



A new species of snapper (Perciformes: Lutjanidae) from Brazil, with comments on the distribution of *Lutjanus griseus* and *L. apodus*

RODRIGO L. MOURA¹ & KENYON C. LINDEMAN²

¹Conservation International Brasil, Programa Marinho, Rua das Palmeiras 451 Caravelas BA 45900-000 Brazil.

E-mail: r.moura@conservation.org.br

²Environmental Defense, 485 Glenwood Avenue, Satellite Beach, FL, 32937 USA. E-mail: klinedeman@environmentaldefense.org

Abstract

Snappers of the family Lutjanidae contain several of the most important reef-fishery species in the tropical western Atlantic. Despite their importance, substantial gaps exist for both systematic and ecological information, especially for the southwestern Atlantic. Recent collecting efforts along the coast of Brazil have resulted in the discovery of many new reef-fish species, including commercially important parrotfishes (Scaridae) and grunts (Haemulidae). Based on field collecting, museum specimens, and literature records, we describe a new species of snapper, *Lutjanus alexandrei*, which is apparently endemic to the Brazilian coast. The newly settled and early juvenile life stages are also described. This species is common in many Brazilian reef and coastal estuarine systems where it has been often misidentified as the gray snapper, *Lutjanus griseus*, or the schoolmaster, *L. apodus*. Identification of the new species cast doubt on prior distributional assumptions about the southern ranges of *L. griseus* and *L. apodus*, and subsequent field and museum work confirmed that those species are not reliably recorded in Brazil. The taxonomic status of two Brazilian species previously referred to *Lutjanus*, *Bodianus aya* and *Genyoroge canina*, is reviewed to determine the number of valid *Lutjanus* species occurring in Brazil. Twelve species of *Lutjanus* are now recognized in the western Atlantic, eight of which occur in Brazil (one endemic). A key for the identification of all western Atlantic *Lutjanus* species and their known distributional ranges is also provided.

Key words: *Lutjanus alexandrei* new species; snappers; biogeography; Brazil

Introduction

The fish fauna of the tropical western Atlantic is relatively homogeneous, but recent evidence demonstrates that the southwestern Atlantic holds a considerable number of endemic species (e.g., Menezes *et al.* 1997, 2003). As a result of major collection-building efforts in the last decade, several groups of demersal fishes have been investigated in the southwestern Atlantic, resulting in the identification of new species of myxinids (Mincarone 2000, 2001), elasmobranchs (Gomes *et al.* 2000, Gomes & Paragó 2001), batrachoidids (Menezes & Figueiredo 1998), atherinids (Bemvenuti 1995), grammids (Sazima *et al.* 1998), haemulids (Rocha & Rosa 1999), chaetodontids (Burgess 2001), pomacentrids (Moura 1995, Gasparini *et al.* 1999), labrids (Heiser *et al.* 2000), scarids (Moura *et al.* 2001, Gasparini *et al.* 2003), dactyloscopids (Feitoza 2002), labrisomids (Sazima *et al.* 2002, Guimarães & Bacellar 2002), gobiids (Sazima *et al.* 1997), microdesmids (Gasparini *et al.* 2001), and tetraodontids (Moura & Castro 2002). Several valuable species of Caribbean fishes that were long assumed to extend to Brazil have also been shown to not occur there. Examples include Nassau grouper (*Epinephelus striatus*), hogfish (*Lachnolaimus maximus*), and several parrotfish species (Sadovy & Eklund 1999, Moura *et al.* 2001, Moura & Sazima 2003).

Endemism levels in the tropical southwestern Atlantic are therefore higher than previously supposed (Briggs 1974), encompassing a broad taxonomic spectrum of pelagic (e.g. Menezes 1971), estuarine (e.g. Bemvenuti 1995), demersal (e.g. Menezes & Figueiredo 1998), and reef-associated fishes (e.g. Moura & Saz-

ima 2003, Rocha 2003). As taxonomic studies progress, the discovery of southwestern Atlantic endemics will continue to increase, both by description of new species and resurrection of valid names from synonymies (e.g. Moura *et al.* 2001, Rocha 2004).

All western Atlantic *Lutjanus* species that are currently recognized as valid (Allen 1985, 1987, Anderson 2003, Loftus 1992) were described in the 18th and 19th centuries by European and Cuban naturalists (e.g. Bloch 1790, Poey 1860). Following these descriptions and subsequent taxonomic reassessments (Jordan & Swain 1884, Jordan & Fesler 1893, Ginsburg 1930, Rivas 1949), western Atlantic *Lutjanus* were reviewed by Rivas (1966), Anderson (1967, 2003), and Vergara (1977). In a catalogue of world lutjanids, Allen (1985) provided an identification key and diagnoses for the 12 *Lutjanus* species he recognized in the western Atlantic (see also Allen 1987). However, Loftus (1992) subsequently demonstrated that *L. ambiguus* (Poey) is a natural hybrid between the yellowtail snapper, *Ocyurus chrysurus* (Bloch) and the lane snapper, *L. synagris* (Linnaeus), an alternative that was hypothesized in Poey's original description.

In this paper we describe a new species of *Lutjanus* that is endemic to the tropical Brazilian coast, re-establishing the number of valid western Atlantic species as 12. This species was first recognized as distinct during underwater surveys on reefs of northeastern Brazil (Moura 2003) based on its red body and fins, six white vertical lines, and dark (bright blue in life) spots between the snout and preopercle. Its status as a distinct species was further confirmed by additional morphological evidence and the inability to confirm field or museum records in Brazil of the two most similar species, *Lutjanus griseus* and *L. apodus* (the gray and schoolmaster snappers). The new *Lutjanus* species has long been confused with not only *L. griseus* and *L. apodus*, but also *L. jocu*, which definitely occurs in Brazil.

Because of the economic and ecological value of snappers in the tropical western Atlantic (e.g. Polovina & Ralston 1987, Claro *et al.* 2001), including the largely unreported reef fisheries in Brazil, and the abundance of the new species across many nearshore habitats, we also describe pigment patterns of the distinctive newly settled life stage. We also reassessed the taxonomic status of two Brazilian species previously referred to *Lutjanus*: *Bodianus aya* Bloch 1790, an unidentifiable nominal species, and *Genyoroge canina* Steindachner 1869, a junior synonym of the west African species *Lutjanus endecacanthus* Bleeker, 1863. A revised key for the identification of all western Atlantic species (modified from Allen 1985, 1987, and Anderson 2003) is provided, with emphasis on characters that are easily assessed in the field.

Materials and methods

Counts and measurements follow Anderson (1967) and Allen (1985); SL refers to standard length and HL to head length. Measurements were made with dial calipers and recorded to the nearest 0.1 mm. Type specimens are in the fish collections of MZUSP and USNM (institutional abbreviations follow Leviton *et al.* 1985). The number of specimens, followed by the size range in mm SL, is given in parentheses following each catalog number. Description is based on the holotype and all 21 paratypes. In the description, ranges of counts and measurements are presented first, followed by values for the holotype in parentheses. Proportional measurements are either expressed as percentages of standard length (% SL) or head length (% HL). Specimens were collected on reefs with SCUBA using nets and speargun or with hook and line. Underwater photographs were obtained to document live color patterns. In shallow patch reefs, tidepools, mangrove roots and grassbeds, seine and hand nets were used for collecting. In addition to the type material described below, we examined specimens of all *Lutjanus* species known from the southwestern Atlantic (see Comparative Material section). Vertebral count was obtained from a radiograph of the holotype.

