

A checklist of marine bryozoan taxa in Scottish sea regions

Sally Rouse¹, Jennifer Loxton², Mary E. Spencer Jones³, Joanne S. Porter⁴

1 *Scottish Association for Marine Science, Oban, Argyll, PA37 1QA, UK* **2** *School of Geosciences, University of Edinburgh, Edinburgh, EH9 3FE, UK* **3** *Department of Life Sciences, Natural History Museum, Cromwell Road, London, SW7 5BD, UK* **4** *International Centre for Island Technology, Heriot Watt University, Orkney, Old Academy, Back Road, Stromness, KW16 3DA, UK*

Corresponding author: Joanne S. Porter (j.s.porter@hw.ac.uk)

Academic editor: D. Gordon | Received 23 February 2018 | Accepted 27 August 2018 | Published 3 October 2018

<http://zoobank.org/85A8A747-5876-4100-89E5-5D172F129BBE>

Citation: Rouse S, Loxton J, Jones MES, Porter JS (2018) A checklist of marine bryozoan taxa in Scottish sea regions. ZooKeys 787: 135–149. <https://doi.org/10.3897/zookeys.787.24647>

Abstract

Contemporary and historical bryozoan records were compiled to provide a comprehensive checklist of species in Scottish waters. The checklist comprises 218 species in 58 families, with representatives from each of the extant bryozoan orders. The fauna was relatively sparse compared to other regions for which bryozoan checklists were available e.g. New Zealand and Australia. Six non-indigenous bryozoan species from the Scottish seas region were included in the checklist. Baseline information on species distributions, such as that presented in this checklist, can be used to monitor and manage the impact of human activities on the marine environment, and ultimately preserve marine biodiversity.

Keywords

Bryozoa, distribution, non-indigenous species, Scotland

Introduction

The phylum Bryozoa comprises approximately 6000 known/described extant species of filter feeding invertebrates that predominantly occur in the marine environment (Gordon and Costello 2016). There are three classes and four orders of extant bryozo-

ans (class Gymnolaemata, orders Cheilostomatida and Ctenostomatida; class Phylactolaemata (freshwater), order Phylactolaemata *incertae sedis*; class Stenolaemata, order Cyclostomatida). The order Cheilostomatida is the most diverse.

All bryozoans are clonal and the colonies can take many different forms including encrusting, erect and arborescent forms (McKinney and Jackson 1991). The majority of bryozoan species have a calcium carbonate skeleton, but there are also a number of chitinous and gelatinous species. Colony growth proceeds via the asexual budding of individual units, called zooids, with sexual reproduction producing free-swimming larvae (McKinney and Jackson 1991). Bryozoan species occur in all major marine habitats, from the Polar regions to the tropics, ranging from the intertidal zone to the deep sea. The vast majority of species live attached to a substrate, which may be rocks, biogenic structures (e.g. coral, shells), algae or man-made debris (Hayward and Ryland 1998).

Bryozoans contribute to ecosystem functioning and services through the provision of three-dimensional structure and habitat for other species, and by serving as a food source for other marine species (Bitschofsky et al. 2011; Lidgard 2008). Bryozoans are also recognized for their potential economic importance due to the pharmaceutical and active compounds that are associated with a number of species. (Narkowicz et al. 2002). Several bryozoan species are recognized as invasive and are potentially harmful to native marine species (O'Brien et al. 2013; Yorke and Metaxas 2011). Despite these ecological and economic roles, knowledge on local bryozoan species and faunistic inventories are often lacking or incomplete (Rouse et al. 2014). Such baseline information on species distributions is required to monitor and manage the impact of human activities on the marine environment, and ultimately preserve marine biodiversity (Powney and Isaac 2015).

Scotland lays claim to one of the largest marine resources in Europe with over 9910 km of mainland coastline, 8092 km of island coastline, and an estimated 88,600 km² of territorial seas (Baxter et al. 2011). The west coast of Scotland has numerous exposed islands, high sea cliffs, and fjordic inlets, while the east coast is less variable and dominated by low-lying sedimentary shores. Marine spatial planning has been identified as priority by the Scottish Government (Baxter et al. 2011), and there is a drive towards providing reliable information on species occurrences and distribution. Scotland has historically been the focus of much marine biological research and as such a vast back catalogue of bryozoan records exist (e.g. Norman 1869, Hiscock 1996). These records, however, are often disparate, unreliable and/or difficult to locate. Rouse et al. (2014) analysed records of marine bryozoan from Scotland between 1792 and 2010 to assess spatial and temporal trends in bryozoan diversity. Records were compiled from museum collections, professional/academic surveys, consultancy reports and a citizen science scheme consisting of trained amateurs. Records for which the location was uncertain or not provided, and/or the species seemed likely to be wrong based on its generally accepted distribution (e.g. tropical or Antarctic) were discarded. Other records that had only been documented in Scotland by one source, with an unknown or non-expert identified, were also excluded from the analysis. Approximately 8% of these records were museum collections with associated specimens, 60% from a ten-

year expert survey of the British coastline and 16% from the citizen science scheme, with the latter two relying on identification via optical microscopes. The remaining records were compiled from published manuscripts that used a combination of optical and scanning electron microscopy for identification.

Using these records, Rouse et al. (2014) found bryozoan diversity to be higher on the west coast of Scotland than other regions, but this was largely attributed to a sampling bias towards the west coast. The study also highlighted the lack of a bryozoan species list for Scottish waters. The aim of the present study, therefore, is to combine the data collated by Rouse et al. (2014) with recent bryozoan studies in Scotland to provide to a comprehensive species checklist of marine bryozoan species in the region.

Methods

Study area

The Scottish sea region was defined according to the ‘Clean Sea Assessment’ in the Scottish Government’s Marine Atlas (Baxter et al. 2011). The region constitutes 15 sub-regions covering coastal and offshore areas (Figure 1). Previous sub-divisions of the Scottish seas (e.g., the MNCR regions used by Rouse et al. (2014)) are restricted to coastal areas, and as such have not been selected for use in this checklist. There is no *a priori* reason to expect that the Scottish sea region would have a distinct fauna, however the region does support a greater range of habitat types than the adjoining English Sea area (Baxter et al. 2011). The north of Scotland also represents a transitional area between arctic and boreal species (Boulton et al. 1991).

Data sources

Historical and contemporary records of bryozoans were obtained from sources including museum collections, literature, and online databases according to the methods of Rouse et al. (2014). These records were supplemented with records from occasional field surveys carried around Scottish harbours and marinas as part of an on-going invasive species survey programme (Collin et al. 2015; Loxton 2014; Nall et al. 2015; Porter et al. 2015; Wasson and De Blauwe 2014). The checklist represents the species known from Scotland up until 2015.

