PANAMJAS
Pan-American Journal of Aquatic Sciences

First record of *Spirobranchus giganteus* (Pallas, 1766) (Polychaeta, Serpulidae) on Southeastern Brazillian coast: new biofouler and free to live without corals?

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Abstract. The serpulid *Spirobranchus giganteus* is recorded by first time at Arraial do Cabo, Southeastern Brazilian coast, with two important observations of its biology and dispersal: is the first time that this species is recorded living without coral association and the possibility to disperse and colonize new areas as part of biofouling. Until the present, we do not know if this species will spread or disappear in the region, so monitoring dives are needed to follow its distribution.

Keywords: christmas tree worm, tubeworms, marine fouling, introduced species, marine activities

Resumo: **Primeiro registro de *Spirobranchus giganteus* (Pallas, 1766) (Polychaeta, Serpulidae) na costa sudeste do Brasil: novo bioincrustante e live para viver sem corais?.** O serpulídeo *Spirobranchus giganteus* é registrado pela primeira vez em Arraial do Cabo, na costa sudeste brasileira, com dois registros importantes de sua biologia e dispersão: é a primeira vez que esta espécie é observada vivendo sem a associação com corais e a possibilidade de dispersão e colonização de novas áreas como parte da bioincrustação. Até o momento, não sabemos se esta espécie irá se espalhar ou desaparecer na região, então mergulhos de monitoramento são necessários para acompanhar sua distribuição.

Palavras chave: verme-árvore-de-natal, poliqueto tubícola, incrustação marinha, espécies introduzidas, atividades marítimas

Introduction

Polychaetes included in Sabellida clade are represented by two families: Sabellidae Latreille, 1825 and Serpulidae Rafinesque, 1825. They are easily recognized by the anterior branchial crown and also by a distinct thoracic and abdominal regions. These groups are easiest distinguishable among then: Serpulidae are tubeworms whose tubes are calcareous and Sabellidae are tubeworms with tube made by sediment and mucous (Kupriyanova & Rouse 2008, ten Hove & Kupriyanova 2009). These families are two of the most important polychaetes from benthic hard substrata, mainly on fouling communities (Bastida-Zavala 2008, Tovar-Hernandez *et al.* 2009).

Marine fouling species are subjected to be transported among biogeographical regions by ships and oil platforms hulls, ballast water and aquaculture. Recent studies worldwide put hull fouling as an important, current and ongoing vector for species translocation (Gollasch 2002, Lewis *et al.* 2006, Tovar-Hernandez *et al.* 2009). Dispersion of many serpulid species has been reported from tropical and subtropical harbors in all oceans, and related to this vector (Schwindt & Iribarne 1998, Lewis *et al.* 2006, Bingham 2008, Tovar-Hernández *et al.* 2009).

The Christmas Tree Worm *Spirobranchus giganteus* (Pallas, 1766) (Figure 1) is a tropical calcareous tubeworm, commonly associated to several coral species (Hunte *et al.* 1990), and belongs to a complex-species (Fiege & ten Hove 1999). Many papers described its distribution as obligatory associated to live corals (Marsden *et al.*

1990, Ben-Tzvi *et al.* 2006, Floros *et al.* 2005, Petitjean & Myers 2005). They could live for 18-20 years, and mature at a small size (and presumably early age) and produces a large number of very small offspring (Nishi & Nishihira 1996).