Comparative material examined

Lutjanus analis: MZUSP 66038 (1, 90.2), São Sebastião (23°49'S, 45°25'W), São Paulo State, Brazil. *Lutjanus apodus*: MZUSP 65929 (2, 142–138), Bahamas, San Salvador Island. *Lutjanus bucanella*: MZUSP 65240 (1, 232), Tamandaré (8°49'S, 35°5'W), Pernambuco State, Brazil. *Lutjanus cyanopterus*: MZUSP 65931 (1,

131), Lagoa de Mundaú (9°37'S, 35°48'W), Maceió, State of Alagoas, Brazil. *Lutjanus jocu*: MZUSP 51168 (1, 119), same locality as MZUSP 65931. *Lutjanus synagris*: MZUSP 65242 (1, 205), same locality as MZUSP 65240. *Lutjanus vivanus*: MZUSP 13586 (1, 199), São Paulo Fish Market, Southeastern Brazil.

Lutjanus alexandrei, new species

(Figures 1–3; Tables 1, 2)

Lutjanus apodus not of Walbaum, 1792. Jordan, 1891:330 (Bahia); Ribeiro, 1915 (not paginated); Jordan & Fessler, 1893:510 (Pernambuco); Gilbert, 1900:170; Starks, 1913:32; Fowler, 1941:160; Allen, 1985:56 (in part); Carvalho-Filho, 1994:138 (in part); Rocha *et al.*, 1998:562; Rocha & Rosa, 2001:990; Moura & Menezes, 2003:82 (in part).

Lutjanus griseus not of Linnaeus, 1758. Ribeiro, 1915 (not paginated, in part); Ribeiro, 1918 (not paginated, in part); Menezes & Figueiredo, 1980:22 (in part), Carvalho-Filho, 1994:135 (in part); Moura & Menezes, 2003:83 (in part).

Holotype: MZUSP 65664 (153) Camurupim Reef, Tamandaré (8°49'S, 35°5'W), State of Pernambuco, Brazil, 05 m depth; collected by R.L. Moura, R.B. Francini-Filho & C.H. Flesh, 22 January 1999.

Paratypes (21 specimens, 69–243): USNM 388233 (1, 161), Abrolhos Bank (17°57'08"S, 38°41'W), State of Bahia, Brazil, 20 m depth, collected by R.L. Moura & R.B. Francini-Filho, 1 April 2000. MZUSP 52721 (2, 227–243) Parcel dos Abrolhos (17°57'08 S", 38°41'6"W), Abrolhos Bank, State of Bahia, Brazil, collected by R.L. Moura, R.B. Francini-Filho, C. Sazima & I. Sazima, 22 January 1998. MZUSP 84862 (1, 108), collected with the holotype. MZUSP 66066 (1, 131) Itaparica (12°52'S, 38°41'W), State of Bahia, Brazil, collected by A. Carvalho-Filho, October 1982. MZUSP 60838 (1, 150) Parcel das Paredes (17°53'54"S, 38°57'13"W), Abrolhos Bank, State of Bahia, Brazil, collected by R.L. Moura, C.E.L. Ferreira & R.B. Francini-Filho, 19 February 2000. MZUSP 66021 (3, 82–95) Salvador (12°56'S, 38°31'W), State of Bahia, Brazil, collected by V.G. Almeida, 21 July 1970. MZUSP 65939 (3, 71–89) same locality as MZUSP 66021, collected by C.E. Dawson, N.A. Menezes & V.G. Almeida. MZUSP 66020 (1, 82) same locality as MZUSP 66066, collected by N.A. Menezes & V.G. Almeida, 24 August 1972. MZUSP 66022 (5, 69–128), Lagoa Mundaú (09°37'S, 35°48'W), Maceió, State of Alagoas, Brazil, collected by CETESB, 1985. MZUSP 66026 (1, 79) Ponta de Pedras (8°3'S, 34°46'W) State of Pernambuco, Brazil, collected by P. Montouchet, 30 August 1970. MZUSP 51167 (1, 87), same data as MZUSP 66022. MZUSP 65062 (1, 91) Fortaleza (3°45'S 38°20'W) State of Ceará, Brazil, 0.5m depth (tidepool), collected by R.L. Moura, R.B. Francini-Filho & C.H. Flesh, 26 March 2000.

Diagnosis. Among western Atlantic snappers, *Lutjanus alexandrei* is similar to the gray snapper, *Lutjanus griseus* (Linnaeus), and the schoolmaster, *Lutjanus apodus* (Walbaum), with which it shares the following characters: 14 soft dorsal-fin rays, 6 (5–7 in *L. apodus*) scales between lateral line and dorsal-fin origin, anchor-shaped vomerine tooth patch with a median posterior extension, upper canines much larger than lower canines. *Lutjanus alexandrei* differs from *L. griseus* by the presence of 6 pale vertical bars (sometimes faded) on the trunk (absent in *L. griseus*), a longer pectoral fin (length exceeding the distance from the snout to the posterior margin of preopercle), and the angularity of the dorsal scale rows below the soft dorsal fin (not markedly oblique as in *L. griseus*). *Lutjanus alexandrei* differs from *L. apodus* in having a red to pale-red body cast and reddish fins instead of a yellowish-pale body with yellow fins, and by having only six narrow pale vertical lines dorsally (sometimes faded) instead of eight wider pale bands as in *L. apodus*. The number of lateral-line scales, varying from 43 to 48, is also slightly higher than that of *L. apodus* (40–45), and more similar to that of *L. griseus* (43–47).

Description. The general morphological features of *Lutjanus* are presented by Allen (1985) and Anderson (1987) for adults and by Lindeman *et al.* (2005) for larvae and juveniles, and are not repeated herein. Dorsal rays X, 14; anal rays III, 8; pectoral rays 16 (uppermost rudimentary and unbranched); pelvic rays I, 5; principal caudal rays 9+8; lateral line with 43–48 (45) pored or tubed scales forming a continuous sensory canal between the upper end of gill opening and the caudal-fin base, tubes in lateral line simple, unbranched; branchiostegal rays 7; gill rakers 17–19 (17) total, 5–6 (5) fully developed rakers on the upper limb and 6–9 (8) fully developed plus 3–5 (4) rudimentary rakers on the lower limb; gill membranes separate, free from isth-

mus; vertebrae 10+14. Body relatively deep, maximum depth 37.3–45.6% (40.3) of SL; snout pointed and long, 27.8–37.8% (33.9) of HL; mouth terminal, large and protractile, with one row of conical teeth in each jaw; a prominently enlarged pair of caniniform teeth on upper jaw, visible when mouth is closed, 3–5 (3) pairs of fanglike pointed conical teeth in lower jaw, vomerine tooth patch anchor-shaped, with a prominent median posterior extension. Morphometric and meristic data are summarized in Tables 1 and 2, respectively.

TABLE 1. Proportional measurements for the holotype and 21 paratypes of *Lutjanus alexandrei*, **sp.n.** Measurements 1 to 6 expressed as proportions of standard length, and measurements 7 to 22 expressed as proportions of head length.