Organization of the checklist

The checklist is arranged phylogenetically for the higher-level taxa, with the families, genera, and species listed alphabetically. Taxonomy was checked against the World Register of Marine Species (Horton et al. 2016), and names that were currently listed as ‘ac-

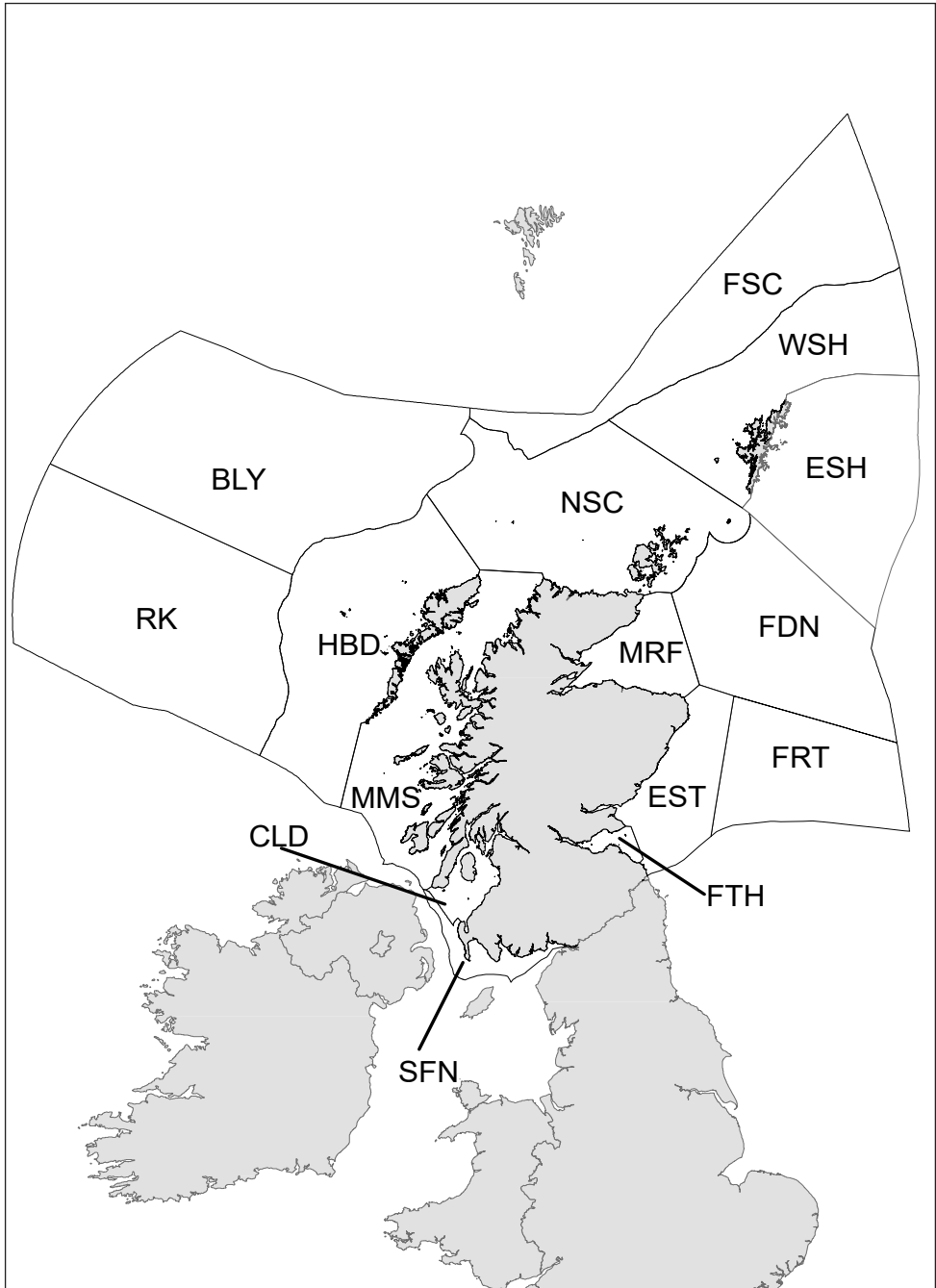


Figure 1. Scottish sea regions. The abbreviations given are used in the checklist. BLY (Bailey), CLD (Clyde), ESH (East Shetland), EST (East Scotland), FDN (Fladen), FRT (Forties), FSC (Faroe-Shetland Channel), FTH (Forth), HBD (Hebrides), MMS (Minches and Malin Sea), MRF (Moray Firth), NSC (North Scotland), RK (Rockall), SFN (Solway Firth and North Channel), WSH (West Shetland).

cepted' are presented. The number in parentheses immediately to the right of the family name indicates the number of associated taxa, and the abbreviations next to each species specify the sub-region from which records originated (see Figure 1 for definitions of abbreviations). Bryozoan non-indigenous species (NIS) are denoted with an asterisk (*) in the checklist. Individual bryozoan records are provided in the Suppl. material 1.

Results

Table 1 shows the checklist of marine Bryozoa from the Scottish sea regions. A total of 218 species are included in the list, belonging to 128 different genera from 58 families. The Scottish records represent approximately 3.7% of the total number of bryozoan species known worldwide ($n = 5869$) (Bock and Gordon 2013). There are representatives from each of the extant marine bryozoan orders (Cyclostomatida, Ctenostomatida, and Cheilostomatida). The most speciose bryozoan families in Scotland were the Calloporidae (13 species) and the Romancheinidae (13 species), which both contain mainly encrusting species.

Six NIS were identified as part of the Scottish fauna. These were *Bugulina fulva* (Ryland, 1960), *Bugulina simplex* (Hincks, 1886), *Bugula neritina* (Linnaeus, 1758), *Tricellaria inopinata* d'Hondt & Occhipinti Ambrogi, 1985, *Fenestrulina delicia* Winston, Hayward & Craig, 2000, *Schizoporella japonica* Ortmann, 1890. The Clyde sub-region contained the greatest number of NIS (all except *B. fulva*).

Table 1. Checklist of marine bryozoan fauna occurring in the Scottish sea region. Species denoted with an asterisk (*) indicate those considered to be non-indigenous within Scotland.