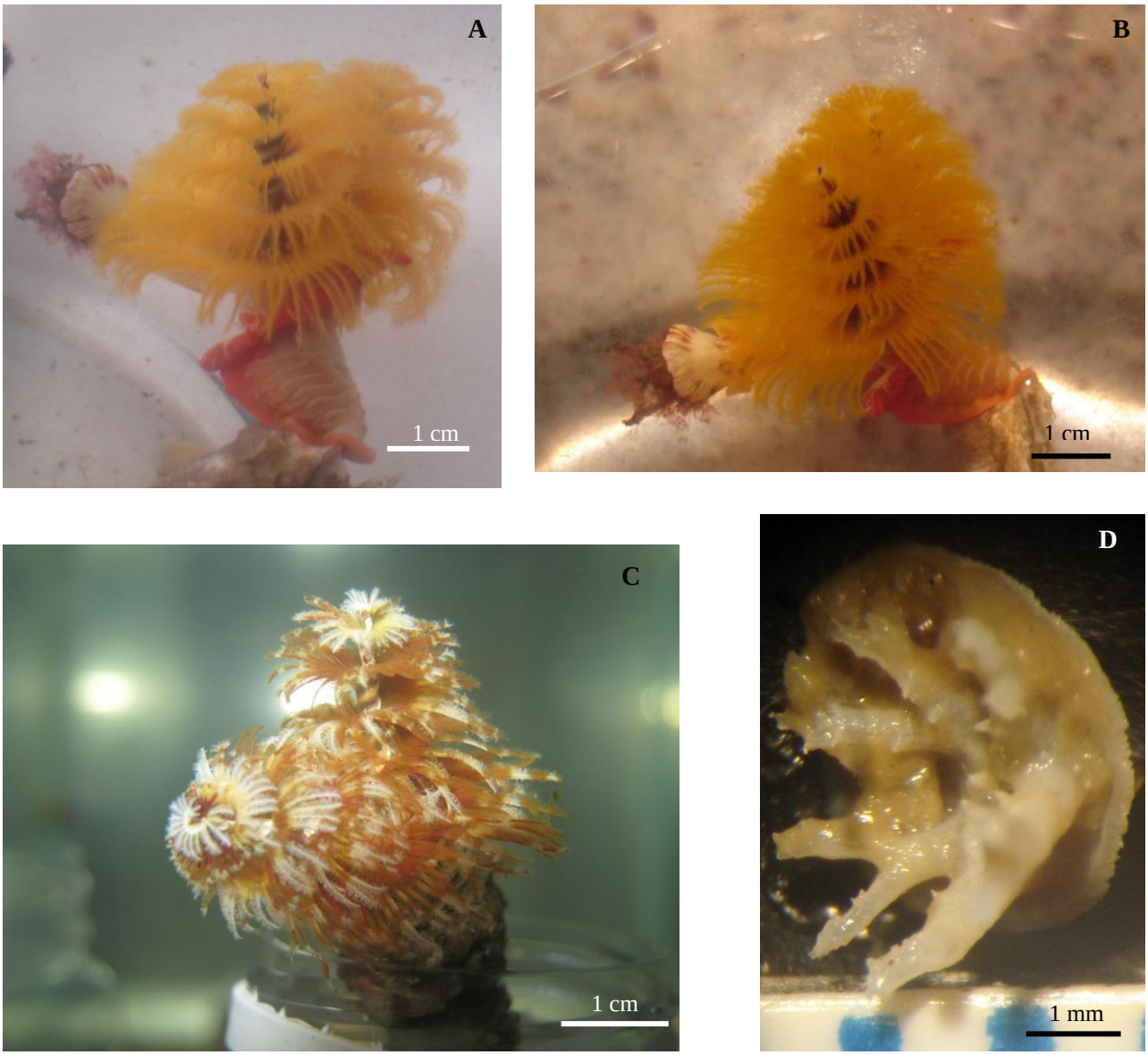

Figure 1. *Spirobranchus giganteus* collected from Buoy, at Arraial do Cabo..Pictures shows the typical radiolar crown, some color variation and lateral view of operculum (A and B). Detail of operculum (D) 20X. Distance between bars= 1mm. Photo by L.F. Skinner

The first record of *S. giganteus* from Brazil was by Quatrefagues 1865, as *Cymospira megasoma* and *Cymospira rubus* from "le Brésil" and from "Bahia" (*sensu* ten Hove 1970); Zibrowius (1970) recorded *S. giganteus* from Fernando de Noronha. Paiva (2006a, 2006b) reports the occurrence of this species in Abrolhos reef bank on sedimentary bottom samples, probably eroded from the reefs. Also, *S. giganteus* is recorded from the coast of Rio Grande do Norte (RN) by Amaral *et al.* (2006).

The purpose of this paper is to describe the first occurrence of *S. giganteus* at Arraial do Cabo, on Brazilian southeastern coast, 650 km away of its previous southernmost record, to record its association to artificial substrata, not to coral species as described on literature and also, the transference between artificial substrates.