	Holotype MZUSP 65664	Mean	SD	Min	Max	
1-	Predorsal, length	45.2	44.9	1.5	40.8	47.5
2-	Prepectoral, length	39.3	36.8	1.2	34.6	39.3
3-	Prepelvic, length	46.3	42.9	2.0	40.6	46.8
4-	Preanal, length	74.9	73.2	1.8	70.2	77.4
5-	Dorsal-fin base, length	49.0	51.7	1.6	48.9	54.6
6-	Body, depth	40.3	41.5	2.2	37.3	45.6
7-	Orbit, diameter	23.1	27.4	2.1	23.1	30.8
8-	Interorbital, width	17.4	18.0	1.1	15.6	20.4
9-	Premaxillary, length	37.4	38.1	1.6	35.0	42.1
10-	Snout, length	33.9	31.8	2.7	27.8	37.8
11-	Pelvic-fin, length	53.6	59.7	4.4	53.3	68.2
12-	Pectoral-fin, length	74.6	78.0	3.5	67.8	84.2
13-	Caudal peduncle, depth	32.7	34.2	1.6	30.34	37.1
14-	1 st dorsal spine, length	15.7	17.0	2.2	14.03	22.9
15-	2 nd dorsal spine, length	27.7	28.8	2.4	24.57	34.8
16-	3 rd dorsal spine, length	37.1	37.9	2.8	30.77	43.4
17-	4 th dorsal spine, length	40.1	40.7	2.0	37.58	44.9
18-	Anal-fin base, length	38.5	40.5	2.7	36.36	47.5
19-	1 st anal spine, length	20.3	22.7	2.3	17.21	27.6
20-	2 nd anal spine, length	37.2	40.7	3.2	33.14	44.5
21-	3 rd anal spine, length	34.9	37.5	2.2	33.56	40.4
22-	Body, width	44.5	45.5	3.8	37.02	52.2

TABLE 2. Frequency of counts for some type specimens of *Lutjanus alexandrei*, **sp. n.** (specimens with damaged gill rakers/ lateral-line scales not included).

		Gill rakers								Lateral-line scales					
Upper limb		Lower limb				Total									
5	6	11	12	13	14	17	18	19	20	43	44	45	46	47	48
2	11	4	4	4	1	7	1	3	1	1	2	4	4	4	2

Origin of dorsal fin slightly posterior to opercular margin; dorsal fin continuous, with only a slight notch between the spinous and soft portions. Caudal fin slightly emarginated; anal fin rounded; pectoral fin pointed and reaching the level of anus, length longer than the distance from tip of snout to posterior edge of preopercle, and 3.0–3.6 (3.5) times in SL. Nostrils small, posterior nostril elongate and at level of pupil, anterior nostril more rounded and located slightly below the level of the posterior one. Preopercle serrate, its lower margin

with visible but weak notch and knob. Scales small, ctenoid, not extending dorsally on head above upper margin of orbit nor onto interorbital and internarial space; scales above lateral line (between dorsal-fin origin and lateral line) 6; transverse scale rows between upper edge of opercle and caudal base 37–47 (39); scale rows on cheek 6–7 (7); soft dorsal and anal fins scaled; dorsal scale rows parallel to the longitudinal body axis. Reddish body cast in life (Figure 2), becoming light brown dorsally and pale ventrally in preserved specimens (Figure 1). Body scales with more intense pigmentation on margins, paler in centers. Sides with six pale, thin, vertical lines dorsally. First band on the nape in front of the dorsal fin, fifth under the junction of spiny and soft portion of dorsal fin, and sixth below soft dorsal fin. These pale lines are still visible in some preserved specimens but, as observed by Starck (1970) for *L. apodus*, some specimens may lack these lines. Conspicuous spots (blue in life) are present on the cheek and preopercle, 7–10 of these typically present on snout and ventral portion of head, most below ventral margin of orbit and above superior margin of premaxilla. Median fins red, with more dense pigment on the margins, becoming pale brown in preserved specimens. Live individuals with thin blue distal margins on ventral, anal, and soft dorsal fins (Figure 2) that are not apparent in preserved specimens (Figure 1). Pupils black, iris reddish copper.

In life, early juveniles less than approximately 5 cm typically have reddish or gray bodies and fins. Between 2–3 cm SL, specimens from shaded mangrove areas have dense melanophore rows on body, 6–8 pale vertical bands, and an oblique, black eye stripe (Figure 3). Distal portions of first dorsal and pelvic fins dark red. Caudal, soft dorsal, posterior elements of anal, and pectoral fins transparent. Two thin blue lines from maxilla to posterior margin of opercle. Short, oblique blue line from posterior orbit to opercular margin (Figure 3). Specimens from unshaded rocky areas or tidepools can also exhibit pale yellow pigment dorsally and on the distal portions of the soft dorsal and caudal fins. Newly settled individuals from softbottom adjacent to mangroves lack red fin pigment, instead with melanophores concentrated distally on first dorsal, pelvic and anterior anal fins. Remaining fins transparent. Lateral bands on body, and blue and black lines on head begin development by 15 mm.

Etymology. The specific name honors the pioneer Brazilian naturalist Alexandre Rodrigues Ferreira (1756–1815), whose many years of field work in Brazil during the late 18th Century remain underrecognized due to the confiscation of his and others' collections at Lisbon's Museu da Ajuda in 1808 (Oliveira & Daly 2001). Ferreira collected many specimens that were ultimately described as new without any reference to his efforts. The common name Brazilian snapper is proposed for *L. alexandrei*.

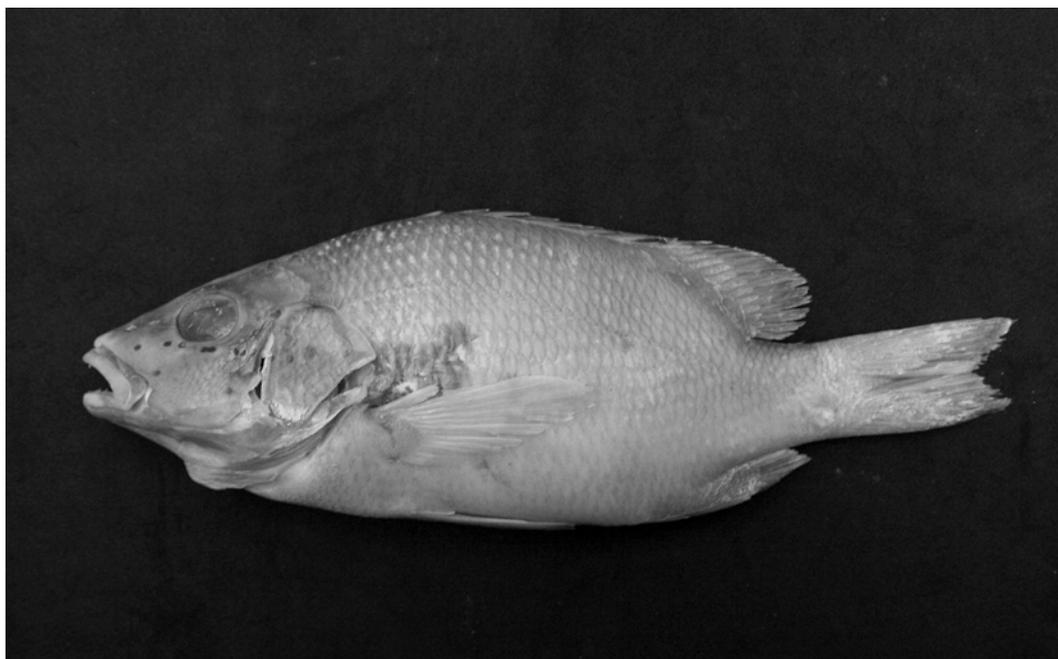


FIGURE 1. Holotype of *Lutjanus alexandrei*, MZUSP 65664, 152.6 mm SL, Camurupim Reef, Tamandaré (8°49'S, 35°05'W), State of Pernambuco, Brazil.



