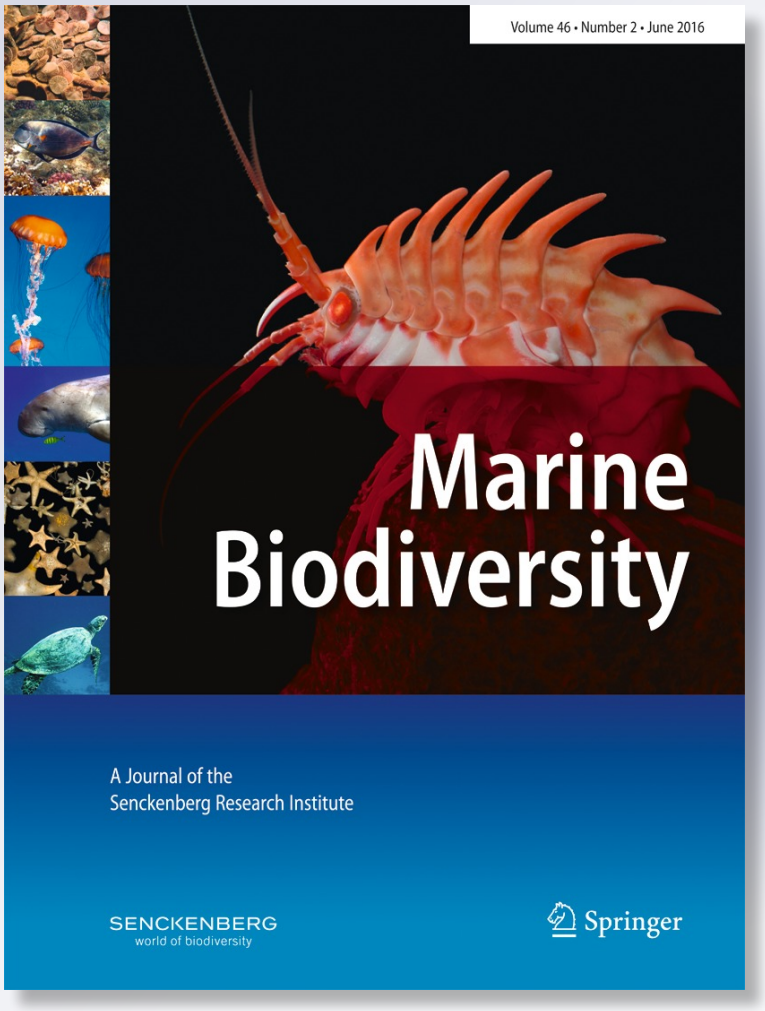
High density of the alien bryozoan Fenestrulina delicia *in the fouling assemblage of a South American harbour (Argentina)*

Juan López-Gappa & María G. Liuzzi

Marine Biodiversity

ISSN 1867-1616
Volume 46
Number 2

Mar Biodiv (2016) 46:509-513
DOI 10.1007/s12526-015-0380-2



Springer

Your article is protected by copyright and all rights are held exclusively by Senckenberg Gesellschaft für Naturforschung and Springer-Verlag Berlin Heidelberg. This e-offprint is for personal use only and shall not be self-archived in electronic repositories. If you wish to self-archive your article, please use the accepted manuscript version for posting on your own website. You may further deposit the accepted manuscript version in any repository, provided it is only made publicly available 12 months after official publication or later and provided acknowledgement is given to the original source of publication and a link is inserted to the published article on Springer's website. The link must be accompanied by the following text: "The final publication is available at link.springer.com".

Author's personal copy

Mar Biodiv (2016) 46:509–513
DOI 10.1007/s12526-015-0380-2

SENCKENBERG CrossMark

SHORT COMMUNICATION

High density of the alien bryozoan *Fenestrulina delicia* in the fouling assemblage of a South American harbour (Argentina)

Juan López-Gappa[1] · **María G. Liuzzi**[1]

Received: 23 June 2015 / Revised: 4 August 2015 / Accepted: 10 August 2015 / Published online: 23 August 2015
© Senckenberg Gesellschaft für Naturforschung and Springer-Verlag Berlin Heidelberg 2015

Abstract The non-indigenous cheilostome bryozoan *Fenestrulina delicia* Winston, Hayward and Craig has been recorded for the first time in the southern hemisphere. It was found on experimental substrata submersed to study the fouling assemblage of Quequén Harbour (Argentina, southwest Atlantic), an estuarine environment. Its density on experimental panels was very high, reaching almost 5,000 colonies.m^{-2}. The percentage of ovicellate colonies, however, was relatively low (mean±SD: 5.2±2.3 %, range: 1.6 – 9.9 %) due to the abundance of newly recruited zoaria. *F. delicia* was originally described for the Atlantic coast of the United States. It was later discovered in Alaska, Oregon and California, and has recently been reported as a highly invasive fouler along the Atlantic coasts of Europe. This species seems to have the potential to continue its dispersion by means of maritime traffic, or rafting on plastic debris, and become a stable component of this and neighbouring harbours in the area.