Methods

Study area. The study area was inside Forno harbor, at Arraial do Cabo (22°58'22.13"S, 42° 0'49.69"W) (Figure 2). This harbor previously operates in salt transfer from NE coast of Brazil but since 90's years, support activities to oil industry have increased and also traffic of ships and platforms to this region. Many exotic species were detected in these years like sponges *Paraleucilla magna* (Klautau *et al.* 2004) soft and azooxanthelate corals like *Chromonephthea braziliensis* (previously identified as *Stereonephthya* aff. *Curvata)* and *Tubastrea coccinea* (Ferreira 2005, Fleury *et al.* 2005), the bivalve *Isognomom bicolor* (López *et al.* 2010), the sabellid polychaete *Branchiomma luctuosum* (Costa-Paiva 2006) among others (Lopes 2009). Many of these introductions have been associated to this increase on ship traffic. The main available substrata for fouling organisms on harbor area are the breakwater, formed by large granite boulders, and the pillars of the pier, besides five decommissioned buoys. These buoys has 15m in diameter and 5m deep and its hull is replenished with fouling species, many of them exotic (Coutinho 2009).

We collected the first two individuals of *S. giganteus* on July 2009 from one buoy hull. After taxonomic confirmation, two more individuals were collected on buoy and dissected, and we could record the presence of eggs inside body segments. This indicates that they are reproducing in the region and lead us to look for its presence on available natural or artificial substrata. From July 2009 up to October 2010, we performed 10 scuba dives to search and mappping *S. giganteus* distribution in associations with massive zooxanthelate coral species (*Mussismilia hispida*, *Siderastrea stellata*) and azooxanthelate coral species (*Tubastrea* spp). Other coral species at the study region are *Madracis decactis*, *Phyllangia americana* and the hydrocoral *Millepora alcicornis* (Laborel 1970), but they are not found inside harbor. During these dives, we recorded the presence of three individuals at breakwater and two more at buoy. All individuals collected were found on shallow waters, up to 3 m deep. Also, the individuals collected from breakwater were located very close to buoy, in distances up to 5 m. Specimens were deposited at "Edmundo Ferraz Nonato" Polychaete collection, at UFRJ (IBUFRJ).

Results and discussion

For the first time, *S. giganteus* was recorded at Arraial do Cabo and out of its typical environment: warm temperate waters in coral reef region. Mean water temperature at Anjos Bay is 22.5 ^{o}C (Guimaraens & Coutinho, 2000). The presence of some individuals that recruited on breakwater, closer to the buoy, represents its introduction on region, and is based on three aspects: firstly, the absence of any previously register, even photographic, of this wonderful species (Song 2006) on region, and Arraial do Cabo is the most visited dive site on Brazil. Secondly, the presence of many individuals on decommissioned oil buoy hull (pers. obs.) and third, its occurrence only inside harbor area, site favorable to species introduction (Cohen *et al.* 2005, Lopes 2009). Previous records include Fernando de Noronha Island, Atol das Rocas and Abrolhos bank (Figure 2). Despite Cabo Frio region be recognized as southern limit for many endemic coral species (Laborel 1970, Lins de Barros *et al.* 2003), mean water temperature is few (circa 2-3) degrees below mean water temperature on northeastern coast and corals could not form a reef, but grow over natural rocks (Lins de Barros *et al.* 2003).

But, besides the introduction, two additional aspects are very relevant. The first one is the possibility of *S. giganteus* colonizes, be transported and transferred as fouling species between different regions. Carrerette (2010) also detected new records of *S. giganteus*, both on natural and artificial substrates at Sepetiba bay, Rio de Janeiro. Like Arraial do Cabo, these records are performed in an harbor area. These observations at two different bays could indicate that *S. giganteus* is being transferred on Brazilian coast among regions as biofouling species. Other possibilities, less supported by our data are larval transport by ballast water or range expansion due to global climate change.

Sabellidae and Serpulidae develops both on natural and artificial substrata (Bastida-Zavala 2008, Tovar-Hernandez *et al.* 2009) and among Serpulidae, excluding Spirorbinae, 18 of 350 species are described as exotic or cryptogenic (Link *et al.* 2009; ten Hove & Kupriyanova 2009). Serpulidae dispersion has been well documented and registered in many places and being associated to fouling on ship hulls (Schwindt & Iribarne 1998, Schwindt *et al.* 2001, Lewis *et al.* 2006, Bingham 2008, Tovar-Hernández *et al.* 2009). Species translocation among biogeographical regions has been associated to several sources, and navigation is now recognized as a very important, actual and continuous vector of species translocation (Gollasch 2002, Hayes 2002, Orensanz *et al.* 2002, Lewis *et al.* 2006, Farrapeira *et al.* 2007, Tovar-Hernandez *et al.* 2009, Wanless *et al.* 2009).