STENOLAEMATA (30)	
Order Cyclostomatida (30)	Sub-region
Family Annectocymidae (2)	
<i>Annectocyma major</i> (Johnston, 1847)	ESH, MMS, RK, WSH
<i>Entalophoroecia deflexa</i> (Couch, 1842)	CLD, HBD, MMS, RK
Family Crisiidae (8)	
<i>Bicrisia abyssicola</i> Kluge, 1962	HBD, NCS
<i>Crisia aculeata</i> Hassall, 1841	CLD, EST, FTH, HBD, MMS, NCS, WSH
<i>Crisia denticulata</i> (Lamarck, 1816)	CLD, EST, FTH, HBD, MMS, NCS, SFN, WSH
<i>Crisia eburnea</i> (Linnaeus, 1758)	CLD, EST, FTH, HBD, MMS, NCS, SFN, WSH
<i>Crisia ramosa</i> Harmer, 1891	HBD, MMS
<i>Crisidia cornuta</i> (Linnaeus, 1758)	CLD, EST, HBD, MMS, NCS, SFN, WSH
<i>Crisiella producta</i> (Smitt, 1865)	CLD, WSH
<i>Filicrisia geniculata</i> (Milne Edwards, 1838)	CLD, HBD, MMS,
Family Horneridae (1)	
<i>Hornera lichenoides</i> (Linnaeus, 1758)	ESH, FSC, RK, WSH
Family Lichenoporidae (3)	
<i>Coronopora truncata</i> (Fleming, 1828)	MMS, NCS, RK, WSH

<i>Disporella hispida</i> (Fleming, 1828)	CLD, EST, FTH, HBD, MMS, NCS, WSH
<i>Patinella verrucaria</i> (Linnaeus, 1758)	CLD, EST, FTH, MMS, NCS, WSH
Family Oncousoeciidae (2)	
<i>Oncousoecia diastoporides</i> (Norman, 1869)	MRF, WSH
<i>Oncousoecia dilatans</i> (Johnston, 1847)	ESH, MMS, WSH
Family Plagioeciidae (2)	
<i>Diplosolen obelia</i> (Johnston, 1838)	CLD, ESH, HBD, MMS, WSH
<i>Plagioecia patina</i> (Lamarck, 1816)	CLD, EST, HBD, MMS, NCS, WSH
Family Stigmatoechidae (1)	
<i>Stigmatoechos violacea</i> (M.Sars, 1863)	RK, WSH
Family Stomatoporidae (2)	
<i>Stomatopora gingrina</i> Jullien, 1882	RK
<i>Stomatopora incurvata</i> (Hincks, 1859)	MMS, MRF
Family Terviidae (1)	
<i>Tervia irregularis</i> (Meneghini, 1844)	RK
Family Tubuliporidae (8)	
<i>Exidmonea atlantica</i> (Forbes in Johnston, 1847)	MMS, RK, WSH
<i>Tubulipora aperta</i> Harmer, 1898	EST, FTH, NCS
<i>Tubulipora flabellaris</i> (O. Fabricius, 1780)	CLD
<i>Tubulipora liliacea</i> (Pallas, 1766)	CLD, EST, FTH, FRT, HBD, MMS, MRF, NCS, RK, WSH
<i>Tubulipora lobifera</i> Hastings, 1963	CLD, MMS, MRF, NCS
<i>Tubulipora penicillata</i> (O. Fabricius, 1780)	MMS, MRF
<i>Tubulipora phalangea</i> Couch, 1844	HBD, MMS, NCS, WSH
<i>Tubulipora plumosa</i> Thompson in Harmer, 1898	EST, FTH, MMS, NCS, WSH
GYMNOLAEMATA (189)	
Order Ctenostomatida (27)	
Family Alcyonidiidae (8)	
<i>Alcyonidioides mytili</i> (Dalyell, 1848)	CLD, EST, FTH, HBD, MMS, NCS, SFN, WSH
<i>Alcyonidium albidum</i> Alder, 1857	CLD, EST, FTH, MMS, MRF, NCS, WSH
<i>Alcyonidium diaphanum</i> (Hudson, 1778)	CLD, ESH, EST, FTH, FRT, HBD, MMS, MRF, NCS, RK, SFN, WSH
<i>Alcyonidium gelatinosum</i> (Linnaeus, 1761)	CLD, EST, FTH, FRT, HBD, MMS, MRF, NCS, SFN, WSH
<i>Alcyonidium hirsutum</i> (Fleming, 1828)	CLD, ESH, EST, FTH, HBD, MMS, MRF, NCS, SFN, WSH
<i>Alcyonidium mamillatum</i> Alder, 1857	CLD, EST, MMS, MRF, NCS, SFN
<i>Alcyonidium parasiticum</i> (Fleming, 1828)	CLD, EST, FTH, MMS, MRF, NCS, WSH
<i>Alcyonidium polyoum</i> (Hassall, 1841)	HBD
Family Arachnidiidae (2)	
<i>Arachnidium clavatum</i> Hincks, 1877	CLD, MMS, WSH
<i>Arachnidium fibrosum</i> Hincks, 1880	CLD
Family Buskiidae (1)	
<i>Buskia nitens</i> Alder, 1857	WSH
Family Farrellidae (1)	
<i>Farrella repens</i> (Farre, 1837)	SFN
Family Flustrellidridae (1)	
<i>Flustrellidra hispida</i> (O. Fabricius, 1780)	CLD, EST, FTH, HBD, MMS, MRF, NCS, SFN, WSH
Family Hypophorellidae (1)	
<i>Hypophorella expansa</i> Ehlers, 1876	CLD
Family Nolellidae (3)	