Keywords Introduced species · Bryozoa · *Fenestrulina delicia* · Estuarine environment · Southwest Atlantic

Communicated by P. Martinez Arbizu

✉ Juan López-Gappa
lgappa@macn.gov.ar

[1] Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) - Museo Argentino de Ciencias Naturales (MACN), Angel Gallardo 470, C1405DJR Ciudad Autónoma de Buenos Aires, Argentina

Introduction

Bryozoans are frequent components of the biofouling settled on submerged artificial substrates in harbour environments worldwide (e.g. Ryland 1965; Lichtschein de Bastida and Bastida 1980; Brock 1985; Gordon and Mawatari 1992; Liu et al. 2001). As ports are initial incursion sites frequently used by non-indigenous species (NIS) (Carlton 2010), it is not unusual to find non-indigenous bryozoans attached to hard surfaces in harbours (Hewitt et al. 2004; Ryland et al. 2011; Kelso and Wyse Jackson 2012; Lodola et al. 2015; among others) and marinas (Ryland et al. 2011, 2014).

The bryozoan fauna reported for Argentine harbours encompasses at least 25 species (Lichtschein de Bastida and Bastida 1980; Schwindt et al. 2014), of which only 5 are documented NIS and another 4 are regarded as cryptogenic (Orensanz et al. 2002).

Fenestrulina delicia Winston, Hayward and Craig is a cheilostome bryozoan originally described for the Gulf of Maine (Atlantic coast of the United States) (Winston et al. 2000; Winston and Hayward 2012). Shortly after, *F. delicia* was simultaneously found in Alaska, Oregon and California (Dick et al. 2005), casting doubts about the original distribution of the species. Some aspects of its biology and anatomy had been studied before its formal description as a new species based on material from the same area (Craig 1994, as *Fenestrulina* sp.). According to Winston et al. (2000), the colonies reach sexual maturity after approximately 2 months. The lecitotrophic larvae, which are brooded in ovicells, are ready to be released after 14 days of development. Larval settlement achieves a maximum in autumn (October).

The main aim of this study is to report for the first time the presence of *Fenestrulina delicia* in Quequén Harbour (Argentina, southwest Atlantic), quantify its abundance, and discuss its potential to continue its dispersion in the area.

Author's personal copy

Materials and methods

Quequén Harbour is located at the mouth of Quequén Grande estuary (Fig. 1). Mean water temperatures recorded at a neighbouring site within the estuary (Necochea Power Station) range from 10 °C (July) to 21 °C (February), while absolute minimum and maximum temperatures may reach 8.9 and 22 °C, respectively (Brankevich et al. 1985). Large salinity fluctuations related to the tidal cycle are common in this harbour. Mean values range from 6 to 27 PSU, while extreme salinity records may attain 4 and 32 PSU. pH values are always higher than 8, due to the absence of significant organic matter pollution (Brankevich et al. 1985).

Colonies of *F. delicia* were collected using two different strategies: (1) 48 rectangular (210×260×3.5 mm) low-density polyethylene panels screwed to vertical supporting structures suspended from a pier at Quequén Harbour ("Bita 49", 38°34.310'S, 58°42.814'W; Fig. 1) were submersed on September 20, 2012 (winter) and collected on June 21, 2013 (autumn); and (2) vertical concrete walls dominated by the non-indigenous tubicolous polychaete *Ficopomatus enigmaticus* (Fauvel) were sampled by SCUBA divers on June 20, 2013, at a depth of 2–4 m below mean low water level. The dense stands of intermingled calcareous tubes were detached from the pier using scrapers, fixed in a 5 % solution of formaldehyde in seawater, and later transferred to 70 % ethanol for storage.

The density of *F. delicia* on the panels and the percentage of colonies bearing ovicells were quantified by counting all colonies under a stereoscopic microscope.