Buoys were introduced from 2002 to 2006 and are replenished by *Tubastrea coccinea*, a very

invasive species on southeastern Brazilian coast. Densities of *T. coccinea* on buoy are very high (more than 300 colonies) than any site at Arraial do Cabo region, suggesting that it could be the focus itself for several exotic species as noted in other places (Coutinho 2009). Apparently, *S. giganteus* remains restricted to buoy and very few individuals on breakwater.

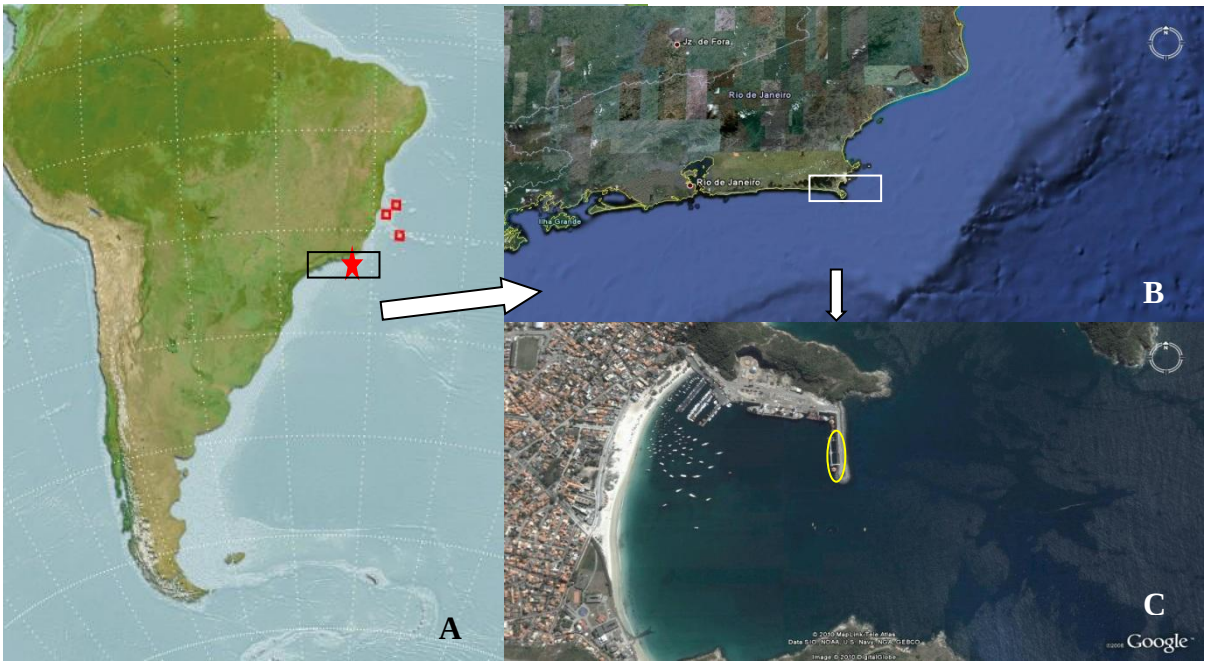

Figure 2. A) Distribution map for *Spirobranchus giganteus* in Brazillian coast. Data from OBIS (http://iobis.org/mapper/). Squares indicate the known distribution; star is the new record at Arraial do Cabo. B and C) Position of Forno harbor in Brazilian coast and location of collected individuals. Maps Source: OBIS (Vanden Berghe 2007) and Google Earth.

The second and the most intriguing question, contrasting to literature, was that we do not record *S. giganteus* living associated to hard corals and many authors describe this association as obligatory (Marsden *et al.* 1990; Hunte *et al.* 1990a). In Cozumel, Mexican Caribbean, *S. giganteus* is found in abundance in the first 0-2 meters, associated to several massive scleractinean corals, *Millepora* (Hydrozoa), rocks (Bastida-Zavala & Salazar-Vallejo 2000) and also to piers (Bastida-Zavala Pers. Obs.).