FIGURE 2. Underwater photograph of *Lutjanus alexandrei*. Parcel das Paredes (17°53'54"S, 38°57'13"W), Abrolhos Bank, Bahia, Brazil (R.L. Moura).



FIGURE 3. Early juvenile individual of *Lutjanus alexandrei*, 27 mm SL, collected in the mouth of Rio Mamucabas, Tamandaré (08°49'S, 035°05'W), State of Pernambuco, Brazil, 1 m depth (Beatrice P. Ferreira & Sérgio Resende, 18 February 2005).

Distribution, ecology and behavior. The Brazilian snapper, *L. alexandrei* is only recorded from the tropical portion of the southwestern Atlantic continental shelf, and has a narrower latitudinal range than other Western Atlantic species of *Lutjanus*. It is known from the state of Maranhão (00°52'S) to the southern coast of the state of Bahia (18°0'S), Brazil, in areas under the influence of the west-flowing Equatorial Current (northern Brazil) and the south-flowing Brazil Current (northeastern Brazil). It is apparently absent from oceanic islands. Additional collections may show an even broader distributional range for this species, as was the case with 48 other poorly known reef-fish species in the southwestern Atlantic (Moura *et al.* 1999).

Habitats of the Brazilian snapper include coral reefs, rocky shores, coastal lagoons with brackish water, mangroves and other shallow habitats with a mixture of soft- and hard-bottom. Recorded depths range from intertidal (early stages only) to at least 54 m (Feitoza *et al.* 2005 — identified as *L. apodus*). During the day, adults of *L. alexandrei* were observed on reefs as solitary individuals or in small groups showing restricted activity. Adults can co-occur with *L. jocu* (see figure on page 40 in MMA 2002, several *L. alexandrei* were misidentified as *L. jocu*). These mixed groups are often composed of large (> 20 cm), probably adult, individuals. Similar to several other *Lutjanus* species, this species appears to be active predominantly during crepuscular and nocturnal periods. Juveniles smaller than 10 cm SL can be common in mangroves and rocky

tidepools, sometimes together with *L. jocu* juveniles, and may also occur in other shallow habitats. Based on available information, early juvenile stages of *L. alexandrei* are uncommon or rare in deeper, offshore reef habitats, as in many congeners (Lindeman *et al.* 1998, Lindeman & DeMaria 2005).

Discussion

The existing literature typically gives the southern distributional limits of *L. griseus* and *L. apodus* as southeastern Brazil and northeastern Brazil, respectively (*e.g.* Menezes & Figueiredo 1980, Uyeno *et al.* 1983, Allen 1985, Moura & Menezes 2003). All examined lots labeled as *Lutjanus griseus* and *L. apodus* in the two major marine fish collections in Brazil (MZUSP and MNRJ) are actually *L. alexandrei*. We have determined from photographs or voucher materials that all lutjanids commonly identified as *L. griseus* or *L. apodus* in field surveys also are *L. alexandrei*. The same result applies for reef and estuarine fishery catches. The presence of either species in Brazil is highly doubtful given their absence in Brazilian museum collections, field surveys, and fishery landings.

In the southwestern Atlantic there are cases of Caribbean fishes restricted to offshore islands [*e.g.* *Inermia vitatta* (Inermiidae) and *Haemulon chrysargyreum* (Haemulidae)] (Moura & Sazima 2003) or occurring only along restricted portions of the coast [*e.g.* *Chromis scotti* (Pomacentridae)] (Moura *et al.* 1999, Rocha & Rosa 2001). With more surveys, small populations of *L. griseus* or *L. apodus* could be definitively recorded from offshore or mainland sites in Brazil. Clearly, the abundant and widespread *L. alexandrei* is not a product of current hybridization of *L. griseus* and *L. apodus*, which, if present in Brazil, must be highly uncommon. Other prominent reef species have also been erroneously recorded from Brazil, including *Epinephelus striatus* and *Lachnolaimus maximus* (Serranidae and Labridae) (Sadovy and Eklund 1999, Moura & Sazima 2003). Careful examination of a wide array of seemingly pan-western Atlantic reef species may result in additional changes to long-assumed southern distributions.

Recent discoveries of new species belonging to major coastal fish families in Brazil (referenced in Introduction) suggest a considerable level of isolation between Caribbean and Brazilian populations of coastal fishes, especially those that associate with reefs. Genetic studies also indicate limited gene flow between these two zoogeographic areas, even within groups with a high potential for dispersion such as surgeonfishes (Rocha *et al.* 2002). Mechanisms of speciation and faunal enrichment in another group of coastal fishes (Scaridae) were recently studied in the Atlantic by Robertson *et al.* (2006), based on mtDNA and nDNA sequences to assess the effects of two major geographic barriers (the >30 million year old Atlantic ocean and the ~11 million year old Amazon–Orinoco outflow). Fluctuations in sea level, climate, and ocean-current dynamics over the past ~10 million years likely produced marked variation in the effectiveness of the Amazon barrier, allowing intermittent dispersal leading to establishment and allopatric speciation. This dynamic Amazon barrier represents a major engine of West Atlantic faunal enrichment that has repeatedly facilitated bi-directional dispersal, allopatric speciation, and remixing of the Caribbean and Brazilian faunas (Moura & Sazima 2003, Rocha 2004, Robertson *et al.* 2006).

Because of this considerable isolation, caution should be used when management decisions are based on populations from different sides of the Amazon–Orinoco barrier. Moreover, several of the recently discovered species are relatively abundant on coastal habitats such as reefs and mangroves, but were frequently misidentified (see Rocha & Rosa 1999, Moura *et al.* 2001). This amplifies the need for depositing voucher specimens from ecological and fishery studies in major collections, supports the call for collection building in developing countries, and stresses the need for additional analyses of the numerous systematic problems peculiar to tropical coastal ichthyofaunas.

Taxonomic remarks on *Bodianus aya* and *Genyoroge canina*

Bodianus aya Bloch, 1790, described from Brazil after a pre-Linnaean work by the Dutch naturalist Marc-

grave (1648), has been considered a *Lutjanus* species (e.g. Jordan & Fesler 1893, Meek & Hildebrand 1925, Lima 1965, Anderson 1967). However, because types are not extant and the original description of *B. aya* is not informative, the assignment of *B. aya* within the family Lutjanidae has been controversial. Lima (1965) and Anderson (1967) recognized *Lutjanus aya* (Bloch) as the commercially important “red snapper.” On the other hand, Rivas (1966) regarded *Bodianus aya* Bloch as a sciaenid, and distinguished two species of red snappers, the northern red snapper, *L. campechanus* (Poey), and the southern red snapper, *L. purpureus* Poey, as previously suggested by Hildebrand & Ginsburg (1926) and Ginsburg (1930). Allen (1985), apparently following Rivas (1966), did not include *L. aya* in his list of nominal species of Lutjanidae. We examined Marcgrave’s (1648) and Bloch’s (1790) descriptions and plates and could not assign *B. aya* to any known Atlantic *Lutjanus* species, and consider it to be an unidentifiable nominal species, as already suggested by Eschmeyer (1998). For the purpose of nomenclatural stability a petition should be submitted to the International Commission on Zoological Nomenclature requesting the suppression of the name *Bodianus aya* Bloch, 1790.