Colonies were cleaned in diluted domestic bleach (NaOCl solution) and coated with gold-palladium (40 %–60 %). Digital images were obtained using a conventional SEM (Phillips XL–30) at the Museo Argentino de Ciencias Naturales (MACN). Voucher specimens were deposited in the collection of invertebrates of MACN (MACN-In No. 40141).

Results

Fenestrulina delicia Winston, Hayward and Craig, 2000

Figure 2a–d

Diagnosis Zooids (Fig. 2a–c) oval, longer than wide, separated by deep sutures. Frontal wall smooth, with one to three rows of stellate pores between the orifice and the ascopore. Orifice D-shaped, wider than long, with a pair of minute condyles near each proximolateral corner, surrounded by one to four erect spines. There are two groups of stellate pores distal to orifice. Lateral walls smooth, conspicuous, sloping inwards over the frontal wall. Ascopore (Fig. 2d) fractal in appearance, surrounded by a distinct, slightly raised border, deeply serrated, with irregularly branched processes ending in tiny points. Ovicell (Fig. 2a, b) raised, hemispherical, longer than wide, with a row of large pores around its margin and a characteristic transverse fold near its centre. Only the proximal pair of spines persists in ovicelled zooids. Ancestrula (Fig. 2c) tatiform, with 10 spines around the opesia, surrounded in early astogeny by

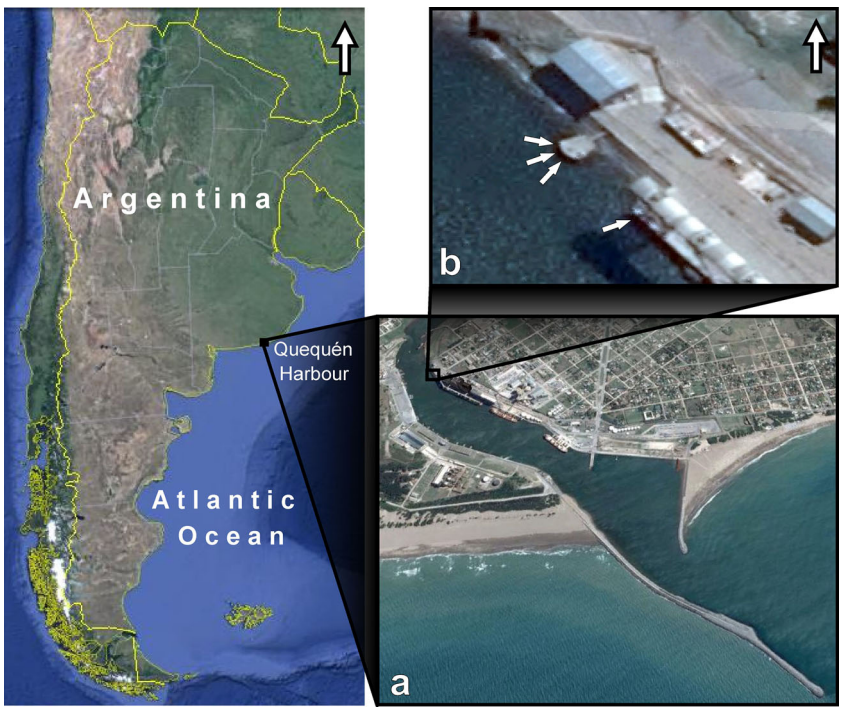


Fig. 1 Study area. **a** Quequén Harbour; **b** detail of the piers (*arrows*) where the material was collected