Several field and laboratory experiments were conducted to know factors that influence *S. giganteus* recruitment. Among factors, light (Marsden 1984, 1986, 1990) and coral species presence (Marsden 1987, Marsden *et al.* 1990) are the most studied as a settlement cues to this species. However, as we found *S. giganteus* over buoy hull (iron) surrounded by Didemnidae ascidians (Figure 3) and on rocks from breakwater, without any proximity to coral species, it is possible that other substances or surfaces could signalize settlement location. In the laboratory experiments performed to assess the specificity of *S. giganteus* to coral species (Marsden 1987, Marsden *et al.* 1990) control substrata were coral rubble or glass and they did not isolate the natural larval settlement inducers in these studies. From literature, we know that polychaete larval settlement could be stimulated by several biological, inorganic and substrate surface signals (Qian 1999). Although some marine invertebrate larvae could settle on clean surfaces, settlement on hard surfaces is enhanced by bio-organic film (Unabia & Hadfield 1999, Hammer *et al.* 2001, Lau & Qian 2001) or by surface roughness (Qian *et al.* 1999, 2000, Skinner & Coutinho 2005, Koehl 2007). Sometimes keep clean surfaces could avoid larval settlement (Qian & Pechenick 1998). It is possible that other unknown signals are influencing *S. giganteus* settlement.

Continuous monitoring of *S. giganteus* distribution and reproduction is important for defining the status of the species as potentially invasive or not. Another important conclusion is the need of environmental protection decisions to avoid problems regarding hull colonization by fouling species due large inactivity periods of ships (Floerl & Coutts 2009) and decommissioning of nautical

structures without pre-cleaning (Wanless *et al.* 2009). Both actions could increase transfer of marine species among marine regions and it is a problem that managers have to deal to prevent species introductions.

Figure 3. *Spirobranchus giganteus* attached to buoy hull surrounded by Didemnidae Ascidia (white) and some anemones.

Acknowledgements

This work has been partially supported by Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ) in "Apoio a Grupos emergentes 2008". Schoolarship from Universidade do Estado do Rio de Janeiro (UERJ) to A.A. Tenório and to L.F. Skinner. Authors would like to thanks to Paulo Paiva (UFRJ) for *S. giganteus* identification confirmation. We would like to thanks also to Rolando Bastida-Zavala for their very important suggestions and review of this paper. Logistic support by Porto do Forno and Dive Point underwater activities. Instituto Chico Mendes de Biodiversidade (ICMBio) Research authorization number 25024-1

References

Amaral, A. C. Z., Nallin, S. A. H. & Steiner, T. M. 2006. **Catálogo das espécies dos Annelida Polychaeta da costa brasileira**, Available from http://www.ib.unicamp.br/projbiota/bentos_marinho/catalogo_polychaeta2006.pdf . Accessed 06/24/2010

Bastida-Zavala, J. R. & Salazar-Vallejo S.I. 2000. Serpúlidos (Polychaeta: Serpulidae) del Caribe noroccidental con claves para la región del Gran Caribe: *Salmacina*, *Ficopomatus*, *Pomatoceros*, *Pomatostegus*, *Protula*, *Pseudovermilia*, *Spirobranchus y Vermiliopsis*. **Revista de Biologia Tropical**, 48(4): 807-840.

Bastida-Zavala, J. R. 2008. Serpulids (Annelida: Polychaeta) from the Eastern Pacific, including a brief mention of Hawaiian serpulids. **Zootaxa,** 1722: 61 pp.

Ben-Tzvi, O., Einbinder, S. & Brokovich, E. 2006. A beneficial association between a polychaete worm and a scleractinian coral? **Coral Reefs,** 25: 98

Bingham, P. 2008. Quarterly report of investigations of suspected exotic diseases. **Surveillance** 35: 38-39.

Carrerette, O. 2010. Polychaeta de substratos consolidados artificiais e Naturais da Baía de Sepetiba, RJ-Brasil, **M. Sc.Dissertation**, MN-UFRJ. 73 pp.

Cohen, A. N., Harris, L. H., Bingham, B. L., Carlton, J. T., Chapman, J. W., Lambert, C. C., Lambert, G., Ljubenkov, J. C., Murray, S. N., Rao, L. C., Reardon, K. & Schwindt, E. 2005. Rapid Assessment Survey for Exotic Organisms in Southern California Bays and

Harbors, and Abundance in Port and Non-port Areas. **Biological Invasions,** 7, 995-1002.

