pore in each lateral line scale while *H. bivittatus* has anterior lateral-line scales with more than one pore. Additionally, the posterior two thirds of the mid-body stripe of *H. sazimai* consisted in a line of close-set spots in a zigzag pattern on alternate scales of two adjoining rows while in *H. bivittatus* the mid-body stripe is a sequence of close-set spots in the same row. Moreover, *H. sazimai* and *H. bivittatus* are allopatric. The known range of *H. bivittatus* in the South West Atlantic is restricted to the North Eastern coast of Brazil, from Parcel Manuel Luiz to the hump of Brazil, whereas *H. sazimai* occurs only in the South Eastern coast of Brazil, from Espírito Santo to Santa Catarina States. *Halichoeres sazimai* could be distinguished from *H. penrosei* by possessing 12 soft rays in the anal fin and two pairs of enlarged canines anteriorly in lower jaw vs. 11 soft rays in the anal fin and a single pair of enlarged canines anteriorly in lower jaw. The mid-body stripe in juveniles *H. penrosei* is broader than in *H. sazimai*, covering two or more rows continuously, and is black, whereas it is golden or dark yellow in juveniles *H. sazimai*. Moreover, the body of juveniles *H. penrosei* is not entirely white, being the upper body brownish-pink from the head to caudal peduncle.

Among *Halichoeres* species occurring in other biogeographical provinces, juveniles of *H. maculipinna* from the tropical North Western Atlantic and initial phase adults of *H. scapularis* from the tropical Indo-Pacific most resemble *H. sazimai* in color. *Halichoeres sazimai* can be distinguished from juveniles *H. maculipinna* by the same diagnostic characteristics showed above for juveniles *H. penrosei*, except for the upper body being yellowish-green. Finally, *H. sazimai* can be distinguished from *H. scapularis* by possessing 12 anal soft rays vs. 11. Additionally, the mid-body stripe of initial phase adults *H. scapularis* starts just behind the eye to the upper part of the caudal peduncle while in *H. sazimai* it start at snout and continues through the eye to the mid of tail. The mid-body stripe of *H. scapularis* is slight curved towards the dorsal fin at its anterior part while straight in *H. sazimai*.

Habitat and behavior. This species was regularly observed foraging solitary on sand bottoms immediately adjacent to the lower end of rocky reefs. Harems composed of a few (five to ten) individuals are not common but occasionally seen. Sometimes the fish venture over the reefs, but generally never shallower

than 20 m depth depending on water temperature (they seem to be associated with temperatures lower than 18°C). As observed in other labrids, *Halichoeres sazimai* forages mostly on mobile invertebrates on soft and hard substratum, being more commonly observed foraging on sand bottoms. This behavior makes *H. sazimai* a potential nuclear species in following associations, as it has been observed in other species of *Halichoeres* (Strand 1988; Sazima *et al.* 2007) and underwater observations revealed that *H. sazimai* is followed by *Haemulon aurolineatum* (Fig. 5). It was also observed acting as a follower of other nuclear species (Luiz Jr. *et al.* 2008), namely *Dactylopterus volitans*, *Pseudocaranx dentex* and *Pseudupeneus maculatus*. Spawning occurs during the summer, probably from December to March, and the juveniles (20 mm TL) associate with the substrate, mainly reef sheltered areas and algae patches. They may be observed mixed in small groups with juvenile *H. poeyi* and *H. brasiliensis* as well as with larger females of its own species (A. Carvalho-Filho, pers. com.).

Distribution and ecology. *Halichoeres sazimai* is apparently restricted to the South Eastern and Southern coast of Brazil, from Linhares, Espírito Santo State (J. L. Gasparini pers. com.) to the Arvoredo Marine Biological Reserve, Santa Catarina State (D.R. Barneche pers. com.). A single specimen was collected in North Eastern Brazil, at Arembepe, Bahia State (record based on one juvenile recruit collected by A. Carvalho-Filho; MZUSP 46386), but no established population was found there. It is most commonly observed at the deeper parts of rocky reefs on the islands of São Paulo State (Laje de Santos, Alcatrazes and Vitória islands), and Rio de Janeiro State (Cagarras Archipelago and Ilha de Cabo Frio, Arraial do Cabo). These fish were not abundant in visual census performed from 20 to 35 meters deep in the Brazilian South Eastern coast (mean density for Arraial do Cabo 23°S, 42°W = 0.1 / 40m²). As this species is restricted to the deeper part of the reefs and shows apparently low abundance, one need to have caution in categorizing its conservation status.

Etymology. The specific name honors Dr. Ivan Sazima for his contributions to the advancement of the natural history and taxonomy of Brazilian reef fishes, as well for his exemplary guidance, which influenced a generation of Brazilian ichthyologists.

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