Allen (1985) did not include *L. caninus* in his list of nominal species of Lutjanidae; however, Jordan & Fesler (1893) reassigned *Genyoroge canina* Steindachner, 1869 to *Lutjanus* and recognized *L. caninus* as valid. They remarked that it might be a synonym of the West Atlantic cubera snapper, *L. cyanopterus* based on its deeply emarginate preopercle. The original description of *G. canina* was based on three syntypes (NMW 41312) from Lagos, Nigeria, and Brazil (Steindachner 1869). Following a remark by Eschmeyer (1998), we concur that *Genyoroge canina* Steindachner 1869 should be regarded as a junior synonym of the West African species *Lutjanus endecacanthus* Bleeker, 1863, which also has a deeply emarginate preopercle.

Based on the new information added here, a total of eight *Lutjanus* species are now recorded from the southwestern Atlantic (Brazilian common names are in parentheses): *L. alexandrei*, the Brazilian snapper (“baúna”, “caranha”, “caranho”); *L. analis* (Cuvier), the mutton snapper (“caranho-vermelho”, “cioba”, “saioba”); *L. bucanella* (Cuvier), the blackfin snapper (“pargo-boca-preta”); *L. cyanopterus* (Cuvier), the cubera snapper (“caranha”, “caranho”); *L. jocu* (Bloch & Schneider), the dog snapper (“dentão”, “vermelho”); *L. purpureus* (Poey), the southern red snapper (“pargo”, “vermelho”, “cachucho”); *L. synagris* (Linnaeus), the lane snapper (“greacó”, “ariocó”, “vermelho-henrique”, “baúna”); and *L. vivanus* (Cuvier), the silk snapper (“pargo”, “vermelho”). Brazilian records of *L. mahogany* (Cuvier), the mahogany snapper are probably based on misidentifications (Carvalho-Filho 1994). As noted for the western North Atlantic (e.g. Camber 1955, Carpenter 1965), common names used for snappers has been very inconsistent in the southwestern Atlantic.

Key to the Western Atlantic species of *Lutjanus* (modified from Allen 1985 and Anderson 2003)

- 1a. Dorsal fin with 10 spines and usually 12 soft rays (rarely 11 or 13) 2
- 1b. Dorsal fin usually with 10 spines (rarely 9 or 11) and 14 soft rays (rarely 13 or 15) 3
- 2a. Gill rakers 7–8 + 15–17 (including rudiments); 1/4 to 1/2 of black lateral spot extending below lateral line; no evident paler (yellow in life) stripes on body and head; angle of preopercle greatly projecting and strongly serrated *L. mahogoni* (Cuvier)
[southeastern coast of Florida and eastern coast of Yucatan peninsula to Venezuela]
- 2b. Gill rakers 6–7 + 13–14 (including rudiments); less than 1/4 of black lateral spot extending below lateral line; 8–10 prominent paler (golden-yellow in life) stripes on body, often also 3–4 irregular paler (golden-yellow in life) stripes on head; angle of preopercle scarcely projecting and finely serrated
..... *L. synagris* (Linnaeus)
[Bermuda and North Carolina to Santa Catarina, southern Brazil, including the West Indies, Gulf of Mexico, and Caribbean Sea]
- 3a. Large, pronounced black spot at base and in axil of pectoral fin in specimens larger than 5 cm SL; dark area at base of soft portion of dorsal fin (not always visible on preserved specimens); no black spot on flanks; anal fin rounded *L. bucanella* (Cuvier)

[Bermuda and North Carolina to northeastern Brazil (at least to Bahia), including West Indies, Gulf of Mexico, and Caribbean Sea]

- 3b. No black spot at base or axil of pectoral fin no dark area at base of soft portion of dorsal fin; black spot on flanks may be present or absent; anal fin rounded or angulate..... 4
- 4a. Anal fin angulated, at least in specimens larger than 10 cm SL; middle anal-fin rays produced, the longest at least half length of head (rounded in *L. analis*, *L. campechanus*, *L. purpureus* and *L. vivanus* less than 4 to 6 cm SL); a black spot on flank (disappears in *L. campechanus*, *L. purpureus* and *L. vivanus* at about 20 cm SL) 5
- 4b. Anal fin rounded at all sizes, middle rays less than half the length of head; no dark spot on flank..... 8
- 5a. Vomerine tooth path without a distinct medial posterior extension; anal soft rays usually 8 (rarely 7); iris red in life; spot on flanks below anterior part of soft dorsal fin distinct at all sizes, being relatively larger in smaller specimens..... *L. analis* (Cuvier)
[New England to São Paulo, southeastern Brazil, including West Indies, Gulf of Mexico, and Caribbean Sea]
- 5b. Vomerine tooth path triangular or anchor-shaped, with a medial posterior extension; anal soft rays 7 to 9; spot on flank below anterior part of soft dorsal fin distinct in smaller specimens but may be absent in specimens larger than 20 cm SL (*L. campechanus*, *L. purpureus* and *L. vivanus*)..... 6
- 6a. Scales on sides of anterior part of body, below lateral line, conspicuously larger than those on posterior part of body; anal soft rays 9 (rarely 8); lateral line scales usually 47 or 49 (rarely 46 or 50); scales above lateral line 7 to 10, most frequently 8 or 9..... *L. campechanus* (Poey)
[North American coast from Massachusetts to the Florida Keys and in the Gulf of Mexico; rare north of the Carolinas]
- 6b. Scales on anterior part of body, below lateral line, not conspicuously larger than those on posterior part of body; anal soft rays 8 (rarely 7 or 9); lateral line scales usually 50 or 51 (rarely 49, 52 or 53); scales above lateral line 9 to 12, most frequently 10 or 11 7
- 7a. Cheek scale rows 6 (rarely 5 or 7); scales above lateral line, on anterior part of body, smaller than those below; scales below lateral line 16 to 19; lateral spot on flank present on juveniles equal to, or larger than eye; iris red in live and freshly preserved specimens; sum of lateral scales and scales above and below lateral line usually 77 to 81 (rarely 76 or 82) *L. purpureus* (Poey)
[Yucatan Peninsula and the southern coast of Cuba southeastward throughout the Caribbean and most of the Antilles to São Paulo, southeastern Brazil; also collected at localities off the Carolinas, Georgia, and Northeast Florida].
- 7b. Cheek scale rows 7 (rarely 8); scales on anterior part of body above lateral line, on anterior part of body, about equal in size to those below; scales below lateral line 20 to 24; lateral spot on flank, when present, smaller than eye; iris yellow in live and freshly preserved specimens; sum of lateral scales and scales above and below lateral line usually 82 to 87 (rarely 81 or 88) *L. vivanus* (Cuvier)
[Bermuda and North Carolina south to São Paulo, southeastern Brazil, including West Indies, Gulf of Mexico, and Caribbean Sea]
- 8a. Vomerine tooth patch without a distinct medial posterior extension; upper and lower canines very strong and about equally developed; cheek scales usually in 9 rows (rarely 8 or 10)..... *L. cyanopterus* (Cuvier)
[Nova Scotia and Bermuda south to São Paulo, southeastern Brazil, including West Indies, Gulf of Mexico, and Caribbean Sea]
- 8b. Vomerine tooth patch triangular or anchor-shaped, with a distinct medial posterior extension; upper canines larger than lower; cheek scales usually in 7 or 8 rows (rarely 5, 6 or 9) 9
- 9a. Usually 9 to 10 scales between dorsal-fin origin and lateral line (rarely 8 or 11); 45–49 transverse scale