Costa-Paiva, E. M., Paiva, P. C. & Klautau, M. R. L. 2007. Anaesthetisation and fixation effects on the morphology of sabellid polychaetes. **Journal of the Marine Biological Association of the United Kingdom,** 87: 1127–1132.

Coutinho, R. 2009. Apoio ao projeto de erradicação da bioinvasão e de campanhas de conscientização do lixo submarino como formas de reversão às ameaças de degradação da biodiversidade do ecossistema marinho da região. In: **Projeto de gestão socioambiental de reserva extrativista marinha para o ecodesenvolvimento** http://sage.coppe.ufrj.br/ressurgencia/images/stories/relatorios/vi_relatorio/vi_rt.pdf. Accessed 07/10/2010

Farrapeira, C. M. R., Melo, A. V. O. M., Barbosa, D. F. & Silva, K. M. E. 2007. Ship hull fouling in the port of Recife, Pernambuco. **Brazilian Journal of Oceanography,** 55(3):207-221, 2007

Ferreira, C. E. L. 2005. **Espécies exóticas no ambiente marinho: estudos de caso em Arraial do Cabo (RJ).** Resumos do VII Congresso de Ecologia do Brasil. http://www.seb-ecologia.org.br/viiceb/resumos_professores/Conferidos/PDF/Kadu.pdf. Accessed 07/03/2010

Fiege, D. & Ten Hove, H. A.. 1999. Redescription of *Spirobranchus gaymardi* (Quatrefages, 1866) (Polychaeta: Serpulidae) from the Indo-Pacific with remarks on the *Spirobranchus giganteus* complex. **Zoological Journal of the Linnean Society,** 126: 355-364.

Fleury, B. G., Lages, B. G., Pereira, R. C. & Ferreira, C. E. L. 2005. Coral invasor em Arraial do Cabo. **Ciência Hoje,** 212: 64-67

Floerl, O. & Coutts, A. 2009. Potential ramifications of the global economic crisis on human-mediated dispersal of marine non-indigenous species. **Marine Pollution Bulletin,** 58: 1595–1598

Floros, C. D., Samways, M. J. & Armstrong, B. 2005. Polychaete (Spirobranchus giganteus) loading on South African corals. **Aquatic Conservation: Marine and Freshwater Ecosystems,** 15: 289–298

Gollasch, S. 2002. The importance of ship hull fouling as a vector of species introductions into the North Sea. **Biofouling,** 18: 105–121

Guimaraens, M. A. & Coutinho, R. 2000. Temporal and spatial variation of Ulva spp. and water properties in the Cabo Frio upwelling region of Brazil. **Aquatic Botany,** 66: 101–114

Hayes, K. R. 2002. Identifying hazards in complex ecological systems. Part 2: infection modes and effects analysis for biological invasions. **Biological Invasions,** 4:251–261.

Hunte, W., Conlin, B. E. & Marsden, J. R. 1990a. Habitat selection in the tropical polychaete *Spirobranchus giganteus*. I. Distribution on corals. **Marine Biology,** 104:87-92

Hunte, W., Marsden, J. R. & Conlin, B. E. 1990b. III. Effects of coral species on body size and body proportions. **Marine Biology,** 104:101-107

Klautau, M., Monteiro, L. & Borojevic, R. (2004). First occurrence of the genus *Paraleucilla* (Calcarea, Porifera) in the Atlantic Ocean: *P. magna* sp. nov.. **Zootaxa,** (Auckland), v. 710, p. 1-8.

Koehl, M. R. A. 2007. Hydrodynamics of larval settlement into fouling communities', **Biofouling**, 23: 357 - 368. DOI: 10.1080/08927010701492250

Kupriyanova, E. K. & Rouse, G.W. 2008. Yet another example of paraphyly in Annelida: Molecular evidence that Sabellidae contains Serpulidae. **Molecular Phylogenetics and Evolution,** 46: 1174–1181

Laborel, J. 1970. Madreporaires et hydrocoralliaires recifaux des cotes bresiliennes. Sysèmatique ecologie repartition verticale et geographique. Pages 171-229. **XXXVI Campagne de la Calypso au large des cotes Atlantiques de l'Amerique du Sud (1961-1962). Premiere et deuxieme partie** (suite)

