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Research Article

Rapid Assessment Survey for exotic benthic species in the São Sebastião Channel, Brazil

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ABSTRACT. The study of biological invasions can be roughly divided into three parts: detection, monitoring, mitigation. Here, our objectives were to describe the marine fauna of the area of the port of São Sebastião (on the northern coast of the state of São Paulo, in the São Sebastião Channel, SSC) to detect introduced species. Descriptions of the faunal community of the SSC with respect to native and allochthonous (invasive or potentially so) diversity are lacking for all invertebrate groups. Sampling was carried out by specialists within each taxonomic group, in December 2009, following the protocol of the Rapid Assessment Survey (RAS) in three areas with artificial structures as substrates. A total of 142 species were identified (61 native, 15 introduced, 62 cryptogenic, 4 not classified), of which 17 were Polychaeta (12, 1, 1, 3), 24 Ascidiacea (3, 6, 15, 0), 36 Bryozoa (17, 0, 18, 1), 27 Cnidaria (2, 1, 24, 0), 20 Crustacea (11, 4, 5, 0), 2 Entoprocta (native), 16 Mollusca (13, 3, 0, 0). Twelve species are new occurrences for the SSC. Among the introduced taxa, two are new for coastal Brazil. Estimates of introduced taxa are conservative as the results of molecular studies suggest that some species previously considered cryptogenic are indeed introduced. We emphasize that the large number of cryptogenic species illustrates the need for a long-term monitoring program, especially in areas most susceptible to bioinvasion. We conclude that rapid assessment studies, even in relatively well-known regions, can be very useful for the detection of introduced species and we recommend that they be carried out on a larger scale in all ports with heavy ship traffic.

Keywords: bioinvasion, fouling, artificial structures, port, São Sebastião, Brazil, southwest Atlantic.

Estudio de evaluación rápida de especies bentónicas exóticas en São Sebastião, Brasil

RESUMEN. El estudio de invasiones biológicas puede ser dividido en tres partes: detección, supervisión y atenuación. El objetivo fue describir la fauna marina del puerto de São Sebastião (costa norte del estado de

São Paulo, en el canal de São Sebastião, SSC) para detectar las especies introducidas. No existen descripciones de la comunidad faunística del SSC en relación a la diversidad nativa y alóctona (invasiva o potencialmente) de todos los grupos de invertebrados. El muestreo se a cabo por especialistas de cada grupo taxonómico en diciembre de 2009, siguiendo el protocolo de Estudio de Evaluación Rápida (EER) en tres zonas con sustratos artificiales. Se identificaron 142 especies (61 nativas, 15 introducidas, 62 criptogénicas y cuatro no determinadas), de las cuales 17 correspondieron a poliquetos (12, 1, 1, 3), 24 a ascidias (3, 6, 15, 0), 36 a briozoarios (17, 0, 18, 1), 27 a cnidarios (2, 1, 24, 0), 20 a crustáceos (11, 4, 5, 0), 2 a entoproctos (nativo) y 16 a moluscos (13, 3, 0, 0). Doce especies constituyen nuevos registros para el SSC. Entre los taxa introducidos, dos son nuevos para la costa de Brasil. Las estimaciones de los taxa introducidos son conservativas dado que los resultados obtenidos en estudios moleculares sugieren que algunas especies anteriormente consideradas criptogénicas son introducidas. Se destaca que el gran número de especies criptogénicas refleja la necesidad de un programa de monitoreo a largo plazo, especialmente en las zonas más susceptibles a la invasión biológica. Se concluye que los estudios de evaluación rápida, incluso en las regiones relativamente bien conocidas, pueden ser útiles para detectar especies introducidas y se recomienda expandir este tipo de estudios en todos los puertos con tráfico marítimo.

Palabras clave: bioinvasión, incrustaciones, sustratos artificiales, puerto, São Sebastião, Brasil, Atlántico suroccidental.

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INTRODUCTION

Bioinvasions are biological phenomena with ecological and evolutionary consequences to local biota. The study of biological invasions can be roughly divided into detection, monitoring, and remediation/mitigation, and all of them are better informed by basic (*e.g.*, biogeographically, ecological, ecophysiological constraints) and applied knowledge (*e.g.*, prevention, management, eradication, conservation). Biological invasions are ubiquitous, continental and marine, in all biomes and ecosystems. The introduction of species is the successful establishment of a species in a region where it did not occur before (Elton, 1958). This process can happen naturally by the expanding population of a species, but can also be caused by human activities, that occur more frequently in recent decades (Carlton, 1996).

Becoming invasive, introduced species may compete with native species (including those of commercial or cultural importance) and displace or prevail over native species, change trophic relationships in the food chain, introduce new diseases or toxic substances that affect native organisms and human populations. Thus, biological invasions have obvious negative consequences for biodiversity and public health, cultural and economical issues for the affected regions.

In the marine realm, biological invasion vectors are fundamentally associated with economic activities such as commerce and tourism, both of which are associated with ports. Consequently, records of invasive species in ports around the world are increasing (Carlton, 1989; Ruiz *et al*., 2000), often seriously endangering natural habitats. Transportation of potential invaders may be by hull fouling and its associated species, or ballast water (Fofonoff *et al*., 2003). Both have reached alarming proportions as ships become more numerous, faster and larger, thereby requiring more ballast (Cohen & Carlton, 1998). Despite of the impact of marine bioinvasions, the marine realm has historically received less attention compared to terrestrial and freshwater habitats (Carlton, 1989).

In port areas, the availability of hard artificial substrates (such as buoys, ropes, concrete walls, and marinas) provides many opportunities for settlement and metamorphosis for larvae of introduced species (Stachowicz *et al*., 1999; Tyrrel & Byers, 2007). After recruitment and establishment, a following stage of the invasion process comprises expansion of the geographical distribution of the species or populations. Virtually any marine taxon may include invasive lineages, such as algae (Mathieson *et al*., 2003) and Chordata (Castilla *et al*., 2004).

Detecting invasive species depends on monitoring and adequate knowledge of the native fauna, including genetic, taxonomic, biological and ecological data. Invasion and establishment of a species is frequently not recorded and very seldom observed (Carlton, 2009). Ideally, the control of exotic species will be more efficient with early detection, when populations are small and more easily eradicated or controlled (Bax *et al*., 2001). The lack of previous information about the species makes it difficult to determine its invasive status, in which case the species is of uncertain origin and is classified as cryptogenic (Carlton, 1996).