- rows on body; a triangle-shaped whitish bar between the ventral margin of the orbit and the area immediately posterior to the maxilla in specimens larger than 15 cm SL..... *L. jocu* (Bloch & Schneider)
[From Massachusetts south to São Paulo, southeastern Brazil, including West Indies, Gulf of Mexico, and Caribbean Sea; rare north of Florida]
- 9b. Five to 7 scales between dorsal-fin origin and lateral line; usually 40 to 43 (rarely 39 or 44) transverse scale rows on body; no triangular whitish bar between the ventral margin of the orbit and the area immediately posterior to the maxillary 10
- 10a. Scale rows below soft portion of dorsal fin oblique to the longitudinal body axis; no evident banding pattern on body *L. griseus* (Cuvier)
[Massachusetts and Bermuda to French Guiana, including West Indies, Gulf of Mexico, and Caribbean Sea]
- 10b. Scale rows parallel to the longitudinal body axis, not becoming oblique below the posterior portion of soft dorsal fin; evident banding pattern on body (may disappear in preserved specimens) 11
- 11a. Yellowish to gray fins and body; eight pale vertical lines usually present separating darker bands on dorsal surface of flank; sixth pale vertical line under the junction of spiny and soft portions of dorsal fin; no conspicuous dark spots on cheek and preopercle *L. apodus* (Walbaum)
[Massachusetts and Bermuda south to Tobago, including West Indies, Gulf of Mexico, and Caribbean Sea]
- 11b. Reddish fins and body; six white vertical lines separating darker bands on dorsal surface of flanks; fifth paler vertical bar under junction of spiny and soft portions of dorsal fin; conspicuous dark spots (bright blue in life) on cheek and preopercle, 7–10 of these typically present with varying placement on snout and ventral portion of head *L. alexandrei* **n. sp**
[Tropical southwestern Atlantic, from Maranhão to Bahia, Brazil]

Acknowledgments

We are indebted to William D. Anderson Jr. (GMBL) for providing us with literature and data, and for reviewing the manuscript. Ronaldo B. Francini-Filho (Universidade Federal da Bahia), Naércio A. Menezes and José Lima de Figueiredo (MZUSP), Rodolfo Claro (Instituto de Oceanología, Cuba), Ricardo M. C. Castro (Laboratório de Ictiologia, Universidade de São Paulo, Ribeirão Preto), Bilianna Cicin-Sain (University of Delaware), Les Kaufman (Boston University), Gerald R. Allen and Guilherme F. Dutra (Conservation International), Matheus O. Freitas and Maurício Hostim (VIDAMAR, Projeto Meros), Beatrice P. Ferreira and Sérgio Resende (Universidade Federal de Pernambuco), Carolina V. Minte-Vera (UEM/NUPELIA), Jeff Clayton (USNM) and Luiz A. Rocha (University of Hawaii) provided insightful comments, unpublished information, and/or logistical support. Mário de Pinna (MZUSP) provided the radiographs and Paulo A. Buckup allowed us to examine material deposited at MNRJ. This paper benefited from a PRONEX/MCT grant to Naércio A. Menezes, a FAPESP grant (98/03491-3) to RLM, travel funds from CI-Brasil and ED to RLM and KCL, travel funds from the U.S.-Brazil Marine Policy Consortium via the U.S. Department of Education and the Coordenadoria de Aperfeiçoamento de Pessoal de Nivel Superior (CAPES) to KCL. This is Contribution Number One of the Marine Managed Areas Science Program, Brazil Node.

Literature cited

- Allen, G.R. (1985) FAO species catalogue. Vol. 6 Snappers of the world: An annotated and illustrated catalogue of the lutjanid species known to date. *FAO Fisheries Synopsis* 125, 1–208.
- Allen, G.R. (1987) Synopsis of the circumtropical genus *Lutjanus* (Pisces: Lutjanidae). *In*: Polovina, J.J. & Ralson, S.

- (Eds), *Tropical snappers and groupers: Biology and fisheries management*. Westview Press, pp. 33–88.
- Anderson, W.D., Jr. (1967) Field guide to the snappers (Lutjanidae) of the Western Atlantic. *United States Department of the Interior Circular*, 252, 1–14.
- Anderson, W.D., Jr. (1987) Systematics of the fishes of the family Lutjanidae (Perciformes: Percoidae), the snappers. In: Polovina, J.J. & Ralson, S. (Eds), *Tropical snappers and groupers: Biology and fisheries management*. Westview Press, pp. 1–32.
- Anderson, W.D., Jr. (2003) Lutjanidae. In: Carpenter, K.E. (Ed) *The living marine resources of the Western Central Atlantic. Volume 3: Bony fishes part 2 (Opistognathidae to Molidae)*. FAO Species Identification Guide for Fishery Purposes and American Society of Ichthyologist and Herpetologists Special Publication, 5, pp. 1479–1504.
- Bemvenuti, M.A. (1995) *Odontesthes mirinensis*, sp. n. um novo peixe-rei (Pisces, Atherinidae, Atherinopsinae) para o extremo sul do Brasil. *Revista Brasileira de Zoologia*, 12, 881–903.
- Bleeker, P. (1863) Mémoire sur les poissons de la côte de Guinée. *Natuurkundige Verhandelingen Hollandsche Maatschappye Weetenschappen te Haarlem* (Ser. 2), 18, 1–136.
- Bloch, M.E. (1790) *Naturgeschichte der ausländischen Fische*. Berlin, 4, 128 pp.
- Briggs, J.C. (1974) *Marine zoogeography*. McGraw-Hill, 475 pp.
- Burgess, W.E. (2001) *Prognathodes brasiliensis*, a new species of butterflyfish (Teleostei: Chaetodontidae) from southern Brazil. *Tropical Fish Hobbyist*, 49, 56–63.
- Camber, C.I. (1955) A survey of the red snapper fishery of the Gulf of Mexico, with special reference to the Campeche banks. *Florida State Department of Conservation, Technical Series*, 12, 1–63.
- Carpenter, J.S. (1965) A review of the Gulf of Mexico red snapper fishery. *Fish and Wildlife Series, Bureau of Commercial Fisheries, Circular*, 208, 35 p.
- Carvalho-Filho, A. (1994) *Peixes: Costa Brasileira*. Editora Marca d'água, 304 pp.
- Claro, R., Lindeman, K.C. & Parenti, L. R. (2001) *Ecology of the Marine Fishes of Cuba*. Smithsonian Institution Press, 257 pp.
- Eschmeyer, W.N. (1998) *Catalogue of fishes*. California Academy of Sciences, 3 vols. (with updates accessed on 20 September 2006 from <http://www.calacademy.org/research/ichthyology/catalog/>)
- Feitoza, B.M. (2002) *Platygillellus brasiliensis* n. sp. (Perciformes: Dactyloscopidae), the third species of the genus from the Atlantic. *Aqua, Journal of Ichthyology and Aquatic Biology*, 6, 21–28.
- Feitoza, B.M., Rosa, R.S. & Rocha, L.A. (2005). Ecology and zoogeography of deep reef fishes in northeastern Brazil. *Bulletin of Marine Science* 76, 725–742.
- Fowler, H.W. (1941) A list of the fishes known from the coast of Brazil. *Arquivos de Zoologia, São Paulo*, 3, 115–184.
- Gasparini, J.L., Moura, R.L. & Sazima, I. (1999.) *Stegastes trinidadensis* n. sp. (Pisces: Pomacentridae), a new damselfish from Trindade Island, off Brazil. *Boletim do Museu de Biologia Mello Leitão* (N. Ser.), 10, 3–11.
- Gasparini, J.L., Rocha, L.A. & Floeter, S.R. (2001) *Ptereleotris randalli* n. sp., a new dartfish (Gobioidae: Microdesmidae) from the Brazilian coast. *Aqua, Journal of Ichthyology and Aquatic Biology*, 4, 109–114.
- Gasparini, J.L., Joyeux J.C. & Floeter, S.R. (2003) *Sparisoma tuiupiranga*, a new species of parrotfish (Perciformes: Labroidae: Scaridae) from Brazil, with comments on the evolution of the genus. *Zootaxa*, 384, 1–14.
- Gilbert, C.H. (1900) Results of the Branner-Agassiz expedition to Brazil. III. The fishes. *Proceedings of the Washington Academy of Sciences*, 2, 161–184.
- Ginsburg, I. (1930) Commercial snappers (Lutjanidae) of Gulf of Mexico. *Bulletin of the United States Bureau of Fisheries*, 46, 265–276.
- Gomes, U.L. & Paragó, C. (2001) Espécie nova de rajídeo (Chondrichthyes, Rajiformes) do Atlântico sul ocidental. *Boletim do Museu Nacional, Rio de Janeiro*, 448, 1–10.
- Gomes, U.L., Rosa, R.S. & Gadig, O.B.F. (2000) *Dasyatis macrophthalma* sp. n.: a new species of stingray (Chondrichthyes: Dasyatidae) from the southwestern Atlantic. *Copeia*, 2000, 510–515.
- Guimarães, R.Z.P & Bacelar, A.C.L.H. (2002) Review of the Brazilian species of *Paraclinus* (Teleostei: Labrisomidae), with descriptions of two new species and revalidation of *Paraclinus rubicundus* (Starks). *Copeia*, 2002, 419–427.
- Heiser, J.B., Moura, R.L. & Robertson, D.R. (2000) Two new species of Creole Wrasse (Labridae: *Clepticus*) from opposite sides of the Atlantic. *Aqua, Journal of Ichthyology and Aquatic Biology*, 4, 67–76.
- Hildebrand, S.F. & Ginsburg, I. (1926) Descriptions of two new species of fishes from Key West, Fla., with notes on nine other species collected in the same locality. *Bulletin of the Bureau of Fisheries*, 42, 207–215.
- Jordan, D.S. (1891) List of fishes obtained in the harbor of Bahia, Brazil, and in adjacent waters. Scientific results of explorations by the U. S. Fish Commission steamer Albatross. *Proceedings of the United States National Museum*, 13, 313–336.
- Jordan, D.S. & Fesler, B. (1893) A review of the sparoid fishes of America and Europe. *Reports of the United States Fisheries Commissioner*, 27, 421–544.
- Jordan, D.S. & Swain, J. (1884) A review of the species of Lutjaninae and Hoplopagrinae found in American waters. *Proceedings of the United States National Museum*, 7, 427–474.
- Leviton, A.E., Gibbs, R.H., Jr., Heal, E. & Dawson, C.E. (1985) Standards in herpetology and ichthyology. Part I. Stan-