<i>Nolella dilatata</i> (Hincks, 1860)	CLD, FTH, MMS, NCS, WSH
<i>Nolella pusilla</i> (Hincks, 1880)	CLD
<i>Nolella stipata</i> Gosse, 1855	MMS
Family Spathiporidae (1)	
<i>Spathipora sertum</i> Fischer, 1866	WSH
Family Triticellidae (2)	
<i>Triticella flava</i> Dalyell, 1848	CLD, SFN
<i>Triticella pedicellata</i> (Alder, 1857)	CLD
Family Vesiculariidae (6)	
<i>Amathia gracilis</i> (Leidy, 1855)	CLD, FTH, MMS
<i>Amathia gracillima</i> (Hincks, 1877)	MMS
<i>Amathia imbricata</i> (Adams, 1798)	CLD, EST, FTH, HBD, MMS, NCS, SFN
<i>Amathia lendigera</i> (Linnaeus, 1758)	SFN
<i>Amathia pustulosa</i> (Ellis & Solander, 1786)	CLD, MMS, SFN
<i>Vesicularia spinosa</i> (Linnaeus, 1758)	CLD, FTH, MMS, SFN
Family Walkeriidae (1)	
<i>Walkeria uva</i> (Linnaeus, 1758)	CLD, ESH, MMS, NCS
Order Cheilostomatida (160)	
Family Aeteidae (3)	
<i>Aetea anguina</i> (Linnaeus, 1758)	EST, FTH, HBD, MMS, NCS, WSH
<i>Aetea sica</i> (Couch, 1844)	CLD, MMS, NCS
<i>Aetea truncata</i> (Landsborough, 1852)	CLD, MMS, NCS
Family Antroporidae (1)	
<i>Roselliana rosselii</i> (Audouin, 1826)	ESH, WSH
Family Beaniidae (1)	
<i>Beania mirabilis</i> Johnston, 1840	EST, MMS, NCS
Family Bitectiporidae (7)	
<i>Hippoporina pertusa</i> (Esper, 1796)	CLD, MMS, NCS, SFN, WSH
<i>Pentapora fascialis</i> (Pallas, 1766)	HBD, MMS, SFN
<i>Schizomavella auriculata</i> (Hassall, 1842)	MMS, NCS, SFN, WSH
<i>Schizomavella cornuta</i> (Heller, 1867)	WSH
<i>Schizomavella discoidea</i> (Busk, 1859)	NCS, WSH
<i>Schizomavella hastata</i> (Hincks, 1862)	WSH
<i>Schizomavella linearis</i> (Hassall, 1841)	CLD, EST, FTH, HBD, MMS, MRF, NCS, SFN, WSH
Family Bryocryptellidae (8)	
<i>Marguetta lorea</i> (Alder, 1864)	ESH, WSH
<i>Palmiskenea skenei</i> (Ellis & Solander, 1786)	CLD, EST, MMS, MRF, RK, WSH
<i>Porella alba</i> Nordgaard, 1906	EST, MRF, NCS
<i>Porella compressa</i> (J. Sowerby, 1805)	CLD, HBD, MMS, MRF, NCS, RK, WSH
<i>Porella concinna</i> (Busk, 1854)	CLD, ESH, EST, MMS, MRF, WSH
<i>Porella laevis</i> (Fleming, 1828)	WSH
<i>Porella minuta</i> (Norman, 1868)	MRF, WSH
<i>Porella struma</i> (Norman, 1868)	ESH, WSH
Family Bugulidae (12)	
<i>Bicellariella ciliata</i> (Linnaeus, 1758)	CLD, ESH, EST, FTH, HBD, MMS, NCS, WSH
<i>Bicellarina alderi</i> (Busk, 1859)	MMS, NCS, WSH
<i>Bugulina avicularia</i> (Linnaeus, 1758)	CLD, HBD, MMS, NCS, SFN, WSH
<i>Bugulina calathus</i> (Norman, 1868)	MMS
<i>Bugulina flabellata</i> (Thompson in Gray, 1848)	CLD, ESH, EST, FTH, HBD, MMS, MRF, NCS, RK, SFN, WSH

<i>*Bugulina fulva</i> (Ryland, 1960)	MMS, NCS
<i>Bugulina turbinata</i> (Alder, 1857)	CLD, FTH, HBD, MMS, NCS, WSH
<i>*Bugulina simplex</i> (Hincks, 1886)	CLD, ESH, MMS, NCS
<i>*Bugula neritina</i> (Linnaeus, 1758)	CLD
<i>Crisularia plumosa</i> (Pallas, 1766)	CLD, EST, FTH, HBD, MMS, NCS, SFN
<i>Crisularia purpurotincta</i> (Norman, 1868)	ESH, EST, FTH, HBD, MMS, NCS, WSH
<i>Dendrobeanina murrayana</i> (Bean in Johnston, 1847)	ESH, MMS, NCS, WSH
Family Calloporidae (13)	
<i>Alderina imbellis</i> (Hincks, 1860)	MMS, NCS, WSH
<i>Amphiblestrum auritum</i> (Hincks, 1877)	EST, MMS, NCS, WSH
<i>Amphiblestrum flemingii</i> (Busk, 1854)	CLD, EST, FTH, MMS, MRF, NCS, RK, WSH
<i>Amphiblestrum solidum</i> (Packard, 1863)	ESH, MMS, MRF, WSH
<i>Callopora craticula</i> (Alder, 1856)	CLD, MMS, WSH
<i>Callopora dumerilii</i> (Audouin, 1826)	MMS, MRF, NCS, SFN, WSH
<i>Callopora lineata</i> (Linnaeus, 1767)	CLD, EST, FTH, MMS, MRF, NCS, WSH
<i>Callopora rylandi</i> Bobin & Prenant, 1965	EST, FTH, HBD, MMS, NCS
<i>Cauloramphus spiniferum</i> (Johnston, 1832)	EST, MMS, NCS, WSH
<i>Crassimarginatella solidula</i> (Hincks, 1860)	EST, WSH
<i>Megapora ringens</i> (Busk, 1856)	EST, FSC, WSH
<i>Ramphonotus minax</i> (Busk, 1860)	ESH, RK, WSH
<i>Tegella unicornis</i> (Fleming, 1828)	EST, MRF, NCS, WSH
Family Candidae (9)	
<i>Caberea ellisii</i> (Fleming, 1814)	NCS, WSH
<i>Cradoscrupocellaria reptans</i> (Linnaeus, 1758)	CLD, ESH, EST, FTH, HBD, MMS, NCS, SFN, WSH
<i>Notoplites harmeri</i> Ryland, 1963	WSH
<i>Notoplites jeffreysii</i> (Norman, 1863)	ESH, MMS, WSH
<i>Pomocellaria inarmata</i> (O'Donoghue & O'Donoghue, 1926)	FTH, MMS, WSH
<i>Scrupocellaria scruposa</i> (Linnaeus, 1758)	CLD, ESH, EST, FTH, HBD, MMS, NCS, SFN, WSH
<i>*Tricellaria inopinata</i> d'Hondt & Occhipinti Ambroggi, 1985	CLD, EST, MMS, MRF, NCS
<i>Tricellaria peachii</i> (Busk, 1851)	ESH, EST, MRF, NCS, WSH
<i>Tricellaria ternata</i> (Ellis & Solander, 1786)	ESH, EST, FTH, FRT, HBD, NCS, WSH
Family Cellariidae (4)	
<i>Cellaria fistulosa</i> (Linnaeus, 1758)	CLD, EST, FTH, HBD, MMS, MRF, NCS, SFN, WSH
<i>Cellaria salicornioides</i> Lamouroux, 1816	CLD, MMS, WSH
<i>Cellaria sinuosa</i> (Hassall, 1840)	CLD, EST, HBD, MMS, SFN, WSH
<i>Euginoma vermiformis</i> Jullien, 1883	RK
Family Celleporidae (11)	
<i>Buskea dichotoma</i> (Hincks, 1862)	CLD, EST, MMS, MRF, WSH
<i>Buskea nitida</i> Heller, 1867	CLD, MMS
<i>Cellepora pumicosa</i> (Pallas, 1766)	CLD, ESH, EST, FTH, FRT, HBD, MMS, MRF, NCS, RK, WSH
<i>Celleporina caliciformis</i> (Lamouroux, 1816)	CLD, ESH, FTH, HBD, MRF, MMS, NCS, WSH
<i>Celleporina decipiens</i> Hayward, 1976	HBD
<i>Celleporina pygmaea</i> (Norman, 1868)	FSC, MRF, WSH
<i>Lagenipora lepralioides</i> (Norman, 1868)	ESH, WSH
<i>Omalosecosa ramulosa</i> (Linnaeus, 1767)	CLD, ESH, EST, FTH, HBD, MMS, MRF, NCS, WSH
<i>Palmicellaria elegans</i> Alder, 1864	WSH
<i>Turbicellepora avicularis</i> (Hincks, 1860)	CLD, EST, FRT, HBD, MMS, MRF

