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PENSOFT

First record of the Sea Chub, *Kyphosus atlanticus* (Sakai & Nakabo 2014) (Perciformes, Kyphosidae), in the extreme south of the Brazilian coast

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Abstract
This is the first record of *Kyphosus atlanticus* (Sakai & Nakabo, 2014) from Tramandai, Rio Grande do Sul state, Brazil. In the Western Atlantic, the range of this marine fish known to extend from New England to São Paulo state, Brazil. We hypothesize that the occurrence of *K. atlanticus* outside its natural range is due to the recent (1968) establishment of new fish aggregation devices (two buoys, SPM-1 and SPM-2, of the Sea Terminal "Almirante Soares Dutra"), which enable this species to populate new areas.

Key words
Sea chubs; Western Atlantic coast; extension range; fish aggregation devices.

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Introduction

The family Kyphosidae comprises species of sea clubs, marine teleosts that are distributed throughout tropical and subtropical waters in the Atlantic, Pacific, and Indian oceans (Knudsen and Clements 2013). They inhabit shallow waters, less than 10 m deep (Knudsen and Clements 2013) and are associated mainly with rocky shores and reefs (Nelson 2006). The vast majority of kyphosids are herbivores and are important biomass for energy transfer in coastal ecosystems (Choat et al. 2004, Ferreira et al. 2004).

Kyphosus incisor (Cuvier, 1831) and *K. sectatrix* (Linnaeus, 1766) were described from the Atlantic Ocean (Randall 1968, Smith-Vaniz et al. 1999, Carpenter 2002). However, the genus *Kyphosus* has been object of recent taxonomic revisions (Knudsen and Clements 2013, Sakai and Nakabo 2014) and there is no consensus about the validity of the species assigned to the genus (Gilbert 2015). According Knudsen and Clements (2013), four kyphosids occur in the Atlantic Ocean: *Kyphosus vaigiensis* (Quoy & Gaimard, 1825), *K. bigibbus* (Lacepède, 1801), *K. sectatrix* (Linnaeus, 1766) and *K. cinerascens* (Forsskål, 1775). However, Sakai and Nakabo (2014) limited the occurrence of only three species in Atlantic waters: *K. incisor*, *Kyphosus bosquii* (Lacepède, 1801) and *Kyphosus atlanticus* (Sakai & Nakabo, 2014).

Based on unpublished molecular and morphological phylogenetic analyses, Knudsen and Clements (2013)