Lau, S. C. K. & Qian, P-Y. 2001. Larval settlement and metamorphosis in the serpulid polychaete *Hydroides elegans* in response to bacterial films: an investigation of the nature of putative larval settlement cues. **Marine Biology,** 138: 321–328

Lewis, J. A., Watson, C. & Ten Hove, H. A. 2006. Establishment of the Caribbean serpulid tubeworm *Hydroides sanctaecrucis* Krøyer [in] Mörch 1863 in northern Australia. **Biological Invasions,** 8: 665–671

Link, H., Nishi, E., Tanaka, K., Bastida-Zavala, R., Kupriyanova, E. K. & Yamakita, T. 2009. *Hydroides dianthus* (Polychaeta: Serpulidae) an alien species introduced into Tokyo Bay Japan. **Marine Biodiversity Records,** 2: e87 Cambridge University Press doi:10.1017/S1755267209000931

Lins-de-Barros, M. M.; Pires, D. O. & Castro, C. B. 2003. Sexual reproduction of the Brazilian reef

coral Siderastrea stellata Verrill, 1868 (Anthozoa, Scleractinia). **Bulletin of Marine Sciences,** 73:713-724

Lopes, R.M. (ed.). 2009. **Informe sobre as espécies exóticas invasoras marinhas no Brasil**. Ministério do Meio Ambiente, Brasília: MMA/SBF 440 p., il. color. (Série Biodiversidade 33). Available from http://www.mma.gov.br/estruturas/174/_publicacao/174_publicacao16032010050723.pdf

López, M. S., Coutinho, R., Ferreira, C. E. L. & Rilov, G. 2010. Predator–prey interactions in a bioinvasion scenario: differential predation by native predators on two exotic rocky intertidal bivalves. **Marine Ecology Progress Series,** 403: 101–112

Marsden, J. R. 1984. Swimming in response to light by larvae of the tropical serpulid *Spirobranchus giganteus*. **Marine Biology,** 83:13-16

Marsden, J. R. 1986. Response to light by trocohophore larvae of *Spirobranchus giganteus*. Effects of level of irradiance dark adaptation and spectral distribution. **Marine Biology,** 93:13-16

Marsden, J. R. 1987. Coral preference behaviour by planktotrophic larvae of *Spirobranchus giganteus corniculatus* (Serpulidae: Polychaeta). **Coral Reefs,** 6:71-74

Marsden, J. R. 1990. Light responses of the planktotrophic larva of the serpulid polychaete *Spirobranchus polycerus*. **Marine Ecology Progress Series,** 58: 225-233.

Marsden, J. R., Conlin, B. E. & Hunte, W. 1990. Habitat selection in the tropical polychaete *Spirobranchus giganteus*. II. Larval preferences for corals. **Marine Biology,** 104: 93-99

Nishi, E. & M. Nishihira. 1996. Age-estimation of the Christmas tree worm *Spirobranchus giganteus* (Polychaeta, Serpulidae) living buried in the coral skeleton from the coral-growth band of the host coral. **Fisheries science**, 62(3): 400-403.

Orensanz, L. J. M., Schwindt, E., Pastorino, G., Bortolus, A., Casas, G., Darrigran, G., Elías, R., López Gappa, J. J., Obenat, S., Pascual, M., Penchaszadeh, P., Piriz, M. L., Scarabino, F., Spivak, E. D. & Vallarino, E. A. 2002. No longer the pristine confines of the world ocean: a survey of exotic marine species in the southwestern Atlantic. **Biological Invasions,** 4:115–143.

Paiva, P. C. 2006a. Chapter 7 - Soft-bottom polychaetes of the Abrolhos Bank In Dutra, G. F., Allen, G. R., Werner, T., & McKenna, S. A. (eds): **A Rapid Marine Biodiverstity Assessment of the Abrolhos Bank Bahia Brazil.** Conservation International, Vol. 38: 87-90, Washington D.C.:

Paiva, P. C. 2006b. Filo Annelida. Classe Polychaeta. In: Lavrado, H. P., Ignácio, B. L. (Eds.). **Biodiversidade bentônica da região central da Zona Econômica Exclusiva Brasileira.** 1rst. ed. Rio de Janeiro: Museu Nacional v. 1 p. 261-298

Petitjean, S. E. & Myers, A. E. 2005. **Age Characterization and Distribution of *Spirobranchus giganteus* on Paraiso Reef**. Epistimi Online at: http://www.capital.edu/uploadedFiles/Capital/Academics/Services_and_Programs/Undergraduate_Research/Epistimi/Content/Age,%20Characterization,%20and%20Distribution%20of%20Spirobranchus%20giganteus%20on%20Paraiso%20Reef.pdf Consulted on 26/06/2010.

