Opsanus beta: AN INVASIVE FISH SPECIES IN THE SANTOS ESTUARY, BRAZIL

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ABSTRACT

A non-indigenous fish species, *Opsanus beta*, was found during an ichthyofauna sampling program in Santos Estuary. Common on the west coast of Florida and the Caribbean, the most probable source of this occurrence is due to water ballast from the ships. The 140 specimens reported (18 to 323 mm TL; 8 to 442 g WT) were caught in fish baited traps (215.28 ± 5.95 mm TL; 207.36 ± 16.42 g WT; 25.7% of the total caught), otter-trawls (213.97 ± 5.87 mm TL and 194.92 ± 11.31 g; 54.3%) and gillnets (226.93 ± 5.40 mm TL and 218.14 ± 17.01 g; 20.0%). Of 81 specimens sexed, 43.6% of females (n = 55) and 92.0% of males (n = 24) have mature gonads. Santos estuarine areas are very similar to the *O. beta* original environment, and allied to the absence of natural predators, and its environmental plasticity, projecting it as a well adapted species in region, which must be viewed as a potential serious implication to other Brazilian estuarine systems.

Key words: Bioinvasion; water ballast; exotic species; Batrachoididae

Opsanus beta: UMA ESPÉCIE DE PEIXE INVASORA NO ESTUÁRIO DE SANTOS, BRASIL

RESUMO

Opsanus beta, espécie não nativa, foi registrada em um programa de monitoramento da ictiofauna no estuário de Santos. Comum na costa oeste da Flórida e Caribe, seu registro seria decorrente provavelmente da água de lastro de navios. Os 140 espécimes amostrados (18 a 323 mm CT, 8 a 442 g PT) foram capturados em armadilhas (215,28 ± 5,95 mm CT; 207,36 ± 16,42 g PT; 25,7% do total capturado), em arrastos-de-portas (213,97 ± 5,87 mm CT; 194,92 ± 11,31 g; 54,3%) e redes de emalhe (226,93 ± 5,40 mm CT; 218,14 ± 17,01 g; 20,0%). Dos 81 exemplares sexados, 43,6% das fêmeas (n = 55) e 92,0% dos machos (n = 24) apresentaram gônadas maduras. As áreas estuarinas de Santos são similares ao ambiente original da espécie e aliados à ausência de predadores naturais e à plasticidade ambiental, está se estabelecendo na região, implicando em risco potencial para outros sistemas estuarinos do sudeste-sul do Brasil.

Palavras chave: Bioinvasão; água de lastro; espécies exóticas; Batrachoididae

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INTRODUCTION

The increase of exotic invasive species in the harbor neighborhoods is one of the biggest problems concerning coastal environments and one the main reasons of biodiversity losses (BRITTON *et al.,* 2010; LOPES *et al.,* 2009). A great part of those invasions were caused by water ballast, a few one by aquaculture escaping which may causes economic impacts towards native species as fisheries resources and/or diseases and parasites occurrences (PIMENTEL, 2002; PIMENTEL *et al*., 2005). Potential risks for human are the unknown protozoan parasites and reports of ciguatera poisoning in humans (HALSTEAD, 1970; BURKHOLDER, 1998). As cited by WILLIAMS and GROSHOLZ (2008), 'Estuaries and coasts are particularly susceptible to introductions of nonnative species partly a consequence of being centers for the activities that represent the major vectors for introductions…' and need to be managed.

Santos Estuary is located in the southeastern coast of Brazil, 80 km from the São Paulo City, one of the biggest metropolis of Latin America. This environment has a history of a hard anthropogenic impact after decades of urban, industrial and harbor uses (LAMPARELLI *et al.,* 2001). The region comprises the biggest port in Latin America situated nearside of extensive areas of mangrove, continuously degraded by port expansion. Nevertheless, there are still some well preserved areas in the region, some in relative use for ecotourism and sport fishery due to its location downstream from São Paulo.

The main goal of this contribution was to report the establishment of the Gulf toadfish *Opsanus beta* (Goode and Bean, 1880) as a no native fish species at the Santos estuary and report some biological data to evaluate the potential risk of its presence to the biota.

These species was scarcely studied in its original environment until the beginning of the 80's (HOFFMANN and ROBERTSON, 1983). It was first cited for Santos estuarine area as a new taxon, *O. brasiliensis,* by ROTUNDO *et al.* (2005). Lately, CAIRES *et al.* (2007) considered it as a junior synonym of the Gulf toadfish *O. beta*, and registered the species at the Paranagua Bay, another estuarine port area southwards of Santos, relating its presence to ballast water. Before ROTUNDO *et al.* (2005), other batrachoidids detected in the Santos estuarine and near coastal zone were the Atlantic midshipman *Porichthys porosissimus,* and other two genus of exclusive marine habits, *Thalassophryne* and *Triathalassotia* (MENEZES and FIGUEIREDO, 1998). Recently, the presence of *Batrachoides surinamensis* was reported inside estuarine area (senior author data not published yet).