<i>Turbicellepora boreale</i> Hayward & Hansen, 1999	RK
Family Chaperiidae (1)	
<i>Larnacicus corniger</i> (Busk, 1859)	FSC, RK, WSH
Family Chorizoporidae (1)	
<i>Chorizopora brongniartii</i> (Audouin, 1826)	EST, MMS, NCS, SFN, WSH
Family Cribrilinidae (7)	
<i>Collarina balzaci</i> (Audouin, 1826)	CLD, MMS, WSH
<i>Cribrilina annulata</i> (O. Fabricius, 1780)	CLD, EST, FTH, MMS, NCS, WSH
<i>Cribrilina cryptoecium</i> Norman, 1903	EST, MMS, MRF, NCS, WSH
<i>Cribrilina punctata</i> (Hassall, 1841)	CLD, EST, FTH, MMS, MRF, NCS, WSH
<i>Membraniporella nitida</i> (Johnston, 1838)	CLD, EST, FTH, HBD, MMS, NCS, WSH
<i>Puellina innominata</i> (Couch, 1844)	CLD
<i>Puellina venusta</i> (Canu & Bassler, 1925)	CLD, WSH
Family Cryptosulidae (1)	
<i>Cryptosula pallasiana</i> (Moll, 1803)	CLD, MMS, MRF, NCS, WSH
Family Doryporellidae (1)	
<i>Doryporellina reticulata</i> (Ryland, 1963)	RK
Family Electridae (7)	
<i>Aspidelectra melolontha</i> (Landsborough, 1852)	NCS
<i>Conopeum reticulum</i> (Linnaeus, 1767)	CLD, EST, FTH, FRT, MMS, NCS, MRF
<i>Conopeum seurati</i> (Canu, 1928)	NCS
<i>Einbornia crustulenta</i> (Pallas, 1766)	NCS
<i>Electra monostachys</i> (Busk, 1854)	MMS, NCS, SFN
<i>Electra pilosa</i> (Linnaeus, 1767)	CLD, ESH, EST, FTH, HBD, MMS, MRF, NCS, RK, SFN, WSH
<i>Pyripora catenularia</i> (Fleming, 1828)	CLD, FRT, MMS, NCS, SFN, WSH
Family Escharinidae (5)	
<i>Escharina alderi</i> (Busk, 1856)	FSC, MMS, RK, WSH
<i>Escharina dutertrei haywardi</i> Zabala, Maluquer & Harmelin, 1993	FSC, WSH
<i>Escharina johnstoni</i> (Quelch, 1884)	CLD, MMS
<i>Herentia hyndmanni</i> (Johnston, 1847)	NCS, WSH
<i>Phaeostachys spinifera</i> (Johnston, 1847)	FTH, MMS, NCS, WSH
Family Eurateidae (1)	
<i>Euratea loricata</i> (Linnaeus, 1758)	CLD, ESH, EST, FTH, HBD, MMS, MRF, NCS, SFN, WSH
Family Exechonellidae (1)	
<i>Anarthropona monodon</i> (Busk, 1860)	FSC, WSH
Family Exochellidae (2)	
<i>Escharoides coccinea</i> (Abildgaard, 1806)	CLD, EST, FTH, HBD, MMS, MRF, NCS, WSH
<i>Escharoides mamillata</i> (Wood, 1844)	EST, MMS, NCS, WSH
Family Flustridae (7)	
<i>Carbasea carbasea</i> (Ellis & Solander, 1786)	EST, FTH, HBD, WSH
<i>Chartella barleei</i> (Busk, 1860)	ESH, NCS, WSH
<i>Chartella papyracea</i> (Ellis & Solander, 1786)	CLD, HBD, MMS
<i>Flustra foliacea</i> (Linnaeus, 1758)	CLD, ESH, EST, FTH, FRT, HBD, MMS, MRF, NCS, SFN, WSH
<i>Hincksina flustroides</i> (Hincks, 1877)	HBD
<i>Sarsiflustra abyssicola</i> (Sars G.O., 1872)	WSH
<i>Securiflustra securifrons</i> (Pallas, 1766)	CLD, ESH, EST, FTH, FRT, HBD, MMS, MRF, NCS, SFN, WSH
Family Haplopomidae (4)	

<i>Haplopoma graniferum</i> (Johnston, 1847)	CLD, FTH, NCS, WSH
<i>Haplopoma impressum</i> (Audouin, 1826)	CLD, MMS, NCS, WSH
<i>Haplopoma planum</i> Ryland, 1963	ESH, WSH
<i>Haplopoma sciaphilum</i> Silén & Harmelin, 1976	HBD
Family Hippoporidridae (2)	
<i>Hippoporella hippopus</i> (Smitt, 1867)	MRF
<i>Hippoporidra lusitania</i> Taylor & Cook, 1981	WSH
Family Hippothoidae (4)	
<i>Celleporella hyalina</i> (Linnaeus, 1767)	CLD, EST, FTH, HBD, MMS, MRF, NCS, WSH
<i>Haplota clavata</i> (Hincks, 1857)	CLD
<i>Hippothoa divaricata</i> Lamouroux, 1821	CLD, EST, NCS
<i>Hippothoa flagellum</i> Manzoni, 1870	CLD, MMS, NCS
Family Lacernidae (1)	
<i>Cylindroporella tubulosa</i> (Norman, 1868)	HBD, MRF, NCS, WSH
Family Membraniporidae (1)	
<i>Membranipora membranacea</i> (Linnaeus, 1767)	ESH, EST, FTH, HBD, MMS, MRF, NCS, RK, SFN, WSH
Family Microporellidae (3)	
<i>Fenestulina delicia</i> Winston, Hayward & Craig, 2000	CLD, WSH
<i>Fenestulina malusii</i> (Audouin, 1826)	CLD, EST, HBD, MMS, MRF, NCS, SFN, WSH
<i>Microporella ciliata</i> (Pallas, 1766)	CLD, EST, FTH, MMS, NCS, SFN, WSH
Family Microporidae (3)	
<i>Micropora coriacea</i> (Johnston, 1847)	CLD
<i>Micropora normani</i> Levinsen, 1909	WSH
<i>Mollia multijuncta</i> (Waters, 1879)	WSH
Family Phidoloporidae (5)	
<i>Reteporella beaniana</i> (King, 1846)	MMS, NCS, RK, WSH
<i>Reteporella incognita</i> Hayward & Ryland, 1996	RK, WSH
<i>Reteporella watersi</i> (Nordgaard, 1907)	WSH
<i>Rhynchozoon bispinosum</i> (Johnston, 1847)	WSH
<i>Schizotheca fissa</i> (Busk, 1856)	MMS
Family Romancheinidae (13)	
<i>Arctonula arctica</i> (M. Sars, 1851)	EST, WSH
<i>Escharella abyssicola</i> (Norman, 1869)	FSC, WSH
<i>Escharella immersa</i> (Fleming, 1828)	CLD, EST, MMS, MRF, NCS, WSH
<i>Escharella labiosa</i> (Busk, 1856)	HBD, MMS
<i>Escharella laqueata</i> (Norman, 1864)	MMS, WSH
<i>Escharella octodentata</i> (Hincks, 1880)	FSC, RK, WSH
<i>Escharella variolosa</i> (Johnston, 1838)	CLD, EST, MMS, MRF, WSH
<i>Escharella ventricosa</i> (Hassall, 1842)	CLD, EST, FTH, MMS, MRF, NCS, WSH
<i>Hemicyclopora polita</i> (Norman, 1864)	ESH, MMS, WSH
<i>Neolagenipora collaris</i> (Norman, 1867)	MMS, MRF, NCS, WSH
<i>Neolagenipora eximia</i> (Hincks, 1860)	WSH
<i>Ragionula rosacea</i> (Busk, 1856)	CLD, NCS, WSH
<i>Temachia microstoma</i> (Norman, 1864)	ESH, WSH
Family Schizoporellidae (6)	
<i>Schizoporella cornualis</i> Hayward & Ryland, 1995	MMS