Strategies for monitoring species in port areas include Rapid Assessment Survey (RAS, see for instance Cohen *et al*., 2005; Pederson *et al*., 2005), a procedure with standardized field sampling effort carried out by specialists in taxonomy of target groups, in which the goal is to sample the maximum number of taxa possible in a short time period. The only previous large scale RAS to detect introduced species in Brazil was in Sepetiba Bay, with three ports, as a demonstration study of the Globallast program of the International Maritime Organization – IMO (Clarke *et al*., 2004). Few other surveys have been carried out and are only available for the port of Paranaguá, southern Brazil (Neves *et al*., 2007), Ilha Grande Bay, southeastern Brazil (Ignacio *et al*., 2010), and the port of Recife, northeastern Brazil (Amaral *et al*., 2010; Lira *et al*., 2010). Nonetheless, the literature on introduced species identified in specific taxonomic groups is growing, such as those for ascidians (Rocha & Kremer, 2005; Rocha *et al*., 2009; Marins *et al*., 2010); cnidarians (Calder & Maÿal, 1998; Paula & Creed, 2004; Nogueira Jr. & Oliveira, 2006; Bardi & Marques, 2009); crustaceans (Tavares, 2004; Farrapeira, 2010a); mollusks (Domaneschi & Martins, 2002; Souza *et al*., 2003; Silveira *et al*., 2006; Breves *et al*., 2010; Lopez *et al*., 2010) and bryozoans (Gordon *et al*., 2006; Farrapeira, 2010b). General overviews were given by Lopes *et al.* (2009) and Ferreira *et al.* (2009). Unfortunately, comprehensive surveys in Brazil of the benthos, including those not focusing on bioinvasion, are also rare, even for the better known areas of the country (Migotto & Marques, 2006).

Here we attempt to detect potential bioinvasion of benthic species in the São Sebastião Channel, an important Brazilian port area, using a Rapid Assessment Survey technique.

MATERIALS AND METHODS

Study area

The São Sebastião Channel (SSC), on the northern coast of the state of São Paulo, Brazil, comprises several areas of preservation, and among the best known biodiversity in the coast of Brazil, due to the many extensive floral and faunal surveys carried out under the auspices of the Center of Marine Biology of the University of São Paulo. The SSC also includes the large Port of São Sebastião, in use for more than 50 years, and through which passes a total load of 50 million tons year^{-1}. An important part of the port is the Terminal Marítimo Almirante Barroso (TEBAR-Transpetro/Petrobras), responsible for intense traffic of ships importing and exporting petroleum products both coastal and long-distance (http://www.transportes. gov.br/-bit/portos/ssebastiao/deposaosebastiao.htm).

Rapid Assessment Survey (RAS)

Surveys were carried out in three sites in the vicinity of the port of São Sebastião: a) Ilhabela Yacht Club (IYC, 23°46'27"S, 45°21'20"W), a floating marina located on São Sebastião Island, on 11 December 2009; b) Petrobras Pier (PP, 23°48'07"S, 45°23'27"W), a concrete structure with large columns on 12 December 2009; and c) Pontal da Cruz Pier (PCP, 23°46'53"S, 45°23'48"W), a cement structure, on 12 December 2009. IYC and PCP were examined for two hours by 17 people including specialists in Annelida Polychaeta, Ascidiacea, Bryozoa, Cnidaria, Crustacea Cirripedia, Entoprocta and Mollusca that defined the taxonomical scope of the survey. PP was surveyed to a maximum depth of 8.5 m for an hour by four scuba divers.

Benthic animals were collected by hand on artificial substrates, including floats and pier columns, during low tide at PCP and by snorkeling in shallow waters at IYC and PCP. When necessary, samples were kept separately in individualized jars in the field, and larger samples were packed to be sorted in the laboratory. Material was brought to the laboratory and maintained *in vivo* to be examined by specialists. Dissecting and compound microscopes were used when necessary. Samples were identified while alive to the lowest taxonomic level possible. Part of the material was anesthetized (using magnesium chloride, menthol or M-aminobenzoate ethyl) and fixed (in formalin at 4% prepared with saltwater or in ethanol 70%-100%) following standard procedures for each taxon. The material sampled was deposited in the scientific collections of the Federal University of Ceará, Federal University of Paraná, and University of São Paulo.

RESULTS

A total of 142 taxa were identified, twelve of which are new records for the SSC, but may not all be introduced (Table 1). IYC had 89 taxa, PCP had 81 and PP had 70. The taxa comprise Annelida Polychaeta (17), Ascidiacea (24), Bryozoa (36), Cnidaria (27), Crustacea (20), Entoprocta (2) and Mollusca (16). The majority of taxa were classified as either cryptogenic (69), native (53) or introduced (15), and five were not classified because they were not identified at the species level.

Most taxa were found in only one site (50.7%), with 30.3% in two sites and 19.0% in all three sites

(Continuation)

Family	Species	IYC	PP	PCP	Status	Previous records for SSC	Records for Brazilian states	First record for Brazil	Known distribution	Observation
Annelida Polychaeta Palpata Canalipalpata Terebellida										
Cirratulidae Carus, 1863	*Cirriformia punctata* (Grube, 1859)	x			Cryptogenic	first record	SP	Souza (1989)	Gulf of Mexico, Caribbean Sea, Mozambique, South Africa	
Terebellidae Malmgren, 1867	*Nicolea uspiana* (Nogueira, 2003)	x		x	Native	Alves (2008)	SP	Nogueira (2003)	Brazil	
Annelida Polychaeta Scolecida										
Orbiniidae Hartman, 1942	*Naineris laevigata* (Grube, 1855)	x			Cryptogenic	first record	BA SP	Rullier & Amoureux (1979)	Cosmopolitan	
Ascidiacea Aplousobranchia										
Clavelinidae Forbes & Hanley, 1848	*Clavelina oblonga* Savigny, 1816	x	x	x	Introduced	Rodrigues (1962)	CE ES RJ SP PR SC	Hartmeyer (1912)	Caribbean Sea	
Polyclinidae Milne Edwards, 1842	*Aplidium accarense* (Millar, 1953)	x	x	x	Cryptogenic	Rocha & Bonnet (2009)	SP SC	Rocha *et al*. (2005)	Atlantic	
	Polyclinum constellatum Savigny, 1816	x		x	Cryptogenic	Rodrigues (1962)	CE ES RJ SP SC	Michaelsen (1923)	Circuntropical	
	Aplidiopsis sp.	x			Introduced	first record	___	First record	Pacific	
Holozoidae Berrill, 1950	*Distaplia bermudensis* Van Name, 1902	x	x	x	Native	Rodrigues & Rocha (1993)	PA CE BA ES RJ SP PR SC	Millar (1958)	W. Atlantic	
	Distaplia stylifera (Kowalewsky, 1874)		x		Introduced	first record	SP	first record	Circuntropical	*D. stylifera* previously reported (Rodrigues *et al*. 1998) is a new species
Didemnidae Giard, 1872	*Didemnum perlucidum* Monniot, 1983	x		x	Cryptogenic	Rocha & Monniot (1995)	BA RJ SP SC	Rocha & Monniot (1995)	Circuntropical	
	Diplosoma listerianum (Milne-Edwards, 1841)			x	Cryptogenic	Van Name (1945)	RN-SC	Van Name (1945)	Cosmopolitan	
	Lissoclinum fragile (Van Name, 1902)	x			Cryptogenic	Rodrigues *et al*. (1998)	CE PE RJ SP PR SC	Rodrigues *et al*. (1998)	Circuntropical	
	Trididemnum orbiculatum (Van Name, 1902)	x	x		Native	Rodrigues & Rocha (1993)	CE BA RJ SP PR SC	Rodrigues & Rocha (1993)	W Atlantic	
Ascidiacea Phlebobranchia										
Ascidiidae Adams, 1858	*Phallusia nigra* Savigny, 1816	x	x		Cryptogenic	Van Name (1945)	CE AL BA RJ SP	Van Name (1945)	Atlantic, Mediterranean, Red Sea	
	Ascidia cf. *multitentaculata* (Hartmeyer, 1912)	x			Cryptogenic	Bonnet & Rocha (2011)	CE BA ES SP	Millar (1977)	Brazil, South Africa	
	Ascidia sydneiensis Stimpson, 1855			x	Introduced	Millar (1958)	CE ES RJ SP PR SC	Millar (1958)	Cosmopolitan	
Ascidiacea Stolidobranchia										
Styelidae Sluiter, 1895	*Botrylloides giganteum* (Pérès, 1949)			x	Cryptogenic	Rodrigues & Rocha (1993)	ES RJ SP SC	Rodrigues & Rocha (1993)	Senegal, South Africa, Brazil	