MATERIAL AND METHODS

During bimonthly fisheries samples done in fifteen points inside the Santos Estuary (central coastal area in the State of São Paulo, southeastern Brazil) between June 2006 and December 2011 concerning an ichthyofauna monitoring program, several species was recorded by distinct fishing gears, and were transferred in ice to the laboratory to be identified and measured in nearest mm and weighted in 0.1 g. Among them, 140 *O. beta,* a non-native batrachoidid fish, was identified considered COLLETTE (2002).

The gillnet has a two panel of 50 m length each with 70 mm mesh, immersed at least for 12 hours during the night. The traps were cylinder type, 0,6 m length, 50 mm mesh, baited with fish pieces, and were immersed with gillnets. Trawl operations used a try-net the small-scale fisheries of the seabob shrimp in the coastal areas (120 mm height, 840 mm width and 25 mm mesh codend), in 10 minutes tows by a 5.6 m aluminum boat 15 HP outboard powered along daytime. All sample operations occurred at least bimonthly and in the same areas, with gillnets and traps near the margins and trawls between 1.5 and 5.0 m depth. Catches were kept frozen till the laboratory labour. First they were naturally unfrozen and then identified, measured (at the least milimeter) and weighted (in 1.0 g), and sexed by gonad observation. Maturity was checked based on VAZZOLLER (1996), using a five-scale (immature, early maturing, late maturing, spawning and ripe).

An ANCOVA was performed to verify statistical differences in the length and weight data among sexes using a nonlinear fit method (HUITEMA, 1980). The length-weight relationship was described by means of the power model ($WT = aLT^b$), where *a* represents the linear coefficient of the equation, while *b* is the angular coefficient, also called the allometric coefficient, which can be used to observe isometry ($b = 3$), positive allometry ($b>3$) and

negative allometry (b<3) in the population's growth (FROESE, 2006) and statistical differences from isometry were tested by the parametric Student t test with the significant level of 0.05 (ZAR, 1996). The model was fitted using the nonlinear least-squares iterative weighted method and the determination coefficient (r^2) was calculated, taking into consideration the residual sum, degree of freedom and variance of the dependent variable and were done consider ZAR (1996) using R software.

RESULTS

Along the estuarine areas of Santos (Figure 1) it was caught 140 specimens, ranged from 18 to 323 mm of total length (TL) and 8 to 442 g of total weight (TW), comprising 28.192 g at all in three fishing gears (gillnet, trawl, and trap). The trawl reports highest occurrence (54.3%) followed by the fish-baited traps (25.7%) and gillnets (20.0%). Gillnet fishery presented the high average length and weight and the traps the lowest, but the lesser fish in length (18 mm TL) was caught by trawl (Table 1). Otherwise, gillnet caught the biggest in length (182 mm TL).

The average length and weight (and respective confidence intervals) were 216.90 ± 7.28 mm TL and 202.820 ± 16.046 g, considered both genders. None statistically difference (at 95% level, P<0.05) among sexes was noticed considering length and weight, so the weight-length relationship is shown for both sexes (Figure 2).