<i>Schizoporella dunkeri</i> (Reuss, 1848)	MMS, NCS, WSH
* <i>Schizoporella japonica</i> Ortmann, 1890	CLD, ESH, EST, MMS, MRF, NCS, WSH
<i>Schizoporella patula</i> Hayward & Ryland, 1995	ESH, FSC, NCS, WSH
<i>Schizoporella umbonata</i> O'Donoghue & O'Donoghue, 1926	WSH
<i>Schizoporella unicornis</i> (Johnston in Wood, 1844)	CLD, HBD, MMS, MRF, NCS, WSH
Family Scrupariidae (2)	
<i>Scruparia ambigua</i> (d'Orbigny, 1841)	EST, HBD
<i>Scruparia chelata</i> (Linnaeus, 1758)	CLD, EST, FTH, HBD, MMS, NCS, WSH
Family Setosellidae (1)	
<i>Setosella vulnerata</i> (Busk, 1860)	ESH, WSH
Family Smittinidae (8)	
<i>Parasmittina trispinosa</i> (Johnston, 1838)	CLD, ESH, EST, FTH, HBD, MMS, MRF, NCS, RK, SFN, WSH
<i>Phylactella labrosa</i> (Busk, 1854)	MRF, NCS, WSH
<i>Pseudoflustra virgula</i> Hayward, 1994	FSC
<i>Smittina bella</i> (Busk, 1860)	CLD, EST, WSH
<i>Smittina crystallina</i> (Norman, 1867)	MMS, MRF, NCS, WSH
<i>Smittoidea amplissima</i> Hayward, 1979	WSH
<i>Smittoidea marmorea</i> (Hincks, 1877)	EST, FTH, MMS, NCS, WSH
<i>Smittoidea reticulata</i> (MacGillivray, 1842)	CLD, EST, FTH, MMS, MRF, NCS, WSH
Family Stomachetosellidae (3)	
<i>Stomachetosella normani</i> Hayward, 1994	WSH
<i>Stomacrustula cruenta</i> (Busk, 1854)	CLD, ESH, WSH
<i>Stomacrustula sinuosa</i> (Busk, 1860)	CLD, MMS, WSH
Family Tessaradomidae (1)	
<i>Tessaradoma boreale</i> (Busk, 1860)	HBD, RK, WSH
Family Umbonulidae (1)	
<i>Oshurkovia littoralis</i> (Hastings, 1944)	CLD, ESH, EST, FTH, HBD, MMS, MRF, NCS, SFN, WSH

Discussion

The Scottish sea regions contain 218 bryozoan species with representatives from each of the extant bryozoan orders. Based on the checklist, it can be concluded that Scotland has fewer bryozoan species than New Zealand ($n = 953$), Australia ($n = 886$), and the Mediterranean ($n = 556$) (Gordon 1999; Gordon et al. 2010; Rosso and Di Martino 2016). Given Scotland's location within a single biogeographical region, this relative lack of species is as expected (Baxter et al. 2011). When coastline length is accounted for, Scotland has approximately half the number of species per km (0.01) as Australia (0.02 species/km) and approximately six times fewer than New Zealand (0.06 species/km). The proportion of ctenostomes in Scotland (12% of total species) is greater than the global average (~5%) (Bock and Gordon 2013), and greater than the proportion of ctenostomes reported from New Zealand (5%), Australia (4%), Argentina (4%) and the Mediterranean (10%) (Gappa 2000; Gordon 1999; Rosso and Di Martino 2016). Only the bryozoan fauna of Brazil has a greater percentage (26.2%) of ctenostomes. Previously, higher incidences of ctenostomes (and/or cyclostomes) have been attributed to the results

of focused taxonomic efforts in certain regions (Gappa 2000; Rosso 2003). Rosso and Di Martino (2016), however, suggested that the abundance of ctenostomes in the Mediterranean could also reflect the availability of high-energy algal and seagrass dominated habitats, for which the flexible uncalcified ctenostome colony forms are well adapted to exploit. Scotland, and the Scottish west coast in particular, has a high abundance and diversity of algae and algal dominated habitats (Smale et al. 2013), which may explain the high number of ctenostomes found in the study region.

As with other benthic marine invertebrates in Scotland, the bryozoan fauna includes NIS (Nall et al. 2015). The presence of all but one NIS within the Clyde Sea region most likely represents the fact that the area is both a well-studied region and the location of a significant number of ports. As global shipping and aquaculture increase, along with climate change, it is expected that the number of invasive or non-indigenous bryozoans in the Scottish sea regions will increase in the future (Stretaris et al. 2005).

The estimate of bryozoan species number in Scotland, presented here, is likely to be conservative, since much of the offshore shelf areas and seamounts have not been fully explored. Estimates of the global number of bryozoan species yet to be discovered range from 2800–5200 (Appeltans et al. 2012). Given that the Scottish bryozoan fauna currently constitutes 3.7% of global bryozoan species richness, and assuming that this proportion will remain constant, it could be expected that there are approximately 104–192 bryozoan species in Scotland yet to be discovered.

Acknowledgements

This study received funding from the UK research council knowledge exchange fellowship [NE/P006566/2], a NERC MSc bursary and EOL Rubenstein Fellowship. The authors would like to thank the numerous people who collected the bryozoan records used in this study.