(Continuation)

Family	Species	IYC	PP	PCP	Status	Previous records for SSC	Records for Brazilian states	First record for Brazil	Known distribution	Observation
	Botrylloides nigrum (Herdman, 1886)	x		x	Cryptogenic	Rodrigues (1962)	PB AL BA ES RJ SP PR SC	Rodrigues (1962)	Circuntropical	
	Symplegma brakenhielmi (Michaelsen, 1904)	x		x	Cryptogenic	Rodrigues (1962)	PA- SC	Millar (1958)	Circuntropical	
	Symplegma rubra Monniot, 1972	x	x	x	Native	Rodrigues & Rocha (1993)	ES RJ SP PR SC	Rodrigues & Rocha (1993)	Atlantic	
	Eusynstyela sp.		x	x	Introduced	Rodrigues *et al*. (1998)	SP	Rodrigues *et al.* (1998)		
	Polyandrocarpa anguinea (Sluiter, 1898)		x		Cryptogenic	Van Name (1945)	ES RJ SP PR SC	Van Name (1945)	Circuntropical	
	Polyandrocarpa zorritensis (Van Name, 1931)			x	Cryptogenic	Rodrigues (1962)	BA ES RJ SP SC	Rodrigues (1962)	Atlantic, Pacific, Mediterranean, Japan	
	Styela canopus (Savigny, 1816)	x		x	Cryptogenic	Rodrigues *et al*. (1998)	RN PE BA RJ SP PR SC	Monniot (1969/70)	Cosmopolitan	
	Styela plicata (Lesueur, 1823)	x		x	Introduced	Rodrigues (1962)	BA RJ SP PR SC	Millar (1958)	Cosmopolitan	
Pyuridae Hartmeyer, 1908	*Herdmania pallida* (Heller, 1878)	x	x	x	Cryptogenic	Rodrigues (1962)	AL BA RJ SP	Van Name (1945)	Cosmopolitan	
	Microscosmus exasperatus Heller, 1878	x		x	Cryptogenic	Rodrigues (1962)	CE - SC	Van Name (1945)		
Bryozoa Gymnolaemata Cheilostomata										
Aeteidae Smitt, 1868	*Aetea anguina* (Linnaeus, 1758)		x		Cryptogenic	Amaral *et al*. (2010b)	PE ES RJ SP PR	Marcus (1937)	Circuntropical	*Aetea anguina* is a complex of species (SP specimens are *A. australis* Jullien from Patagonia, but not from Australia)
	Aetea sp.	x	x		Native	Migotto, Vieira & Winston, unpublished data	SP	Marcus (1938)	Atlantic	Not *Aetea truncata* Marcus 1938 or *Aetea curta* Hastings 1943
	Aetea ligulata Busk, 1852	x	x		Cryptogenic	Amaral *et al*. (2010b)	SP	Marcus (1937)	Cosmopolitan	
Electridae Stach, 1937	*Electra tenella* (Hincks, 1881)			x	Cryptogenic	Amaral *et al*. (2010b)	SP	Marcus (1937)	Europe and W. Atlantic	
Membraniporidae Busk, 1852	*Biflustra arborescens* Canu & Bassler, 1928	x	x	x	Cryptogenic	Migotto *et al*. (2011)	RJ SP PR SC	Marcus (1937)	W. Atlantic (Long Island to Brazil, Caribbean and Gulf of Mexico)	
	Biflustra denticulata (Busk, 1856)		x		Cryptogenic	Amaral *et al*. (2010b)	ES SP PR SC	Marcus (1937)	W. Atlantic and Pacific	
	Biflustra sp.			x	Native	Migotto *et al*. (2011)	RJ SP PR	Marcus (1937) as *Acanthodesia savartii*	W. Atlantic	
Catenicellidae Busk, 1852	*Catenicella uberrima* (Harmer, 1957)	x	x		Cryptogenic	Amaral *et al*. (2010b)	AL SP	Busk (1884)	Circuntropical	
	Savignyella lafontii (Audouin, 1826)	x	x	x	Cryptogenic	Amaral *et al*. (2010b)	AL SP	Marcus (1937)	Circuntropical	

(Continuation)