- dard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia*, 1985, 802–832.
- Lima, F.R. (1965) Crescimento do “pargo” (*Lutjanus aya*, Bloch, 1795): Aspectos quantitativos. *Boletim da Estação de Pesca, Recife*, 5, 33–42.
- Linnaeus, C. (1758) *Systema Naturae, Ed. X. (Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio decima, reformata.) Holmiae. Systema Naturae*, pp. 230–338.
- Lindeman, K.C., Diaz, G.A., Serafy, J.E. & Ault, J.S. (1998) A spatial framework for assessing cross-shelf habitat use among newly settled grunts and snappers. *Proceedings of the Gulf & Caribbean Fisheries Institute*, 50, 385–416.
- Lindeman, K.C., Richards, W.J., Lyczkowski-Shultz, J., Drass, D.M., Paris, C.B., Leis, J.M., Lara, M. & Comyns, B.H. (2005) Lutjanidae: Snappers. In: Richards, W.J. (Ed.) *Early Stages of Atlantic Fishes*. CRC Press, pp. 1549–1585.
- Lindeman, K.C. & DeMaria, D. (2005) Juveniles of the Caribbean’s largest coral reef snapper do not use reefs. *Coral Reefs*, 24, 359.
- Loftus, W.F. (1992) *Lutjanus ambiguus* (Poey), a natural intergeneric hybrid of *Ocyurus chrysurus* (Bloch) and *Lutjanus synagris* (Linnaeus). *Bulletin of Marine Science*, 50, 489–500.
- Marcgrave, G. (1648) *Historiae rerum naturalium Brasiliae. Libri viii, a Joh. de Laet in ordinem digesti et annotationibus illustrati*. Lugduni Batavorum et Amstelodami, 303 pp.
- Meek, S.E. & Hildebrand, S.F. (1925) The marine fishes of Panama. *Field Museum of Natural History Publications, Zoological Series*, 226, 15, 331–707.
- Menezes, N.A. (1971) A new species of *Paratrachichthys* from the coast of Brazil (Pisces, Trachichthyidae). *Papéis Avulsos de Zoologia, São Paulo*, 27, 143–148.
- Menezes, N.A. & Figueiredo, J.L. (1980) *Manual de peixes marinhos do sudeste do Brasil. IV. Teleostei (3)*. Museu de Zoologia, Universidade de São Paulo, 96 pp.
- Menezes, N.A. & Figueiredo, J.L. (1998) Revisão das espécies da família Batrachoididae do litoral brasileiro com a descrição de uma espécie nova (Osteichthyes, Teleostei, Batrachoidiformes). *Papéis Avulsos de Zoologia, São Paulo*, 40, 337–357.
- Menezes, N.A., Figueiredo, J.L. & Britsky, H.A. (1997) Ichthyological collection building at the Museu de Zoologia da Universidade de São Paulo, Brazil. In: Pietsch, T.W. & Anderson, W.D., Jr. (Eds.) *Collection building in ichthyology and herpetology*. American Society of Ichthyologists and Herpetologists Special Publication, 3, pp. 561–565.
- Menezes, N.A., Buckup, P.A., Figueiredo, J.L. & Moura, R.L. (2003) *Catálogo das espécies de peixes marinhos do Brasil*. Museu de Zoologia, Universidade de São Paulo, 159 pp.
- Mincarone, M.M. (2000) *Eptatretus menezesi*, a new species of hagfish (Agnatha, Myxinidae) from Brazil. *Bulletin of Marine Science*, 67, 815–819.
- Mincarone, M.M. (2001) *Myxine sotoi*, a new species of hagfish (Agnatha, Myxinidae) from Brazil. *Bulletin of Marine Science*, 68, 479–483.
- MMA (2002). *Avaliação e ações prioritárias para a conservação da biodiversidade das zonas costeira e marinha*. Ministério do Meio Ambiente, Secretaria de Biodiversidade e Florestas, Brasília, 26 pp.
- Moura, R.L. (1995) A new species of *Chromis* (Perciformes:Pomacentridae) from Southeastern Brazil, with notes on other species of the genus. *Revue Française d’Aquariologie et Herpetologie*, 21, 91–96.
- Moura, R.L. (2003) *Riqueza de espécies, diversidade e organização de assembléias de peixes em ambientes recifais: Um estudo ao longo do gradiente latitudinal da costa brasileira*. Instituto de Biociências, Universidade de São Paulo. Ph.D. Thesis, 620 p.
- Moura, R.L. & Castro, R.M.C. (2002) Revision of Atlantic sharpnose pufferfishes (Tetraodontiformes: Tetraodontidae: *Canthigaster*), with description of three new species. *Proceedings of the Biological Society of Washington*, 115, 32–50.
- Moura, R.L. & Menezes, N.A. (2003) Família Lutjanidae. In: Menezes, N.A., Buckup, P.A., Figueiredo, J.L. & Moura, R.L. (Eds.) *Catálogo das espécies de peixes marinhos do Brasil*. Museu de Zoologia, Universidade de São Paulo, pp. 82–83.
- Moura, R.L. & Sazima, I. (2003) Species richness and endemism levels of the Southwestern Atlantic reef fish fauna. *Proceedings, International Coral Reef Symposium*, 9, 481–486.
- Moura, R.L., Gasparini, J.L. & Sazima, I. (1999) New records and range extensions of reef fishes in the Western South Atlantic, with comments on reef fish distribution along the Brazilian coast. *Revista Brasileira de Zoologia*, 16, 513–530.
- Moura, R.L., Francini-Filho, R.B., Rodrigues, M.C. M. & Sazima, I. (1999) Unexpected richness of reef corals near the southern Amazon River mouth. *Coral Reefs*, 18, 170.
- Moura, R.L., Figueiredo, J.L. & Sazima, I. (2001) A new parrotfish (Scaridae) from Brazil, and revalidation of *Sparisoma amplum* (Ranzani, 1842), *Sparisoma frondosum* (Agassiz, 1831), *Sparisoma axillare* (Steindachner, 1878) and *Scarus trispinosus* Valenciennes, 1840. *Bulletin of Marine Science*, 68, 505–524.
- Oliveira, A.A. & Daly, D. (2001) *Florestas do Rio Negro*. Companhia das Letras, 339 pp.
- Poey, F. (1860) *Memorias sobre la historia natural de la Isla de Cuba, acompañadas de sumarios Latinos y extractos en*