Author's personal copy

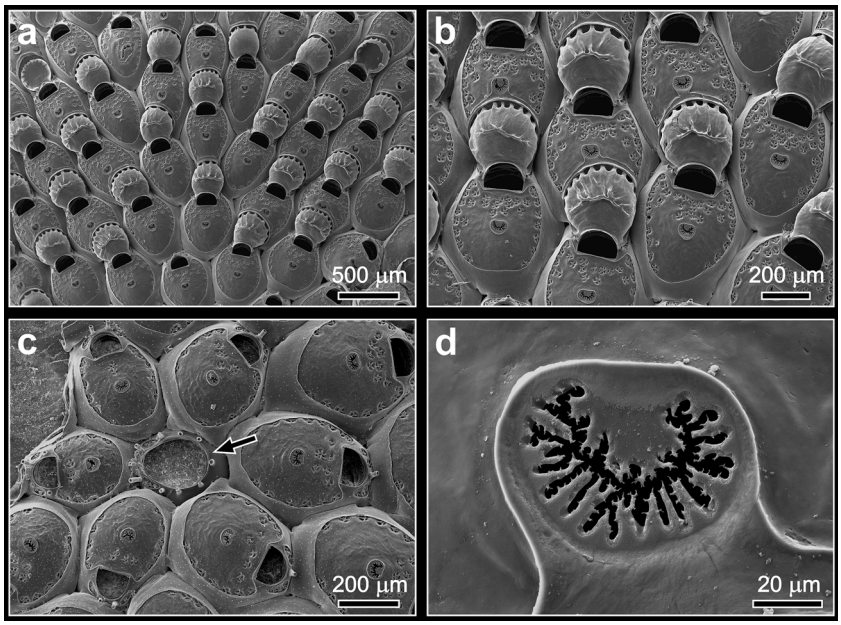


Fig. 2 *Fenestrulina delicia*. **a** General aspect of a colony. **b** Ovicellate zooids. **c** Tatiform ancestrula (*arrow*) and early astogeny. **d** Detail of ascopore

six periancestrular zooids which increase in size from the distal to the proximal one.

Remarks Many colonies of *Fenestrulina delicia* bearing abundant ovicellate zooids were observed on the experimental panels and also on small oysters (*Ostrea* cf. *stentina* Payraudeau; see Shilts et al. 2007) recruited onto nylon ropes and plastic meshes. A small, newly recruited colony was sampled by SCUBA divers on the pier, among calcareous tubes of the serpulid polychaete *Ficopomatus enigmaticus*. The density of the colonies (col) on the experimental panels was very high (mean±SD: 2,547.4±1,238.2 col m^{-2}, range: 863.2 – 4, 995.3 col m^{-2}). The percentage of ovicellate colonies, however, was relatively low (5.2±2.3 %, range: 1.6 – 9.9 %), as many ancestrulae and newly recruited zoaria were observed in autumn (June 2013). Zooidal fusion (homosyndrome) did not occur in our material (but see Craig 1994).

F. delicia can be distinguished from other members of the genus, and particularly from *F. malusii* (Audouin), a species formerly regarded as cosmopolitan, by the presence of a characteristic transverse ridge of calcification in the ovicell, by the development of conspicuous smooth lateral walls sloping inwards towards the frontal surface, and by its deeply serrated ascopore. Hayward and Ryland (1990) have recorded the presence of five species of *Fenestrulina* (*F. dupla* Hayward and Ryland, *F. fritilla* Hayward and Ryland, *F. horrida* Moyano, *F. incusa* Hayward and Ryland, *F. majuscula* Hayward) in different localities of the Magellan region (Burdwood Bank, Cape Horn, Patagonian shelf and Malvinas/Falkland Islands). They can be easily distinguished from *F. delicia* based on the morphology of their ascopores and ovicells, the distribution of stellate pores on the frontal wall, the presence and number of oral spines and the less important development of the smooth lateral walls surrounding the frontal surface. Another still unidentified species of *Fenestrulina* with smooth ovicells and less developed teeth in the ascopore has been recorded in the fouling assemblages of several Patagonian harbours (Schwindt et al. 2014).

Discussion

It has been recognized that hull fouling has a strong potential for the introduction of non-native organisms (Gollasch 2002; Sylvester et al. 2011). Due to their ability to settle on hard surfaces, bryozoans are mainly transported on the hulls of ships (Watts et al. 1998). Quequén Harbour is an important overseas terminal receiving more than 220 cargo ships per year from all over the world (www.puertoquequen.com/, accessed June 2015). In this brackish environment, the successful establishment of NIS would partly depend on the repeated release of individuals into one location (Lockwood et al. 2005), which may be accomplished by the frequent visit of vessels acting as vectors for reproductive colonies. As the lecitotrophic larvae of *F. delicia* do not feed in the plankton, their dispersal ability is assumed to be poor (see Watts et al. 1998). Therefore, the dispersion of this species is more likely to occur as reproductive adult colonies attached to ship hulls or rafting objects than during its larval stage.