Family	Species	IYC	PP	PCP	Status	Previous records for SSC	Records for Brazilian states	First record for Brazil	Known distribution	Observation
Hippopodinidae Levinsen, 1909	*Hippopodina feegeensis* (Busk, 1884)	x			Cryptogenic	Migotto *et al*. (2011)	PE SP	Marcus (1937)	Circuntropical	
Microporellidae Hincks, 1879	*Microporella* sp.		x		Native	Migotto *et al*. (2011)	SP	Marcus (1937) as *Microporella ciliata*	Brazil	not Pallas (1766)
Schizoporellidae Jullien, 1883	*Schizoporella pungens* (Canu & Bassler, 1928)	x	x	x	Cryptogenic	Amaral *et al*. (2010b)	RJ SP	D'Orbigny (1842)	Brazil, widespread in port areas	*errata-pungens-isabelleana* complex (*isabelleana* described from Rio de Janeiro)
	Schizoporella sp.			x	Native	Migotto *et al*. (2011)	PE RJ SP PR	Marcus (1937) as *S. unicornis*	Brazil	
Smittinidae Levinsen, 1909	*Parasmittina* sp.	x	x		Native	Amaral *et al*. (2010b)	SP	Marcus (1937)	Brazil	
Watersiporidae Vigneaux, 1949	*Watersipora subtorquata* (D'Orbigny, 1852)	x			Cryptogenic	Amaral *et al*. (2010b)	ES RJ SP	D'Orbigny (1842)	W. Atlantic and Australia	
Antroporidae Vigneaux, 1949	*Antropora leycocypha* (Marcus, 1937)		x	x	Native	Amaral *et al*. (2010b)	SP PR	Marcus (1937)	Brazil	
Bugulidae Gray, 1848	*Bugula neritina* (Linnaeus, 1758)	x	x	x	Cryptogenic	Amaral *et al*. (2010b)	RJ SP PR	D'Orbigny (1841)	Widespread in port areas	
	Bugula stolonifera Ryland, 1960	x			Cryptogenic	Amaral *et al*. (2010b)	RJ SP	Marcus (1937)	Widespread in port areas	
Candidae D'Orbigny, 1851	*Scrupocellaria aff. diadema* Busk, 1852	x		x	Cryptogenic	first record	RJ	Ramalho *et al*. (2005)	Pacific (=*S. diadema*)	*diadema* is a widespread complex species. The Brazilian specimens require investigation.
	Scrupocellaria sp.	x	x	x	Native	Amaral *et al*. (2010b)	RJ SP	Marcus (1937) as *Scrupocellaria cornigera*	Brazil	
Epistomiidae Gregory, 1893	*Synnotum aegyptiacum* (Audouin, 1826)		x		Cryptogenic	Migotto *et al*. (2011)	PE AL ES SP	Kirkpatrick (1888)	Circuntropical	
Quadricellariidae Gordon, 1984	*Nellia oculata* Busk, 1852		x		Cryptogenic	Amaral *et al*. (2010b)	PE BA	Busk (1884)	Circuntropical	
Bryozoa Gymnolaemata Ctenostomata										
Alcyonidiidae Johnston, 1838	*Alcyonidium* sp.			x	Native	Migotto *et al*. (2011)	ES SP PR	Marcus (1937) as *A. polyoum*	Brazil	
Aeverriliidae Jebram, 1973	*Aeverrillia setigera* (Hincks, 1887)		x		Cryptogenic	Migotto *et al*. (2011)	SP	Marcus (1937)	W. Atlantic and Pacific	
Arachnidiidae Hincks, 1880	*Arachnoidella evelinae* (Marcus, 1937)		x		Native	Migotto *et al*. (2011)	SP	Marcus (1937)	Brazil	
Vesiculariidae Hincks, 1880	*Amathia brasiliensis* Busk, 1886	x	x	x	Native	Fehlauer-Ale *et al.* (2011)	ES RJ SP PR	Marcus (1937)	W. Atlantic	
	Amathia distans Busk, 1886		x		Native	Amaral *et al*. (2010b)	AL BA ES RJ SP PR	Busk (1886)	W. Atlantic	Some records of this species in port areas represent distinct species
	Amathia sp.		x		--	Amaral *et al*. (2010b)	AL SP	Rocha (1995) as *A. vidovici*	Circuntropical in port areas	

(Continuation)

Family	Species	IYC	PP	PCP	Status	Previous records for SSC	Records for Brazilian states	First record for Brazil	Known distribution	Observation
	Bowerbankia maxima Winston, 1982		x	x	Native	Amaral *et al*. (2010b)	RJ SP PR	Marcus (1937)	W. Atlantic	
	Zoobotryon verticillatum (Delle Chiaje, 1828)	x	x	x	Cryptogenic	Amaral *et al*. (2010b)	RJ SP	Marcus (1955)	Widespread in port areas	
Nolellidae Harmer, 1915	*Anguinella palmata* van Beneden, 1845		x		Cryptogenic	Migotto *et al*. (2011)	SP PR	Marcus (1937)	Widespread in port areas	
	Nolella sawayai Marcus, 1938		x		Native	Migotto *et al*. (2011)	SP	Marcus (1937)	Brazil	
	Nolella sp.		x	x	Native	Amaral *et al*. (2010b)	PE AL ES SP	Marcus (1937) as *N. gigantea*	Brazil	
Sundanellidae Jebram, 1973	*Sundanella* sp.		x		Native	Amaral *et al*. (2010b)	RJ SP PR	Marcus (1937) as *V. sibogae*	Brazil	
Victorellidae Hincks, 1880	*Victorella* sp.		x		Native	Migotto *et al*. (2011)	RJ	Marcus (1955) as *V. pavida*	Brazil	
Bryozoa Stenolaemata Cyclostomata										
Crisiidae Johnston, 1838	*Crisia pseudosolena* (Marcus, 1937)	x	x	x	Native	Amaral *et al*. (2010b)	PE RJ SP PR	Marcus (1937)	Brazil	
Cnidaria Anthozoa Hexacorallia Actiniaria										
Actiniidae Gosse 1858	*Bunodosoma caissarum* Corrêa in Belém, 1987	x		x	Native	Oliveira *et al. (*2004)	PE, ES, RJ, SP, PR, SC	Correa1(964)	Brazil	
Cnidaria Anthozoa Hexacorallia Scleractinia										
Rhizangiidae D'Orbigny, 1851	*Astrangia* sp.	x	x		Native	first record	PE-SC	Laborel (1969)	Brazil, Uruguay, Puerto Rico	
Cnidaria Anthozoa Octocorallia Telestacea										
Telestidae Milne-Edwards & Haime, 1857	*Carijoa riisei* (Duchassaing & Michelotti, 1860)	x	x	x	Introduced	Silveira (1986)	PA MA RN PE BA ES RJ SP SC	Deichmann (1936) as *Telesto rupicola*	Atlantic, Pacific	
Cnidaria Hydrozoa Anthoathecata										
Bougainvilliidae Lütken, 1850	*Bougainvillia muscus* (Allman, 1863)	x	x		Cryptogenic	Vannucci & Rees (1961)	AL PR SC	Vannucci & Rees (1961)	Atlantic, Indian, W. Pacific	
Eudendriidae L. Agassiz, 1862	*Eudendrium caraiuru* Marques & Oliveira, 2003	x	x		Native	Marques & Oliveira (2003)	CE RJ SP	Migotto (1996)	Brazil	
	Eudendrium carneum Clarke, 1882			x	Cryptogenic	Marques (2001)	CE - SC	Vannucci (1954)	Atlantic, Indian, E. Pacific	
Oceaniidae Eschscholtz, 1829	*Corydendrium parasiticum* (Linnaeus, 1767)		x		Cryptogenic	Migotto (1996)	PE RJ	Migotto (1996)	Atlantic, Indian, Pacific	
	Turritopsis nutricula (McCrady, 1859a)	x	x		Cryptogenic	Migotto (1996)	PE - RS	Migotto (1996)	Atlantic, Indian, Pacific	
Pennariidae McCrady, 1859b	*Pennaria disticha* Goldfuss, 1820	x	x	x	Cryptogenic	Migotto (1996)	CE - SC	Vannucci (1950)	Atlantic, Indian, Pacific	
Tubulariidae Fleming, 1828	*Acharadria crocea* (L. Agassiz, 1862)	x			Cryptogenic	Migotto (1996)	ES RJ SP PR SC RS	Migotto & Silveira (1987) as *Ectopleura warrani*	Atlantic, Indian	