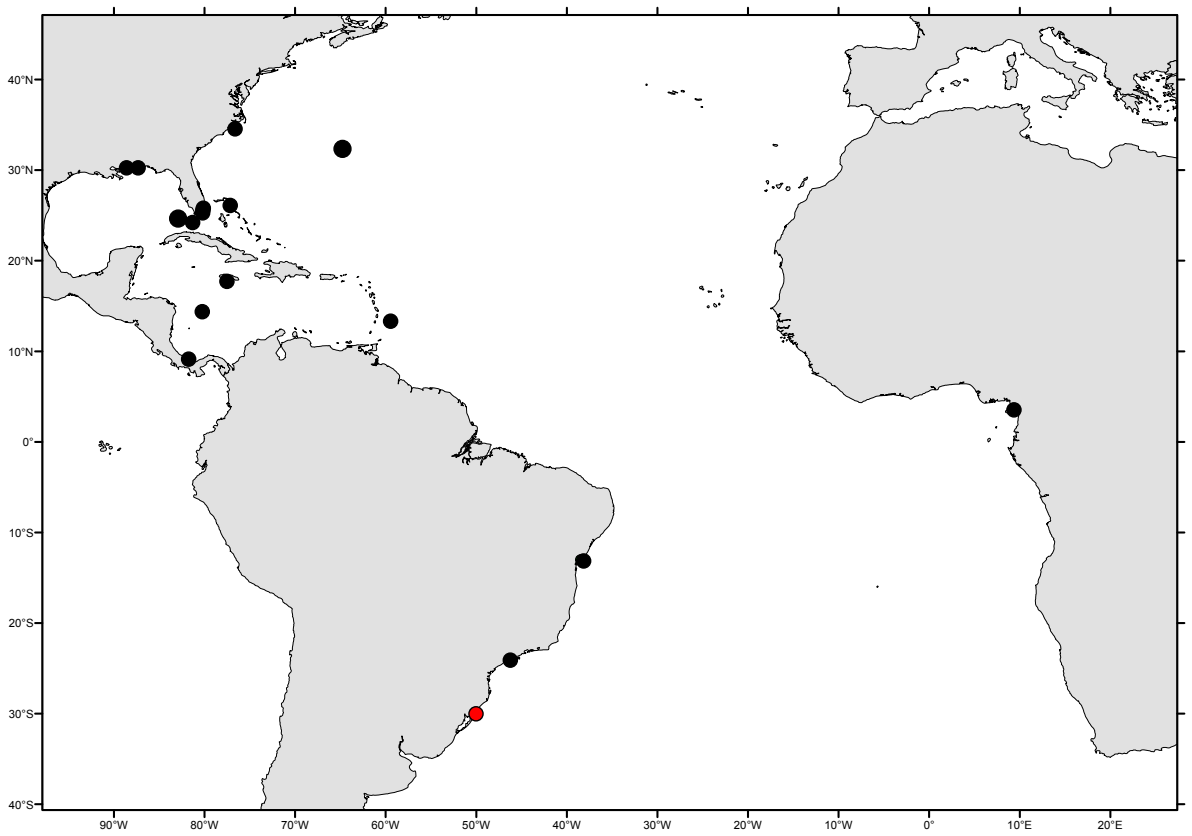

Figure 1. Map with the distribution of *Kyphosus atlanticus* according to work of Sakai and Nakabo (2014). The red circle represents the new record in the city of Tramandaí.

considered *K. incisor* as a synonym of *K. vaigiensis*; they assumed that the identification of *K. bigibbus* was being confused with *K. sectatrix* and concluded that *K. bigibbus* has a broad distribution in the Atlantic Ocean. Additionally, Knudsen and Clements (2013) identified *K. cinerascens* from Atlantic waters, based on photographic records. However, based on morphological data, Sakai and Nakabo (2014) believed that *K. incisor* is a valid species but believed that the *K. sectatrix* is a complex of two different species: *K. atlanticus* and *K. bosquii*.

According to Sakai and Nakabo (2014), *K. incisor* is very similar to *K. vaigiensis* in having 14 dorsal- and 13 anal-fin soft rays but differ in the combination of the longitudinal row of scales along midbody (57–64, mode 60, in *K. incisor* and 56–64, mode 60, in *K. vaigiensis*) and total gill rakers (26–30, mainly 28, in *K. incisor* and 29–34, mainly 31 or 32 in *K. vaigiensis*). The key to the Atlantic species of Kyphosidae (Knudsen and Clements 2013) indicates that *K. vaigiensis* has more than 70 longitudinal rows of scales along midbody and disregards the occurrence of *K. incisor*. The Atlantic *Kyphosus* species with 12 dorsal-fin and 11 anal-fin soft rays have been identified as *K. sectatrix* (Jordan and Fesler 1893, Moore 1962, Randall 1968, Smith-Vaniz et al. 1999, Knudsen and Clements 2013), but Sakai and Nakabo (2014) found differences in the longitudinal row of scales along midbody and reclassified those species as: *K. bosquii* (60–72 scales) and *K. atlanticus* (50–58 scales), the later newly described.

It is assumed that the range of *K. bosquii* includes the region between Nova Scotia (Canada) to Florianopolis (Brazil), and that of *K. atlanticus* from North Carolina (USA) to Santos (southeast Brazil), although there is the possibility that specimens identified as *K. sectatrix* from Santa Catarina state (Brazil) are actually *K. atlanticus* or *K. bosquii* (Sakai and Nakabo 2014). According to Sakai and Nakabo (2014), *K. incisor* occurs along the whole extent of the Brazilian coast and reaching south as far as Mar del Plata, Argentina (Cousseau and Menni 1983).

Herein, we provide an official record of the presence of *K. atlanticus* at Tramandai (RS) and extend the known distribution of this species to extreme south of the Brazilian coast (Fig. 1).

Methods

A live specimen belonging to the genus *Kyphosus* was captured (September 2014) by artisanal fishermen from the town of Tramandaí (30°0′48.95″ S, 050°08′04.92″ W), Rio Grande do Sul (RS) state, southern Brazil. The fishing gear used by the artisanal fishermen was a trammel net ("Rede de cabo" in Portuguese), which comprises nets at depths up to 3 m that remain fixed by a system of cables in the surf zone. Following its capture, the specimen was stored on ice and taken to the Ichthyology Laboratory of the Oceanographic Institute, Federal University of Rio Grande (FURG), where it was fixed in a formalin solution and deposited in the FURG ichthyological collection (FURG 2720-09/2014).