References

- Appeltans W, Ahyong Shane T, Anderson G, Angel Martin V, Artois T, Bailly N, Bamber R, Barber A, Bartsch I, Berta A, Błażewicz-Paszkowycz M, Bock P, Boxshall G, Boyko Christopher B, Brandão Simone N, Bray Rod A, Bruce Niel L, Cairns Stephen D, Chan T-Y, Cheng L, Collins Allen G, Cribb T, Curini-Galletti M, Dahdouh-Guebas F, Davie Peter JF, Dawson Michael N, De Clerck O, Decock W, De Grave S, de Voogd Nicole J, Domning Daryl P, Emig Christian C, Erséus C, Eschmeyer W, Fauchald K, Fautin Daphne G, Feist Stephen W, Fransen Charles HJM, Furuya H, Garcia-Alvarez O, Gerken S, Gibson D, Gittenberger A, Gofas S, Gómez-Daglio L, Gordon Dennis P, Guiry Michael D, Hernandez F, Hoeksema Bert W, Hopcroft Russell R, Jaume D, Kirk P, Koedam N, Koenemann S, Kolb Jürgen B, Kristensen Reinhardt M, Kroh A, Lambert G, Lazarus David B, Lemaitre R, Longshaw M, Lowry J, Macpherson E, Madin Laurence P, Mah C, Mapstone G, McLaughlin Patsy A, Mees J, Meland K, Messing Charles G, Mills Claudia E, Molodtsova Tina N, Mooi R, Neuhaus B,

- Ng Peter KL, Nielsen C, Norenburg J, Opresko Dennis M, Osawa M, Paulay G, Perrin W, Pilger John F, Poore Gary CB, Pugh P, Read Geoffrey B, Reimer James D, Rius M, Rocha Rosana M, Saiz-Salinas José I, Scarabino V, Schierwater B, Schmidt-Rhaesa A, Schnabel Karen E, Schotte M, Schuchert P, Schwabe E, Segers H, Self-Sullivan C, Shenkar N, Siegel V, Sterrer W, Stöhr S, Swalla B, Tasker Mark L, Thuesen Erik V, Timm T, Todaro MA, Turon X, Tyler S, Uetz P, van der Land J, Vanhoorne B, van Ofwegen Leen P, van Soest Rob WM, Vanaverbeke J, Walker-Smith G, Walter TC, Warren A, Williams Gary C, Wilson Simon P, Costello Mark J (2012) The magnitude of global marine species diversity. *Current Biology* 22: 2189–2202. <https://doi.org/10.1016/j.cub.2012.09.036>
- Baxter JM, Boyd IL, Cox M, Donald AE, S.J M, Miles H, Miller B, Moffat CF (2011) Scotland's Marine Atlas: Information for the National Marine Plan. Marine Scotland, Edinburgh, 191 pp.
- Bitschowsky F, Forster S, Scholz J (2011) Regional and temporal changes in epizoobiontic bryozoan-communities of *Flustra foliacea* (Linnaeus, 1758) and implications for North Sea ecology. *Estuarine, Coastal and Shelf Science* 91: 423–433. <https://doi.org/10.1016/j.ecss.2010.11.004>
- Bock PE, Gordon DP (2013) Phylum Bryozoa Ehrenberg, 1831. In: Zhang Z-Q (Ed.) *Animal biodiversity: an outline of higher-level classification and survey of taxonomic richness* (Addenda 2013). *Zootaxa* 3703: 67–74.
- Boulton G, Peacock J, Sutherland D (1991) Quaternary. In: Trewin NH (Ed.) *Geology of Scotland*, 503–543.
- Collin SB, Tweddle JF, Shucksmith RJ (2015) Rapid assessment of marine non-native species in the Shetland Islands, Scotland. *BioInvasions Records* 4: 147–155. <https://doi.org/10.3391/bir.2015.4.3.01>
- Gappa JL (2000) Species richness of marine Bryozoa in the continental shelf and slope off Argentina (south-west Atlantic). *Diversity and Distributions* 6: 15–27. <https://doi.org/10.1046/j.1472-4642.2000.00067.x>
- Gordon D, Costello MJ (2016) Bryozoa - not a minor phylum. *New Zealand Science Review* 73: 63–66.
- Gordon DP (1999) Bryozoan diversity in New Zealand and Australia. In: Ponder W, Lunney D (Eds) *The other 99% The conservation and biodiversity of invertebrates*. Transactions of the Royal Zoological Society of New South Wales, Mosman. doi: <https://doi.org/10.7882/RZSNSW.1999.033> <https://doi.org/10.7882/RZSNSW.1999.033>
- Gordon DP, Beaumont J, MacDiarmid A, Robertson DA, Ah Yong ST (2010) Marine Biodiversity of Aotearoa, New Zealand. *PLoS ONE* 5: e10905. <https://doi.org/10.1371/journal.pone.0010905>
- Hayward P, Ryland J (1998) Cheilostomatous Bryozoa. Part 1. Aeteoidea—Cribrillinoidea. *Synopses of the British fauna*. Field Studies Council, Shrewsbury, 366 pp.
- Hiscock K (1996) *Marine nature conservation review: rationale and methods*. Joint Nature Conservation Committee, Peterborough, 54 pp.
- Horton T, Kroh A, Bailly N, Boury-Esnault N, Nunes Brandão SN, Costello MJ, Gofas S, Hernandez F, Mees J, Paulay G, Poore G, Rosenberg G, Stöhr S, Decock W, Dekeyser S, Vandepitte L, Vanhoorne B, Vranken S, Adams MJ, Adlard R, Adriaens P, Agatha S, Ahn KJ, Ah Yong S, Alvarez B, Anderson G, Angel M, Arango C, Artois T, Atkinson S, Barber A, Bartsch I, Bellan-Santini D, Berta A, Bieler R, Błazewicz M, Bock P, Böttger-Schnack