(Continuation)

Family	Species	IYC	PP	PCP	Status	Previous records for SSC	Records for Brazilian states	First record for Brazil	Known distribution	Observation
	Zyzzyzus warreni Calder, 1888	x			Cryptogenic	Migotto (1996)	PE AL SP SC	Migotto & Silveira (1987)	Atlantic, Indian	
Cnidaria Hydrozoa Leptothecata										
Aglaopheniidae Marktanner-Turneretscher, 1890	*Aglaophenia latecarinata* Allman, 1877			x	Cryptogenic	Migotto (1996)	MA - SC	Ritchie (1909)	Atlantic, Indian, W. Pacific	
	Macrorhynchia philippina Kirchenpauer, 1872			x	Cryptogenic	Migotto (1996)	PE AL BA ES RJ SP SC	Nutting (1900)	Atlantic, Indian, Pacific	
Campanulariidae Johnston, 1836	*Clytia gracilis* (M. Sars, 1851)	x	x		Cryptogenic	Migotto (1996)	CE - PR	Vannucci & Mendes (1946)	Atlantic, Indian, Pacific	
	Obelia bidentata Clark, 1875	x	x	x	Cryptogenic	Migotto (1996)	PE SE BA RJ SP SC	Jäderholm (1903)	Atlantic, Indian, Pacific	
	Obelia dichotoma (Linnaeus, 1758)	x	x	x	Cryptogenic	Migotto (1996)	CE - RS	Stechow (1919)	Atlantic, Indian, Pacific	
	Obelia geniculata (Linnaeus, 1758)		x		Cryptogenic	Migotto (1996)	AL ES SP PR SC RS	Vannucci & Mendes (1946)	Atlantic, Indian, Pacific	
	Lafoeina amirantensis (Millard & Bouillon, 1973)		x		Cryptogenic	Migotto & Cabral (2005)	PE ES RJ SP SC	Nogueira *et al*. (1997)	Atlantic, Indian, Pacific, Mediterranean	
Haleciidae Hincks, 1868	*Halecium ?tenellum* Hincks, 1861	x			Cryptogenic	Migotto (1996)	PE SP SC	Migotto (1996)	Atlantic, Indian, Pacific	
	Nemalecium lighti (Hargitt, 1924)	x			Cryptogenic	Migotto (1996)	ES RJ SP	Migotto (1996)	Indian, W Pacific	
Halopterididae Millard, 1962	*Halopteris diaphana* (Heller, 1868)			x	Cryptogenic	Migotto, 1996	CE AL ES RJ SP	Vannucci & Mendes (1946)	Atlantic, Indian, Pacific	
Hebellidae Fraser, 1912	*Hebella furax* Millard, 1957	x			Cryptogenic	Migotto & Andrade (2000)	RJ SP	Migotto & Andrade, 2000	Atlantic, Indian	
Plumulariidae McCrady, 1859b	*Plumularia strictocarpa* Pictet, 1893	x			Cryptogenic	Migotto (1996)	AL BA ES RJ SP	Vannucci (1949)	Atlantic, Indian, W. Pacific	
Sertulariidae Lamouroux, 1812	*Dynamena disticha* (Bosc, 1802)	x			Cryptogenic	Migotto (1996)	CE PE BA-RS	Ritchie (1909)	Atlantic, Indian, Pacific	
	Idiellana pristis (Lamouroux, 1816)		x	x	Cryptogenic	Migotto (1996)	AL BA SP	Allman (1888)	Circumtropical	
	Sertularia marginata (Kirchenpauer, 1864)	x	x		Cryptogenic	Migotto (1996)	CE - SC	Allman (1888)	Atlantic, Indian, Pacific	
	Sertularia turbinata (Lamouroux, 1816)	x			Cryptogenic	Migotto(1996)		Vannucci & Mendes (1946)	Atlantic, Indian, Pacific	
Crustacea Cirripedia										
Balanidae Leach, 1817	*Amphibalanus amphitrite* (Darwin, 1854)	x		x	Introduced	Young (1994)	AP - RS	Oliveira (1941)	Cosmopolitan	
	Amphibalanus improvisus (Darwin, 1854)		x	x	Cryptogenic	?	MA - RS	Darwin (1854)	Cosmopolitan	
	Amphibalanus reticulatus (Utinomi, 1967)	x	x	x	Introduced	first record	MA RN PB PE AL BA RJ PR SC	Young (1989)	Cosmopolitan	
	Balanus trigonus Darwin, 1854	x	x	x	Introduced	Young (1994)	AP - RS	Darwin (1854)	Cosmopolitan	

(Continuation)