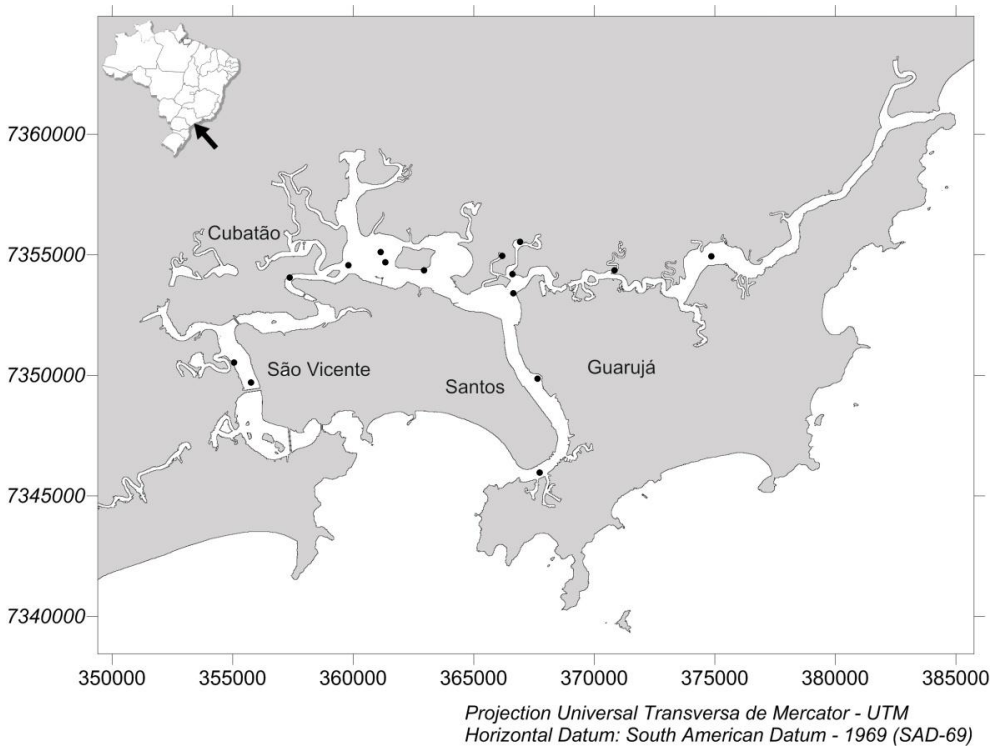

Figure 1. Localities (black circles) with catches of the Gulf toadfish *Opsanus beta* at the Santos estuary.

Table 1. Summary of *Opsanus beta* length and weight data caught by fisheries gear in the Santos estuary, Brazil (n: number of observations; TL: total length; TW: total weight; Avg: average; CI: confidence interval).

Fishery gear	N	%	TL (mm)				TW (g)			
			Lower	Highest	Avg	CI	Lower	Highest	Avg	CI
Trap	36	25.7	145	262	215.28	12.08	47	406	207.36	33.34
Trawl	76	54.3	18	323	213.97	11.69	8	424	194.92	22.53
Gillnet	28	20.0	182	284	226.93	11.08	88	442	218.14	34.90
Total	140	-	18	323	216.90	7.28	8	442	202.82	16.05

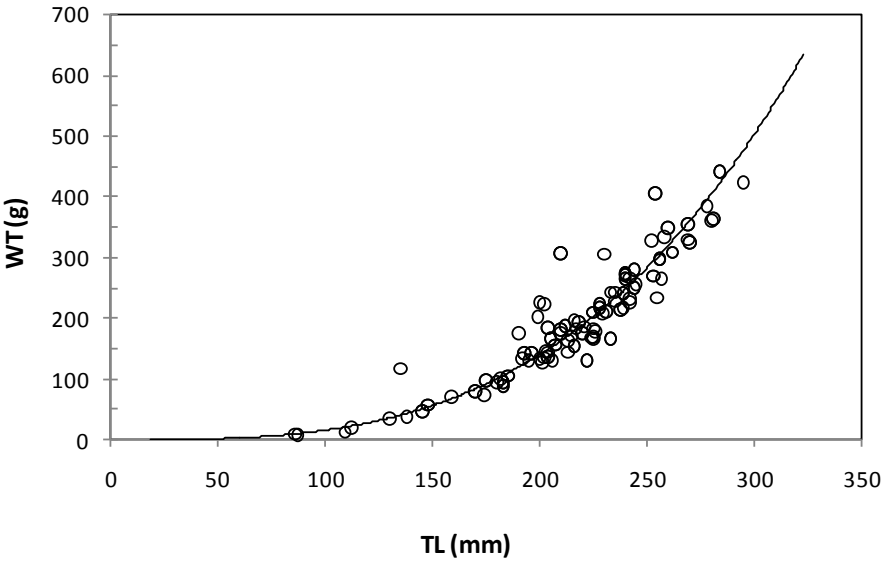

Figure 2. The length-weight relationship for the Gulf toadfish *Opsanus beta* from the Santos estuary ($WT = 8.0 \times 10^{-6}\ TL^{3.147}$; $r^2 = 0.924$; n = 140).

From the eighty-one individuals observed for maturation analysis, eighteen females (32.7%) and twenty-four males (92.3%) present mature gonad (stage C) (Table 2).

The length-weight relationship $TW = 8.0 \times 10^{-6}\ TL^{3.147}$ indicates an isometry, i.e., 'b' not differs statistically from 3 (P = 0.0649) (Figure 2). The graphic shows an increase variance from 200 mm TL whereas values of TW oscillate over the equation fit, would be an indication of an intense reproduction activity, but due to the low number of fishes analyzed and scarcity of reproductive data of the species at its original habitat, none conclusions must be done. In addition to specimens freely caught by the fishing gears, a 247 mm mature male caught inside a plastic pot during a trawl survey in November 2011 had 186 small juveniles reported inside his mouth, which 23 of them were randomically chosen to be measured (Figure 3) resulting in a length range of 11.3 to 19.6 mm (average of 16.323 ± 0.774 mm). The presence of immature, subadults and adults corroborates to the hypothesis of the species establishment at Santos estuarine region.