- R, Bouchet P, Boyko CB, Bray R, Bruce NL, Cairns S, Campinas Bezerra TN, Cárdenas P, Carstens E, Cedhagen T, Chan BK, Chan TY, Cheng L, Churchill M, Coleman CO, Collins AG, Crandall KA, Cribb T, Dahdouh-Guebas F, Daly M, Daneliya M, Dauvin JC, Davie P, De Grave S, de Mazancourt V, Defaye D, d'Hondt JL, Dijkstra H, Dohrmann M, Dolan J, Downey R, Drapun I, Eisendle-Flöckner U, Eitel M, Encarnação SCd, Epler J, Ewers-Saucedo C, Faber M, Feist S, Finn J, Fišer C, Fonseca G, Fordyce E, Foster W, Frank JH, Franssen C, Furuya H, Galea H, Garcia-Alvarez O, Gasca R, Gaviria-Melo S, Gerken S, Gheerardyn H, Gibson D, Gil J, Gittenberger A, Glasby C, Glover A, Gordon D, Grabowski M, Gravili C, Guerra-García JM, Guidetti R, Guilini K, Guiry MD, Hajdu E, Hallermann J, Hayward B, Hendrycks E, Herrera Bachiller A, Ho Js, Høeg J, Holovachov O, Hooper J, Hughes L, Hummon W, Hyzny M, Iseto T, Ivanenko S, Iwataki M, Jarms G, Jaume D, Jazdzewski K, Kaminski M, Karanovic I, Kim YH, King R, Kirk PM, Kolb J, Kotov A, Krapp-Schickel T, Kremenetskaia A, Kristensen R, Kullander S, La Perna R, Lambert G, Lazarus D, LeCroy S, Leduc D, Lefkowitz EJ, Lemaitre R, Lörz AN, Lowry J, Macpherson E, Madin L, Mah C, Mamos T, Manconi R, Mapstone G, Marshall B, Marshall DJ, McInnes S, Meidla T, Meland K, Merrin K, Messing C, Miljutin D, Mills C, Mokievsky V, Molodtsova T, Monniot F, Mooi R, Morandini AC, Moreira da Rocha R, Moretzsohn F, Mortelmans J, Mortimer J, Musco L, Neubauer TA, Neuhaus B, Ng P, Nielsen C, Nishikawa T, Norenburg J, O'Hara T, Okahashi H, Opresko D, Osawa M, Ota Y, Parker A, Patterson D, Paxton H, Perrier V, Perrin W, Petrescu I, Picton B, Pilger JF, Pisera A, Polhemus D, Pugh P, Reimer JD, Reuscher M, Rius M, Rützler K, Rzhavsky A, Saiz-Salinas J, Santos S, Sartori AF, Satoh A, Schatz H, Schierwater B, Schmidt-Rhaesa A, Schneider S, Schönberg C, Schuchert P, Self-Sullivan C, Senna AR, Serejo C, Shamsi S, Sharma J, Shenkar N, Sicinski J, Siegel V, Sierwald P, Sinniger F, Sivell D, Sket B, Smit H, Smol N, Souza-Filho JF, Stampar SN, Sterrer W, Stienen E, Strand M, Suárez-Morales E, Summers M, Suttle C, Swalla BJ, Taiti S, Tandberg AH, Tang D, Tasker M, Taylor J, Tchesunov A, ten Hove H, ter Poorten JJ, Thomas J, Thuesen EV, Thurston M, Thuy B, Timi JT, Timm T, Todaro A, Turon X, Tyler S, Uetz P, Utevisky S, Vacelet J, Vader W, Väinölä R, van der Meij SE, van Soest R, Van Syoc R, Venekey V, Vonk R, Vos C, Walker-Smith G, Walter TC, Wärling L, Whipps C, White K, Williams G, Wilson R, Wyatt N, Wylezich C, Yasuhara M, Zanol J, Zeidler W (2016) World Register of Marine Species (WoRMS). WoRMS Editorial Board.
- Lidgard S (2008) Predation on marine bryozoan colonies: taxa, traits and trophic groups. *Marine Ecology Progress Series* 359: 117–131. <https://doi.org/10.3354/meps07322>
- Loxton JL (2014) Investigations into the Skeletal Mineralogy of Temperate and Polar Bryozoans. PhD Thesis. UK: Heriot Watt University.
- McKinney FK, Jackson JBC (1991) *Bryozoan Evolution*. University of Chicago Press, Chicago, 238 pp.
- Nall CR, Guerin AJ, Cook EJ (2015) Rapid assessment of marine non-native species in northern Scotland and a synthesis of existing Scottish records. *Aquatic Invasions* 10: 107–121. <https://doi.org/10.3391/ai.2015.10.1.11>
- Narkowicz CK, Blackman AJ, Lacey E, Gill JH, Heiland K (2002) Convolutindole A and convolutamine H, new nematocidal brominated alkaloids from the marine bryozoan

- Amathia convoluta*. Journal of natural products 65: 938–941. <https://doi.org/10.1021/np010574x>
- Norman AM (1869) Shetland final dredging report. Part II. On the Crustacea, Tunicata, Polyzoa, Echinodermata, Actinozoa, Hydrozoa, and Porifera. Report of the British Association for the Advancement of Science 38: 247–336.
- O'Brien JM, Krumhansl KA, Scheibling RE (2013) Invasive bryozoan alters interaction between a native grazer and its algal food. Journal of the Marine Biological Association of the United Kingdom 93: 1393–1400. <https://doi.org/10.1017/S0025315412001683>
- Porter JS, Spencer Jones ME, Kuklinski P, Rouse S (2015) First records of marine invasive non-native Bryozoa in Norwegian coastal waters from Bergen to Trondheim. Bioinvasions Rec 4: 157–169. <https://doi.org/10.3391/bir.2015.4.3.02>
- Powney G, Isaac N (2015) Beyond maps: A review of the applications of biological records. Biological Journal of the Linnean Society 115: 532–542. <https://doi.org/10.1111/bij.12517>
- Rosso A (2003) Bryozoan diversity in the Mediterranean Sea. Biogeographia 24: 219–238. <https://doi.org/10.12681/mms.1706>
- Rosso A, Di Martino E (2016) Bryozoan diversity in the Mediterranean Sea: an update. Mediterranean Marine Science 17: 567–607. <https://doi.org/10.12681/mms.1706>
- Rouse S, Spencer Jones ME, Porter JS (2014) Spatial and temporal patterns of bryozoan distribution and diversity in the Scottish sea regions. Marine Ecology 35: 85–102. <https://doi.org/10.1111/maec.12088>
- Smale DA, Burrows MT, Moore P, O'Connor N, Hawkins SJ (2013) Threats and knowledge gaps for ecosystem services provided by kelp forests: a northeast Atlantic perspective. Ecology and Evolution 3: 4016–4038. <https://doi.org/10.1002/ece3.774>
- Stretaris N, Zenetos A, Papthanassiou E (2005) Globalisation in marine ecosystems: the story of non-indigenous marine species across European seas. Oceanography and Marine Biology: An Annual Review 43: 419–453.
- Wasson B, De Blauwe H (2014) Two new records of cheilostome Bryozoa from British waters. Marine Biodiversity Records 7: e123. <https://doi.org/10.1017/S1755267214001213>
- Yorke AF, Metaxas A (2011) Interactions between an invasive and a native bryozoan (*Membranipora membranacea* and *Electra pilosa*) species on kelp and Fucus substrates in Nova Scotia, Canada. Marine Biology 158: 2299. <https://doi.org/10.1007/s00227-011-1734-3>

Supplementary material I

Scottish bryozoan records

Authors: Sally Rouse, Jennifer Loxton, Mary E. Spencer Jones, Joanne S. Porter

Data type: occurrence

Copyright notice: This dataset is made available under the Open Database License (<http://opendatacommons.org/licenses/odbl/1.0/>). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.

Link: <https://doi.org/10.3897/zookeys.787.24647.suppl1>