Family	Species	IYC	PP	PCP	Status	Previous records for SSC	Records for Brazilian states	First record for Brazil	Known distribution	Observation
	Megabalanus coccopoma (Darwin, 1854)	x	x	x	Introduced	Young (1994)	RN ES RJ SP PR RS SC	Lacombe & Monteiro (1974)	W. Atlantic, Indo-Pacific	
	Megabalanus tintinnabulum (Linnaeus, 1758)	x	x	x	Cryptogenic	Luederwaldt (1929)	MA - RS	Linnaeus (1758)	Cosmopolitan	
Chthamalidae Darwin, 1854	*Chthamalus proteus* Dando & Southward, 1980			x	Native	?	MA - RS	Dando & Southward (1980)	W. Atlantic	
Tetraclitidae Gruvel, 1903	*Newmanella radiata* (Bruguière, 1789)	x		x	Cryptogenic	?	PE BA RJ SP	Lacombe (1977)	Cosmopolitan	
	Tetraclita stalactifera (Lamarck, 1818)			x	Native	Luederwaldt (1929)	MA - RS	Darwin (1854)	W. Atlantic	
Crustacea Decapoda Pleocyemata Caridea										
Palaemonidae Rafinesque, 1815	*Periclemenes longicaudatus* (Stimpson, 1860)		x	x	Native	?	AP - SC	Rathbun (1900) as *Urocaris longicauda*	W. Atlantic	
Hippolytidae Bate, 1888	*Thor manningi* Chace, 1972	x	x		Native	Christoffersen (1980)	PB, BA, SP	Fausto-Filho (1970) as *T. floridanus*	W. Atlantic, Central Atlantic, E. Pacific	Commonly found on grass flats from the tide line to a depth of at least 11 m
Alpheidae Rafinesque, 1815	*Synalpheus* sp.	x		x	Cryptogenic					
Crustacea Decapoda Pleocyemata Anomura										
Porcellanidae Haworth, 1825	*Pachycheles monilifer* (Dana, 1852)	x	x	x	Native	Melo (1999)	CE - SC	Cano (1889) as *Pachycheles moniliferus*	W. Atlantic, E. Pacific	From shallow waters to 40 m
	Pisidia brasiliensis Haig in Rodrigues da Costa, 1968	x		x	Native	Melo (1999)	PA - SP	Coelho (1964) as *Megalobrachium poeyi*	W. Atlantic (Brazil)	Intertidal
Crustacea Decapoda Pleocyemata Brachyura										
Inachidae MacLeay, 1838	*Stenorhynchus seticornis* (Herbst, 1788)	x		x	Native	Melo (1996)	AP - RS	Miers (1886) as *Leptodia sagittaria*	W. Atlantic	From shallow waters to great depths
Majidae Salmouelle, 1819	*Microphrys bicornutus* (Latreille, 1825)			x	Native	Melo (1996)	MA - RS	Smith (1869) as *Milnia bicornuta*	W. Atlantic	From shallow waters to 70 m
Epialtidae MacLeay, 1838	*Epialtus bituberculatus* H. Milne Edwards, 1834	x		x	Native	Melo (1996)	CE, PB, PE, BA, ES, RJ, SP	Rathbun (1894)	W. Atlantic	Shallow water species living on algae and seagrass meadows, on hard bottoms, and tidal pools
Pilumnidae Salmouelle, 1819	*Pilumnus quoii* H. Milne-Edwards, 1834	x	x	x	Native	Melo (1996) as *P. quogi*	AP - SP	Milne-Edwards (1834)	W. Atlantic	From shallow waters to 100 m
	Pilumnus dasypodus Kingsley, 1879	x	x	x	Native	Melo (1996)	CE - SC	Rathbun (1900)	W. Atlantic	From shallow waters to 30 m
Grapsidae MacLeay, 1838	*Pachygrapsus transversus* (Gibbes, 1850)	x	x	x	Cryptogenic	Melo (1996)	MA - RS	Rathbun (1898)	W, E. Atlantic, Mediterranean, E. Pacific	Shallow waters

(Continuation)

Family	Species	IYC	PP	PCP	Status	Previous records for SSC	Records for Brazilian states	First record for Brazil	Known distribution	Observation
Entoprocta										
Barentsidae Hincks, 1880	*Barentsia capitata* Calvet, 1904	x		x	Native	first record	RJ	Marcus (1940)	SW. Atlantic	
Pedicellinidae Johnston, 1847	*Sangavella vineta* Marcus, 1957			x	Native	first record	SP	Marcus (1957)	Brazil	
Mollusca Bivalvia Lamellibranchia Pteroida										
Mytilidae Rafinesque, 1815	*Perna perna* (Linnaeus, 1758)	x		x	Introduced	Migotto *et al*. (1993)	ES RJ SP PR SC RS		Atlantic	From intertidal to 10 m depth
	Brachidontes exustus (Linnaeus, 1758)			x	Native	?	CE RN BA RJ SP		Atlantic	Shallow waters
	Brachidontes solisianus (D'Orbigny, 1846)			x	Native	Migotto *et al*. (1993)	AP - RS		Atlantic	Shallow waters
	Myoforceps aristatus (Dillwyn, 1817)	x		x	Introduced	first record	RJ SP	Simone & Gonçal-ves (2006)	Atlantic, Pacific	From intertidal to 5 m depth
Isognomonidae Woodring, 1925	*Isognomon bicolor* (C.B. Adams, 1845)	x		x	Introduced	Rios (2009)	CE RN RJ SP SC	Domaneschi & Martins (2002)	Atlantic	From intertidal to 7 m depth
Pteriidae Gray, 1847	*Pteria hirundo* (Linnaeus, 1758)		x		Native	first record	AP - RS		Atlantic	Shallow waters
	Pinctata imbricata Roding, 1798			x	Native	Rios (1975)	PA - SC		Atlantic	Shallow waters
Mollusca Bivalvia Lamellibranchia Myoida										
Myidae Lamarck, 1809	*Sphenia antillensis* Dall & Simpson, 1901			x	Native	Migotto *et al*. (1993)	CE - SC		Atlantic	Shallow waters
Mollusca Gastropoda Eogastropoda Patellogastropoda										
Lottiidae Gray, 1840	*Collisella subrugosa* (D'Orbigny, 1846)	x		x	Native	Migotto *et al*. (1993)	CE - RS		Atlantic	Shallow waters
Mollusca Gastropoda Orthogastropoda Vetigastropoda										
Fissurellidae Fleming, 1822	*Diodora dysoni* (Reeve, 1850)	x		x	Native	first record	RN - SC		Atlantic	Shallow waters
	Fissurella clenchi Farfante, 1943	x			Native	Migotto *et al*. (1993)	PA - RS		Atlantic	Shallow waters
Mollusca Gastropoda Orthogastropoda Caenogastropoda										
Littorinidae Gray, 1840	*Littorina ziczac* (Gmelin, 1791)	x			Native	Migotto *et al*. 1993	AP - RS		Atlantic	From intertidal to 5 m
	Littorina flava King & Broderip, 1832	x		x	Native	Rios (1975)	MA - RS		Atlantic	From intertidal to 6 m
Columbellidae Swainson, 1840	*Anachis sertulariarum* D'Orbigny, 1841			x	Native	Rios (1975)	CE AL BA ES RJ SP PR		Atlantic	Shallow waters
	Mitrella dichroa Sowerby, 1844	x			Native	Duarte & Nalesso (1996)	AL RJ SP PR SC		Atlantic	Shallow waters
Muricidae Rafinesque, 1815	*Stramonita brasiliensis* Claremont & Reid, 2011			x	Native	Salvador *et al*. (1998)	AP - RS		Atlantic	Shallow waters

(Table 2). By taxon status, half of the native and more than half of the cryptogenic species were in only one site, while only 20% of the introduced species were from one site and 40% in two or three sites (Table 3).

The fifteen introduced species are Polychaetes (*Branchiomma luctuosum*), Ascidiacea (*Clavelina oblonga*, *Distaplia stylifera*, *Aplidiopsis* sp., *Ascidia sydneiensis*, *Styela plicata*, *Eusynstyela* sp.), Cnidaria (*Carijoa riisei*), Crustacea Cirripedia (*Amphibalanus amphitrite, Amphibalanus reticulatus*, *Megabalanus coccopoma*, *Balanus trigonus*), and Mollusca Bivalvia (*Myoforceps aristatus*, *Isognomon bicolor, Perna perna*). Three introduced species are reported here for the first time in Brazilian waters (*D. stylifera*, *Aplidiopsis* sp., *Eusynstyela* sp.).