- Francés. Tomo 2. La Habana. Vol. 2, pp. 97–336.
- Polovina, J.J. & Ralston, S. (1987) *Tropical snappers and groupers: Biology and fisheries management*. Westview Press, 659 pp.
- Ribeiro, A.M. (1915) Fauna brasiliense. Peixes. Tomo V. [Eleutherobranchios aspirophoros]. Physoclisti. *Arquivos do Museu Nacional, Rio de Janeiro*, 17.
- Ribeiro, A.M. (1918) Fauna brasiliense. Peixes. Tomo V. [Eleutherobranchios Aspirophoras]. Physoclisti. *Arquivos do Museu Nacional, Rio de Janeiro*, 21.
- Rivas, L.R. (1949) A record of the lutjanid fish (*Lutjanus cyanopterus*) for the Atlantic coast of the United States, with notes on related species of the genus. *Copeia*, 1949, 150–152.
- Rivas, L.R. (1966) Review of *Lutjanus campechanus* complex of red snappers. *Quarterly Journal of the Florida Academy of Sciences*, 29, 117–136.
- Rivas, L.R. (1970) Snappers of the Western Atlantic. *United States Fish and Wildlife Service, Commercial Fisheries Review*, 860, 41–44.
- Robertson, D.R., Karg, F., Moura, R.L., Victor, B.C. & Bernardi, G. (2006) Mechanisms of speciation and faunal enrichment in Atlantic parrotfishes. *Molecular Phylogenetics and Evolution*, 40, 795–807.
- Rocha, L.A. (2003) Patterns of distribution and processes of speciation in Brazilian reef fishes. *Journal of Biogeography*, 30, 1161–1171.
- Rocha, L.A. (2004) Mitochondrial DNA and color pattern variation in three Western Atlantic *Halichoeres* (Labridae), with the revalidation of two species. *Copeia*, 2004, 70–782.
- Rocha, L.A. & Rosa, I.L. (1999) New species of *Haemulon* (Teleostei: Haemulidae) from the Northeastern Brazilian coast. *Copeia*, 1999, 447–452.
- Rocha, L.A. & Rosa, I.L. (2001) Baseline assessment of reef fish assemblages of Parcel Manuel Luiz Marine State Park, Maranhão, north-east Brazil. *Journal of Fish Biology*, 58, 985–998.
- Rocha, L.A., Rosa, I.L. & Rosa, R.S. (1998) Peixes recifais da costa da Paraiba, Brasil. *Revista Brasileira de Zoologia*, 15, 553–566.
- Rocha, L.A., Bass, A.L., Robertson, D.R. & Bowen, B.W. (2002) Adult habitat preferences, larval dispersal, and the comparative phylogeography of three Atlantic surgeonfishes (Teleostei: Acanthuridae). *Molecular Ecology*, 11, 243–252.
- Sadovy, Y. & Eklund, A.M. (1999) Synopsis of biological data on the Nassau grouper, *Epinephelus striatus* (Bloch, 1792), and the jewfish, *E. itajara* (Lichtenstein, 1822). *NOAA Technical Report*, 146, 1–65.
- Sazima, I., Moura, R.L. & Rosa, R.S. (1997) *Elacatinus figaro* sp. n. (Perciformes: Gobiidae), a new cleaner goby from the coast of Brazil. *Aqua, Journal of Ichthyology and Aquatic Biology*, 2, 33–38.
- Sazima I., Gasparini J.L. & Moura R.L. (1998) *Gramma brasiliensis*, a new basslet from the western South Atlantic (Perciformes: Grammatidae). *Aqua, Journal of Ichthyology and Aquatic Biology*, 3, 39–43.
- Sazima, I., Gasparini, J.L. & Moura, R.L. (2002) *Labrisomus cricota*, a new scaled blenny from the coast of Brazil (Perciformes: Labrisomidae). *Aqua, Journal of Ichthyology and Aquatic Biology*, 5, 127–132.
- Starck, W.A. (1970) Biology of the gray snapper, *Lutjanus griseus* (Linnaeus), in the Florida Keys. *Stud. Trop. Oceanogr. Univ. Miami* 10, 1–150.
- Starks, E.C. (1913) *The Fishes of the Stanford Expedition to Brazil*. Leland Stanford Jr. University Publications, 77 pp.
- Steindachner, F. (1869) Eine Abhandlung über einige neue Fischarten aus den Sammlungen des Wiener-Museums. *Anzeiger (Österreichische Akademie der Wissenschaften)*, 6, 149–150.
- Uyeno, T., Matsuura, K. & Fuji, E. (1983) *Fishes Trawled off Surinam and French Guiana*. Tokio, Japan Marine Fishery Resource Research Center, 519 pp.
- Vergara, R. (1977) Family Lutjanidae. In: Fisher, W. (Ed.) *FAO species identification sheets for fishery purposes*. Eastern Central Atlantic, Fishing Area 31. Rome.
- Walbaum, J.J. (1792) *Petri Artedi sueci genera piscium. In quibus systema totum ichthyologiae proponitur cum classibus, ordinibus, generum characteribus, specierum differentiis, observationibus plurimis. Redactis speciebus 242 ad genera 52. Ichthyologiae pars III. Petri Artedi renovai*. Greifswald (Germany), 723 p.