Until recently, *F. delicia* was only known from North America (Craig 1994; Winston et al. 2000; Dick et al. 2005; Winston and Hayward 2012). Shortly after, introduced populations were discovered on natural and artificial hard substrates along the Atlantic coasts of Europe, where it has not been found on ships' hulls nor in marinas (De Blauwe 2009; Wasson and De Blauwe 2014; De Blauwe et al. 2014). In Europe, *F. delicia* had been previously

Author's personal copy

overlooked or confused with *F. malusii* (De Blauwe et al. 2014 and references therein).

The fouling assemblages of Quequén Harbour were thoroughly analyzed in the 1980s (Brankevich et al. 1985, 1988; among others) and the only bryozoan species known with certainty for this estuary were *Cryptosula pallasiana* (Moll) and an unidentified species of *Conopeum* (Lichtschein de Bastida and Bastida 1980). The absence of any record of the genus *Fenestrulina* or the family Microporellidae in those studies, as well as in a recent survey carried out at Quequén Harbour from January to October 2009 (MJ Albano, 2012, unpublished PhD thesis), suggests that the arrival of this species to Argentina could be relatively recent. In this regard, it is estimated that the appearance of *F. delicia* along the Atlantic coasts of Europe occurred around 2002 (Wasson and De Blauwe 2014). There, it has been regarded as highly invasive, spreading along offshore natural and artificial hard substrata (De Blauwe et al. 2014).

This is the first record of *F. delicia* for the southern hemisphere. The high density of colonies observed in Quequén Harbour suggests that this species has the potential to continue its dispersion by means of maritime traffic, or rafting on plastic debris as in the North Sea (De Blauwe et al. 2014), and to become a stable component of this and neighbouring harbours in the area.

Acknowledgments We thank K. Arias, L. Salgado and the SCUBA divers of Prefectura Naval Argentina for their support during our sampling at Quequén. G. Chiaramonte, L. Tamini and L. Nogueira were very helpful at Puerto Quequén Hydrobiological Station. F. Tricárico operated the scanning electron microscope at Museo Argentino de Ciencias Naturales. M. Huber identified the oyster. Consorcio de Gestión del Puerto de Quequén allowed us access to restricted areas and provided logistic support in the harbour. Consejo Nacional de Investigaciones Científicas y Técnicas (PIP 2010–2012 No. 0291 and PIP 2013–2015 No. 0247 to JLG) and Agencia Nacional de Promoción Científica y Tecnológica (PICT 2012–1043 to JLG and MGL) are acknowledged for financial support during this study.

References

Brankevich G, Bastida R, Martinez D (1985) Estudios ecológicos sobre las comunidades incrustantes de la Central Eléctrica Necochea (Puerto Quequén, Argentina). CIDEPINT-Anales 173:175–239

Brankevich G, Bastida R, Lemmi C (1988) A comparative study of biofouling settlements in different sections of Necochea power plant (Quequen Port, Argentina). Biofouling 1:113–135

Brock BJ (1985) South Australian fouling bryozoans. In: Nielsen C, Larwood GP (eds) Bryozoa: Ordovician to Recent. Olsen and Olsen, Fredensborg, pp 45–49

Carlton JT (2010) The impact of maritime commerce on marine biodiversity. Brown J World Affairs 16:131–142

Craig SF (1994) Intraspecific fusion in the encrusting bryozoan *Fenestrulina* sp. In: Hayward PJ, Ryland JS, Taylor PD (eds) Biology and Palaeobiology of Bryozoans. Olsen & Olsen, Fredensborg, pp 51–54

De Blauwe H (2009) Mosdiertjes van de Zuidelijke bocht van de Noordzee: Determinatiewerk voor België en Nederland. Vlaams Instituut voor de Zee, Oostende

De Blauwe H, Kind B, Kuhlenkamp R, Cuperus J, van der Weide B, Kerckhof F (2014) Recent observations of the introduced *Fenestrulina delicia* Winston, Hayward and Craig, 2000 (Bryozoa) in Western Europe. Studi Trentini di Sci Nat 94:45–51

Dick MH, Grischenko AV, Mawatari SF (2005) Intertidal Bryozoa (Cheilostomata) of Ketchikan, Alaska. J Nat Hist 39:3687–3784

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

Gordon DP, Mawatari SF (1992) Atlas of marine-fouling Bryozoa of New Zealand ports and harbours. Misc Publ N Z Oceanogr Inst 107:1–52

Hayward PJ, Ryland JS (1990) Some Antarctic and Subantarctic species of Microporellidae (Bryozoa: Cheilostomata). J Nat Hist 24:1263–1287