Table 2. Summary of *Opsanus beta* maturity data and respective average length and weight caught in Santos estuary, Brazil. (n: number of observations; TL: total length; TW: total weight; avg: average).

Maturity Stage	Females			Males		
	n (%)	avg TL	avg TW	n (%)	avg TL	avg TW
A	2 (3.6)	242.00	232.00	2 (7.7)	175.00	97.00
B	29 (52.7)	196.38	171.86	-	-	-
C	18 (32.7)	238.11	254.56	24 (92.3)	226.00	207.00
D	6 (10.9)	245.67	280.00	-	-	-

Figure 3. The Gulf toadfish *Opsanus beta* caught by trawl in November 2011 at the Santos estuary: left, male of 247 mm; right: three small juveniles.

DISCUSSION

Introduced species frequently escape the natural enemies (predators, competitors, and parasites) that limit their distribution and abundance in the native range (DERIVERA *et al*., 2005). Although reproductive activities do not represent a well successful establishment in a new area, maybe consider an important step in an invasional scenario (CARLTON, 1996). Early to the present study, in a recent review of invasive species (LOPES *et al.,* 2009) it was considered only one fish species as an established species (the blenny *Omobranchus punctatus*) in the marine Brazilian waters, and other three fish species were cited as non-native detected species (from families Eleotridae, Chaetodontidae and Acanthuridae). As pointed here, the present study joins facts that confirm the species wellbeing in Santos estuary where it reproduces and grows.

The genus *Opsanus*, first isolated in Caribbean and vicinities by the paleoclimatic theory (FRESHWATER *et al.,* 2000), prefers the warmer shallow mangrove waters as occur at Santos estuary, that offers a similar habitats concerning the original *O. beta*'s shallows areas in western coast of Florida (ROBINS and RAY, 1986), where the species spawns in February and March (AVISE *et al*., 1987; BARIMO *et al.,* 2007). In the 12 of the 15 sampled points, it were reported the occurrence of seagrass beds *Spartina* spp (SANTOS, 2007) which is a favorable condition to the specie's spawning. *Opsanus beta* buries itself in sand or hides among seaweeds, darting out to capture prey - fishes, shrimps, crabs, annelids, and mollusks (YÁÑEZ-ARANCIBIA *et al*., 1993), also common in the study area (CORBISIER, 1991; FUNDAÇÃO RICARDO FRANCO, 2008). It may use anthropogenic litter, as the plastic pot (in which a male founded in parental care of the brood was observed) as shelter. That utilization of man-made structures as nest was earlier reported for *Opsanus* (GRAY and WINN, 1961; BARIMO *et al.,* 2007). The parental care of the brood is one of the characteristics shown by the Batrachoid fishes (BLUMER, 1982; HOFFMANN and ROBERTSON, 1983; BARNI *et al*., 2001).

As others batrachoidids, *O. beta* is able to survive in waters containing low levels of dissolved oxygen, an advantage over other fish species. The scarcity as barracuda (not reported by fishermen) and other large fishes (as groupers and snappers, unpublished authors data) and also marine mammals (the marine tucuxi dolphin *Sotalia guianensis* (common in the past in Santos estuary, was reported by fishermen as not be seen in this region since February 1999), which are potential predators of this species in the original habitat (ROBINS and RAY, 1986), and the maximum length observed close to those reported from the Gulf of Mexico population (324 mm, SERAPY *et al*., 1997) may be seen as indicators of the enabling adequate conditions for an increase of the *O. beta* population. A species from the same genus (*O. tau*) was reported for temperate waters of Canada as introduced by water ballast (GAUTHIER and STEEL, 1996). The presence of *O. beta* in the Santos estuary, far away from its pristine areas, more than an anomalous fact due to an environment tolerance adaptation, its unique characteristic respects to urea metabolism and excretion – whose allow hard environment

conditions (MCDONALD *et al.*, 2003; BARIMO *et al.*, 2007), its confirmed spawning and parental care, as mentioned here, must be seen as an aggravating risk for estuarine areas with harbour presence, allied to the its resilience and any biotic resistance (PIMM, 1989). Those risks are particular higher besides the species is a k-strategist, has a lesser number of predators and physiologic characteristics towards anthropogenic and environmental impacts. Species like *O. beta* represents a serious risk to native fauna for any estuarine systems.

We concluded that *Opsanus beta* is an invasive and has a higher probability of be an established fish species in Santos estuarine waters and a potential risk to others estuaries submitted to ship traffic due to water ballast.

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