DISCUSSION

Although the SSC may have the best known marine fauna in Brazil (Migotto & Marques, 2006), at least 14 species found, 9.8% of the total, are new records (four polychaetes, two ascidians, one cnidarian, one bryozoan, one barnacle, two entoprocts and three mollusks). Clearly, more taxonomical studies are necessary even for the "well-known" regions. Of the 15 recognized introductions, only eight were previously listed in Lopes (2009), with the remaining seven either not included in that publication (*C. oblonga*, *C. riisei*), considered cryptogenic (*A. amphritite, B. trigonus)*, or are new introductions (*D. stylifera*, *Aplidiopsis* sp., *Eusystyela* sp). All the 10 introductions recorded in Ilha Grande Bay (Ignacio *et al.*, 2010) were also found in SSC, evidence of the established condition of these species in the coast of Brazil. Among them, one bryozoan species reported by Ignacio *et al.* (2010), *Schizoporella errata*, is herein identified as *Schizoporella pungens*. Winston (2005) suggested *S. errata* to be part of a species complex that includes *S. pungens*, described from the Caribbean, and *Schizoporella isabelleana* (D'Orbigny, 1842), described from Rio de Janeiro. The similarity among the species in the complex, the necessity of molecular techniques to confirm the identity of Brazilian specimens (as suggested by Tompsett *et al.*, 2009) and the absence of additional studies on biogeography, led us to give a cryptogenic status for *S. pungens*. We also found *Scrupocelaria aff. diadema* but this is another complex of species in need of revision and without knowing which species is actually in Brazil we also prefered to give a cryptogenic status to the complex.

It is important to note that most taxa were found in only one site (Table 2). Of the introduced taxa, most were in two or three sites (80%), and only 20% in one site (Table 3). Thus, distribution patterns of the introduced taxa are quite different than those of the native and cryptogenic taxa, and may indicate that the introduced are already widespread at the SSC, in the process of successful establishment. It is therefore urgent that monitoring in the region (as well as other major ports) be swiftly carried out to better understand whether those species are also successfully colonizing natural habitats and threatening the native species elsewhere. The study in Ilha Grande Bay showed that most introduced species also occurred on natural substrata in that region (Ignacio *et al.*, 2010).

Although the sites were not surveyed with the same effort, the number of species in each site was not very different (IYC = 89, PP = 70, PCP = 81). Subtidal areas are usually richer in species than intertidal, which is the case for IYC and PP, but effort in PP was much less then IYC and PCP. PCP survey was mainly intertidal. The fact the most species were found in only one site shows that sites were complementary in species composition and that the RAS should include different types of habitats to comprehensively survey a region.

In this study, Ascidiacea has the greatest number of introduced species, followed by Cirripedia, and Bivalvia. However, if we base ranking on the proportion of introduced, relative to the total number per taxa, the order changes to Cirripedia, Bivalvia, and Ascidiacea (Table 4). In the SSC, Cirripedia is a critical case in which most taxa are introduced, and all introduced taxa are widespread (three species in three sites, one in two sites). These introduced species have been reported elsewhere along the Brazilian coast (Farrapeira, 2010a) and some are very old introductions (Carlton *et al*., 2011). The taxon Cirripedia certainly deserves attention, especially because of its difficult taxonomy and the few taxonomists that address biodiversity inventories (which may have caused other introduced species to be overlooked).

The three introduced species of bivalves reported here were also recorded elsewhere in Brazil. *Perna perna* was probably introduced during intensive ship traffic between Africa and Brazil during the 1800 and 1900s; earlier sambaquis (coastal indian fossil deposits) do not contain shells of this species (Souza *et al*., 2003). It is now established throughout the region between Espírito Santo and Santa Catarina and is cultivated for food. *Myoforceps aristatus*, widely distributed in the Atlantic Ocean, is a borer that lives in hard substrates and shells of other mollusks. It was first recorded in southeastern Brazil in 2006 (Simone & Gonçalves, 2006). *Isognomon bicolor*, from the Caribbean, has been seen on rocky coasts in Brazil

Table 2. Number of species (percentage) present in one, two or three sites in the São Sebastião Channel.

	1	2	3	Sum
Annelida - Polychaeta	13 (76.5)	2 (11.8)	2 (11.8)	17
Ascidiacea	10 (41.7)	9 (39.1)	5 (21.7)	24
Bryozoa	20 (55.6)	8 (22.2)	8 (22.2)	36
Cnidaria	15 (55.6)	8 (30.8)	4 (15.4)	27
Crustacea - Cirripedia	2 (22.2)	3 (33.3)	4 (44.4)	9
Crustacea - Decapoda	1 (9.1)	6 (54.5)	4 (36.4)	11
Entoprocta	1 (50)	1 (50)	0 (0)	2
Mollusca - Bivalvia	5 (62.5)	3 (37.5)	0 (0)	8
Mollusca - Gastropoda	5 (62.5)	3 (37.5)	0 (0)	8
Total	72 (50.7)	44 (30.3)	26 (19.0)	142

Table 3. Number of species (percentage) by status present in one, two or three sites in the São Sebastião Channel.

	1	2	3	Sum
Native	24 (45.3)	20 (37.8)	9 (17.0)	53
Cryptogenic	40 (58.0)	18 (26.1)	11 (15.9)	69
Introduced	3 (20.0)	6 (40.0)	6 (40.0)	15
Not classified	5 (100)	0 (0)	0 (0)	5
Total	72 (50.7)	44 (30.3)	26 (19.0)	142

Table 4. Number of species (percentage) by status in the São Sebastião Channel. N: native, I: Introduced, C: Cryptogenic.

	N	I	C	Not classified
Annelida - Polychaeta	4 (23.5)	1 (5.9)	8 (47.1)	4 (23.5)
Ascidiacea	3 (12.5)	6 (25.0)	15 (62.5)	0 (0)
Bryozoa	17 (47.2)	0 (0)	18 (50)	1 (2.8)
Cnidaria	3 (11.0)	1 (3.7)	23 (85.2)	0 (0)
Crustacea - Cirripedia	2 (22.2)	4 (44.4)	3 (33.3)	0 (0)
Crustacea - Decapoda	9 (81.8)	0 (0)	2 (18.2)	0 (0)
Entoprocta	2 (100)	0 (0)	0 (0)	0 (0)
Mollusca - Bivalvia	5 (62.5)	3 (37.5)	0 (0)	0 (0)
Mollusca - Gastropoda	8 (100)	0 (0)	0 (0)	0 (0)
Total	53 (37.3)	15 (10.6)	69 (48.6)	5 (3.5)

since the 1990s and was first recorded in 1989 in Santa Catarina (Domaneschi & Martins, 2002). It is believed that this invasive bivalve was accidentally introduced between 1970 and 1980 by petroleum platforms, boat hulls or by ballast water of ships. Their rapid population growth must have occurred during the 1990s. The species has no commercial value but competes for the same habitat with other commercially valuable species, causing economic losses. In 2002/2003 it has reached very dense populations of more than 800 individuals 100 cm^{-2} (Breves-Ramos *et al*., 2010) in Rio de Janeiro, causing serious changes to the natural hard bottom benthic community, but suffered great mortality in this region in 2006 (Lopes *et al*., 2009).