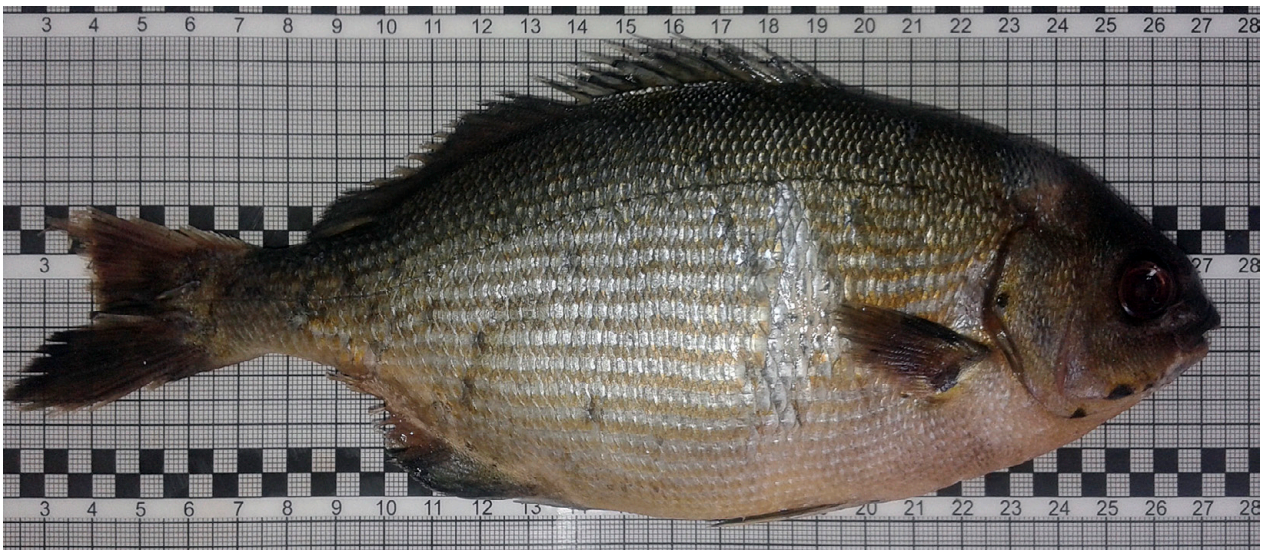

Figure 2. *Kyphosus atlanticus* (FURG 2720-09/2014) captured off the southern Brazilian coast.

Table 1. Morphometric and meristic data of *Kyphosus atlanticus* captured in Tramandai, Brazil.

Morphometric characters	**(mm)**
Total length (TL)	243
Fork length (FL)	222
Standard length (SL)	203
Head length (HL)	50
Dorsal fin length 1	51
Dorsal fin length 2	48
Pectoral fin length	32
Pelvic fin length	32
Anal fin length	53
Eye diameter	12
Interorbital space	20
Snout length	10
Upper jaw length	9
Lower jaw length	7
Meristic characters	**Count**
Dorsal fin spines and soft rays	XI+12
Pectoral fin rays	18
Pelvic fin spines and soft rays	I+5
Anal fin spines and soft rays	III+11
Gill raker on first arch (upper limb + lower limb)	7+18
Scales along lateral line	52

Results

The specimen was identified following morphometric and meristic analyses using the identification key of Sakai and Nakabo (2014).

The specimen is an immature male weighting 256 g and measuring 243 mm total length (Fig. 2). The body is gray-silver with longitudinal yellow stripes, oval-shaped, and with a small head and mouth. The shape of the head is slightly convex immediately above the eyes. The main meristic features are: dorsal fin with 12 soft rays, anal fin with 11 soft rays, 25 gill rakers on first arch, and 52 scales along lateral line. The full meristic and morphometric traits of this specimen are presented in Table 1.

The morphological and meristic identification keys by Knudsen and Clements (2013) and Sakai and Nakabo (2014) provided differing identifications for our specimen. According the key of Knudsen and Clements (2013), our specimen is *K. sectatrix*. However, using Sakai and Nakabo's (2014) key the species was identified as *K. atlanticus*. We follow Sakai and Nakabo (2014) which is the most current study and has a broad review of specimens reported to the Atlantic Ocean.

Discussion

The species-level systematics of the genus *Kyphosus* in the Atlantic Ocean is not well established, and authors (Knudsen and Clements 2013, Sakai and Nakabo 2014) do not agree which species are valid. It is possible that there is erroneous or misleading information and conflicting meristic data (Carter 2015). Therefore, the choice of which identification key to use is difficult. The correct identification is crucial because this completely changes our understanding of species' ranges.