Hewitt CL, Campbell ML, Thresher RE, Martin RB, Boyd S, Cohen BG, Currie DR, Gomon MF, Keough MJ, Lewis JA, Lockett MM, Mays N, McArthur MA, O´Hara TD, Poore GCB, Ross DJ, Storey MJ, Watson JE, Wilson RS (2004) Introduced and cryptogenic species in Port Phillip Bay, Victoria, Australia. Mar Biol 144:183–202

Kelso A, Wyse Jackson PN (2012) Invasive bryozoans in Ireland: first record of *Watersipora subtorquata* (d'Orbigny, 1852) and an extension of the range of *Tricellaria inopinata* d'Hondt and Occhipinti Ambrogi, 1985. BioInvasions Rec 3:209–214

Lichtschein de Bastida V, Bastida R (1980) Los briozoos de las comunidades incrustantes de puertos argentinos. In: Aritio L (ed) Proc 5th Int Congr Mar Corros Fouling, Mar Biol, Barc, Spain, 19–23 May 1980. Gráficas Orbe, Madrid, pp 371–390

Liu X, Yin X, Ma J (2001) Biology of marine-fouling bryozoans in the coastal waters of China. Science Press, Beijing (In Chinese, with English summary)

Lockwood JL, Cassey P, Blackburn T (2005) The role of propagule pressure in explaining species invasions. Trends Ecol Evol 20:223–228

Lodola A, Ferrario J, Occhipinti-Ambrogi A (2015) Further Mediterranean expansion of the non-indigenous bryozoan *Celleporaria brunnea*: multiple records along the Italian coasts. Sci Mar 79. doi:10.3989/scimar.04174.31A

Orensanz JM, Schwindt E, Pastorino G, Bortolus A, Casas G, Darrigran G, Elías R, López Gappa JJ, Obenat S, Pascual M, Penchaszadeh P, Piriz ML, Scarabino F, Spivak ED, Vallarino EA (2002) No longer the pristine confines of the world ocean: a survey of exotic marine species in the southwestern Atlantic. Biol Invasions 4:115–143

Ryland JS (1965) Catalogue of main marine fouling organisms, vol 2: Polyzoa. Organisation for Economic Co-operation and Development, Paris

Ryland JS, Bishop JDD, De Blauwe H, Nagar AE, Minchin D, Wood CA, Yunnie ALE (2011) Alien species of *Bugula* (Bryozoa) along the Atlantic coasts of Europe. Aquat Invasions 6:17–31

Ryland JS, Holt R, Loxton J, Spencer Jones ME, Porter JS (2014) First occurrence of the non-native bryozoan *Schizoporella japonica* Ortmann (1890) in Western Europe. Zootaxa 3780:481–502

Schwindt E, López Gappa J, Raffo MP, Tatián M, Bortolus A, Orensanz JM, Alonso G, Diez ME, Doti B, Genzano G, Lagger C, Lovrich G, Piriz ML, Mendez MM, Savoya V, Sueiro MC (2014) Marine fouling invasions in ports of Patagonia (Argentina) with implications for legislation and monitoring programs. Mar Environ Res 99:60–68

Shilts MH, Pascual MS, Ó Foighil D (2007) Systematic, taxonomic and biogeographic relationships of Argentine flat oysters. Mol Phylogenet Evol 44:467–473

Sylvester F, Kalaci O, Leung B, Lacoursière-Roussel A, Clarke Murray C, Choi FM, Bravo MA, Therriault TW, MacIsaac HJ (2011) Hull

Author's personal copy

fouling as an invasion vector: can simple models explain a complex problem? J Appl Ecol 48:415–423

Wasson B, De Blauwe H (2014) Two new records of cheilostome Bryozoa from British waters. Mar Biodivers Rec 7:e123

Watts PC, Thorpe JP, Taylor PD (1998) Natural and anthropogenic dispersal mechanisms in the marine environment: a study using cheilostome Bryozoa. Philos Trans R Soc Lond B 353: 453–464

Winston JE, Hayward PJ (2012) The Marine Bryozoans of the Northeast Coast of the United States: Maine to Virginia. Va Mus Nat Hist Mem 11:1–180

Winston JE, Hayward PJ, Craig SF (2000) Marine bryozoans of the Northeast coast of the United States: new and problem species. In: Herrera Cubilla A, Jackson JBC (eds) Proceedings of the 11th International Bryozoology Association Conference. Smithsonian Tropical Research Institute, Balboa, pp 412–420