Qian P-Y. & Pechenik, J. A. 1998. Effects of larval starvation and delayed metamorphosis on juvenile survival and growth of the tube-dwelling polychaete Hydroides elegans (Haswell). **Journal of Experimental Marine Biology and Ecology,** 227:169-85.

Qian P-Y. 1999. Larval settlement of polychaetes. **Hydrobiologia,** 402: 239–253

Qian, P. Y., Rittschof, D. & Sreedhar, B. 2000. Macrofouling in unidirectional flow: miniature pipes as experimental models for studying the interaction of flow and surface characteristics on the attachment of barnacle, bryozoan and polychaete larvae. **Marine Ecology Progress Series,** 207:109 – 121.

Qian, P. Y., Rittschof, D., Sreedhar, B. & Chia, F. S. 1999. Macrofouling in unidirectional flow: miniature pipes as experimental models for studying the effects of hydrodynamics on invertebrate larval settlement. **Marine Ecology Progress Series,** 191:141 – 151.

Schwindt, E. & Iribarne, O. O. 1998. Reef of Ficopomatus enigmaticus (Polychaeta, Serpulidae) in the Mar Chiquita Coastal Lagoon Argentina. **Bolletí de la Societat d'Història Natural de les Balears,** 41: 35-40.

Schwindt, E., Bortolus, A. & Iribarne, O. O. 2001. Invasion of a reef-builder polychaete: direct and indirect impacts on the native benthic community structure. **Biological Invasions,** 3: 137–149

Skinner, L. F. and Coutinho, R. (2005), Effect of microhabitat distribution and substrate roughness on barnacle **Tetaraclita**

stalactifera (Lamarck, 1818) settlement. **Brazilian Archives of Biology and Technology,** 48 (1): 109-113.

Song, D. S. 2006. **Christmas Colors : Colormorph Distribution of *Spirobranchus giganteus* Pallas 1766 on Moorea French Polynesia**. http://www.escholarship.org/uc/item/12t2697d Accessed 26 June 2010

Ten Hove, H. A. & Kupriyanova, E. K. 2009. Taxonomy of Serpulidae (Annelida Polychaeta): The state of affairs. **Zootaxa**, 2036. 126 pp.

Ten Hove, H. A. & Kupriyanova, E. K. 2009. Taxonomy of Serpulidae (Annelida, Polychaeta): the state of affairs. **Zootaxa,** 2036: 1-126.

Ten Hove, H. A. 1970. Serpulinae (Polychaeta) from the Caribbean: I—the genus Spirobranchus. **Studies on the Fauna of Curaçao and other Caribbean Islands**, 32: 1–57.

Tovar-Hernández, M. A., Méndez, N. & Villalobos-Guerrero, T. F. 2009. Fouling polychaete worms from the southern Gulf of California: Sabellidae and Serpulidae. **Systematics and Biodiversity,** 7(3): 319–336

Unabia, C. R. C. & Hadfield, M. G. 1999. Role of bacteria in larval settlement and metamorphosis of the polychaete *Hydroides elegans* . **Marine Biology,** 133: 55 - 64.

Vanden Berghe, E. 2007 (Ed.). **The Ocean Biogeographic Information System**: web pages. Available on http://www.iobis.org. Consulted on 10/15/2011

Wanless, R. M., Scott, S., Sauer, W. H. H., Andrew, T. G., Glass, J. P., Godfrey, B., Griffiths, C. & Yeld, E. 2009. Semi-submersible rigs: a vector transporting entire marine communities around the world. **Biological Invasions,** 12(8): 2573-2583.

Zibrowius, H. 1970. Contribution a l'ètude des Serpulidae (Polychaeta Sedentaria) du Brésil. **Boletim Instituto Oceanográfico de São Paulo,** 19: 1-32.

Received February 2012
Accepted July 2012
Published online November 2012