Kyphosus atlanticus was recently described (Sakai and Nakabo 2014), and there is a lack of data on its distribution. Our record helps fill this gap. This is the first record of *K. atlanticus* from the extreme south of Brazil and represents a significant range extension for this species, which had its southern limit at Santos, Brazil (Sakai and Nakabo 2014).

Although, many fish species inhabit the surf zone of southern Brazil (Rodrigues and Vieira 2012), no kyphosids have previously been reported (Monteiro-Neto et al. 2003, Lima and Vieira 2009, Rodrigues and Vieira 2012). Considering that kyphosids typically occur in reef environments (Azzurro et al. 2013), the presence of *K. atlanticus* in the surf zone is unusual.

True herbivores, sea chubs have morphological and physiological characteristics that are suitable for consumption of algae (Moran and Clements 2002). Typical herbivore species of reefs are generally less abundant in temperate latitudes of the West Atlantic (Floeter et al. 2004). However, this is not so for *Kyphosus* spp., which

Table 2. Review of recording the presence of *Kyphosus* species in new habitats by world.

Species	Location	Reference
K. analogus (Gill, 1862)	USA (California)	Crooke 1973
K. bigibbus (Lacepède, 1801)	Japan	Zama 1976
K. incisor (Cuvier, 1831)	Mediterranean	Azzuurro et al. 2013
	Mediterranean	Relini et al. 2011
	Argentina	Cousseau and Menni 1983
K. sectatrix (Linnaeus 1766) = *Perca sectatrix*	Libya	Elbaraasi et al. 2013
	Greece (Ionian Sea)	Kiparissis et al. 2012
	Tunisia	Lelong 2012
	Italy	Ligas et al. 2011
	Portugal (Algarve coast)	Canas et al. 2005
	Adriatic Sea	Dulcic and Ahnelt 2006
	France (Mediterranean coast)	Francour and Mouine 2008
	Algeria	Hemida et al. 2004
	Mediterranean	Merella et al. 1998
	Spain (Galician coast)	Bañón 2004
	Tunisia	Hattour 2006
Kyphosus vaigiensis (Quoy & Gaimard, 1825)	New Zealand	Clements 2014
Kyphosus atlanticus (Sakai & Nakabo 2014)	Brazil (southern coast)	New record

are more abundant in reefs at higher latitudes in southeast Brazil (Ferreira et al. 2004). This is probably due to digestive adaptations, which enable them to consume algae from areas with lower temperatures (Ferreira et al. 2004).

Kyphosus species tend to inhabit coastal areas and may also occur in the vicinity of floating objects (fish aggregation devices: FADs) or boats; hence, they are frequently called "rudderfish*"* (Nelson 2006). There are reports that *Kyphosus* spp. have expanded their ranges over long distances (Azzurro et al. 2013). Over the last few years, studies have recorded *Kyphosus* spp. from new habitats (Table 2), and several hypotheses have been proposed to explain this expansion beyond presumed natural distributions. Large-scale changes in the temperature of the marine environment and/or the tendency of *Kyphosus* spp. to travel in the vicinity of FADs are the most commonly cited.

Here, we believe the presence of *K. atlanticus* at Tramandaí, Rio Grande do Sul, is related to anthropic factors. FADs could be changing the coastal environment of southern Brazil, creating conditions that are suitable for the establishment of reef fish species. The southern coast of Brazil, where *K. atlanticus* was found is part of the coastal plain. The coast is characterized by a long stretch of open and straight coastline, with sandy beaches without rock formations (Villwock et al. 2002). This environment is quite different from that characteristic natural distribution range of this species. In 1968, near the town of Tramandaí, the Sea Terminal "Almirante Soares Dutra" was built, which includes two buoys (SPM-1 and SPM-2) that were deployed to facilitate the sea access of oil tankers. The buoys are located 3.1 and 5 km from the shore at depths of 20 and 24 m (Petrobras 2006). According to local fishermen, the installation of these structures changed the fish assemblage in the region. Fishermen reported the capture of species typical of rocky and reef habitats, such as groupers (*Epinephelus* spp.).

Studies performed in Brazil have shown the importance of structures associated with the oil industry in promoting an increase in the abundance and density of species. Silva et al. (2002), for example, stated that platforms and buoys might have a double function for various species as artificial reefs and as FADs, favoring both reef and pelagic species. Records indicating that *K. sectatrix* is the fifth most abundant species in the vicinity of similar structures in the Gulf of Mexico (Stanley and Wilson 2000) and confirms the potential for *Kyphosus* spp. to colonize such artificial environments.

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Authors' Contributions

ML dos S collected the data; ML dos S, VML, DFAT and JPV wrote the text.

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