Ascidiacea, with the greatest number of introduced species in our study, includes well-known important and aggressive invasive species (McKindsey *et al*., 2007). Globally, the distributions of many introduced ascidians are restricted to artificial substrates in ports or marinas (Lambert & Lambert, 2003), but little is known about their impact on natural habitats. The cryptogenic *Didemnum perlucidum, Diplosoma listerianum, Styela canopus, Microcosmus exaspe-ratus, Herdmania pallida* are members of this group. *Styela plicata* and *Ascidia sydneiensis,* are well known introduced species, both invading the bivalve commercial cultures in the state of Santa Catarina (Rocha *et al*., 2009). *Eusynstyela* sp. (previously identified as *Eusynstyela floridana,* Rodrigues *et al*., 1998) may be a new species that was probably introduced in Brazil during the 1990s. *Distaplia stylifera* was introduced during the last ten years, while the species previously identified as *D. stylifera* by Rodrigues *et al*. (1998) is another new and also introduced species. *Clavelina oblonga* was classified as cryptogenic, but a recent molecular study suggested that it is introduced (Rocha *et al*., 2012). The genus *Aplidiopsis* was not found in Brazil until this RAS. We were unable to identify it to species due to the lack of reproductive structures.

Two species of polychaetes, *Branchiomma* (*B. patriota* and *B. luctuosum*) were previously identified as *B. nigromaculatum* (Baird, 1865) which was reported in coastal Brazil (Rullier & Amoureux, 1979; Duarte & Nalesso, 1996), including at SSC. Because of this erroneous identification, *B. patriota* was described only recently by Nogueira *et al*. (2006). According to these authors, *B. luctuosum* is an introduced species known in the SSC at least since 2009 (Amaral *et al*., 2010b), while its type locality is in the Red Sea and it is known to be an invasive species in Italy. The cryptogenic species of Spionidae, *Polydora colonia*, was first recorded in 2001 at Ilha do Mel, Paranaguá Bay, in the state of Paraná (Neves, 2006; Neves & Rocha, 2008). Its records in coastal North and Central America raise doubts as to whether it is an introduced species and hence we consider it to be cryptogenic. Many other species of polychaetes were classified as cryptogenic because of lack of knowledge about their life history and dispersal patterns. *Eunice rubra* has a wide distribution along the Brazilian coast, in addition to Gulf of Mexico and Caribbean Sea, what led us to consider the hypothesis that its natural dispersal area is throughout tropical and subtropical Western Atlantic, and thus it was classified as native. The other native species are those reported only to the Brazilian coast: *Pseudonereis palpata*, *Nicolea uspiana* and *Branchiomma patriota*.

The cnidarian *Carijoa riisei* was considered native to the Caribbean until a recent molecular analysis showed that this species is actually Indo-Pacific in origin and the Atlantic records are therefore introductions (Concepcion *et al*., 2010). It is now very widespread along the Brazilian coast and can be considered naturalized.

Decapod crustaceans, entoprocts, polychaetes and gastropods all have high proportions of native species (over 70%, see Table 4). *Pachigrapsus transversus* was previously known to occur on both sides of the Atlantic and in the eastern Pacific (Manning & Holthuis, 1981; Hendrickx, 1995; Melo, 1996; Poupin *et al*., 2005). Recently, Schubart *et al*. (2005), using morphological and genetic differences (16S mt DNA sequences), revalidated the species *P. socius* Stimpson, 1871 for the eastern Pacific, limiting the occurrence of *P. transversus* to the Atlantic Ocean. However, we maintained the status of the species as cryptogenic because it has been proposed that the different populations on both sides of Atlantic may be introduced in some areas. If so, to determine which populations are introduced will require further molecular studies. On the other hand, the decapod *Pachycheles monilifera*, native to Brazil, has been introduced in Ecuador, in the eastern Pacific (Veloso & Melo, 1993).

In this study, Bryozoa has the greatest number of native species (17). Of these species, both *Amathia distans* and *A. brasiliensis* were reported as wides-pread in warm tropical waters, although a recent study suggested a restricted distribution of these taxa in the western Atlantic (Fehlauer-Ale *et al*., 2011). In addition, the four widespread species in the western Atlantic found in our study (*A. distans*, *A. brasiliensis*, *Bowerbankia maxima* and *Biflustra* sp.) were also found in pelagic algae and may be dispersed by algal rafting, as reported for other bryozoans (Taylor & Monks, 1997; Vieira *et al*., 2010).

It is remarkable that while taxa with a longer history of surveys such as Crustacea Decapoda and Mollusca have a very small proportion of cryptogenic species, a large proportion of species of ascidians, bryozoans and cnidarians, are still considered cryptogenic. These taxa are typically found in small colonies that may have been overlooked in previous faunal studies, and they often comprise many species with wide geographic distribution. Thus the uncertainty of their status, also illustrating the need for periodic monitoring of areas sensitive to bioinvasion, comprehensive surveys of natural areas, and molecular studies to understand their geographical distribution. Also, some widespread bryozoans have been reported to be quite variable morphologically in disjoint areas, which suggest that, in species with short-lived larvae, a complex of cryptic species and hidden endemism may be common (Vieira *et al*., 2010).

With the use of molecular tools, populations of a given species have been shown to be introduced in other areas (*e.g.*, populations of the Atlantic *Clavelina lepadiformis* introduced in the Mediterranean – Turon *et al*., 2003) and species previously considered widely distributed have been split in one or more new species with narrower geographical ranges (*e.g.*, *Thais haemastoma* – Claremont *et al*., 2011; *Pachigrapsus transversus* – Schubart *et al.*, 2005; *Botryllus schlosseri* – Bock *et al*., 2012). We suggest that this kind of genetic monitoring is also important for the study of marine bioinvasions, and such studies are being conducted by our research group for ascidians, bryozoans, and cnidarians. Previous results from these molecular studies show that some species of these groups, now considered cryptogenic, may be instead introduced species or introduced populations of haplotypes. Therefore, the estimated number of introduced taxa should be thought to be very conservative and with continued study, many more species will be shown to be introduced.

Here we demonstrate that RASs, even for reasonably well-known regions of Brazil, such as the São Sebastião Channel, are useful strategies to monitor and detect introduced species. We recommend that RASs be replicated on a large scale in all ports with moderate to heavy ship traffic.

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