An erect bryozoan (*Bugulina turbinata*)

MarLIN – Marine Life Information Network
Biology and Sensitivity Key Information Review

Dr Harvey Tyler-Walters

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Colonies of *Bugulina turbinata* on overhang.
Photographer: Keith Hiscock

See online review for distribution map

Distribution data supplied by the Ocean Biogeographic Information System (OBIS). To interrogate UK data visit the NBN Atlas.

Researched by	Dr Harvey Tyler-Walters	**Refereed by**	Dr Peter J. Hayward
Authority	(Alder, 1857)		
Other common names	-	**Synonyms**	-

Summary

Description

Bugulina turbinata forms an erect, bushy, tufted colony about 3-6 cm in height and orange to brown in colour. The branches are arranged spirally around the main axis and composed of two rows of zooids proximally, increasing to 3-4 rows distally. Individual zooids are rectangular, 0.5-0.6 by 0.15-0.2 mm, narrowing slightly at their proximal end and bearing a single short spine at each corner of the distal end. The front of the zooid is almost entirely membranous. The polypide bears 13 tentacles. Avicularia arise just below the spines and are short and plump resembling a 'birds head', with a rectangularly hooked beak. Inner avicularia are smaller than marginal ones. Brood chambers (ooecia) are globular in shape and conspicuous. Colonies are attached to the substratum by extensions of the basal zooids (rhizoids). Yellow embryos are present from early May to November.

Recorded distribution in Britain and Ireland

A southern species predominantly found on the south and southwest coasts of England and Wales but with records from Shetland, Orkney, the north east coast, Ireland, the west coast of Scotland and St. Kilda.

Global distribution

Recorded from Britain to the Mediterranean.

Habitat

Present on the walls of gullies and under boulders on the lower shore and on bedrock, boulders, stones and shells in the shallow subtidal.

Depth range

Lower shore to ca 21m.

Identifying features

- Colony erect, branching and attached by frontal, lateral and basal rhizoids.
- Operculum absent, orifice closed by a sphincter.
- Ooecia (ovicells) globular and hyperstomial.
- Avicularia prominent, resembling 'birds' heads'.
- Avicularia short, plump, and broader than other species of *Bugula/Bugulina*, with a rectangularly hooked beak.
- A single short spine present on each corner of the distal end of the zooid.
- Branches with autozooids in two rows proximally, three to four distally.

Additional information

All British species of *Bugula* (and presumably *Bugulina*) die back in autumn, overwintering as ancestrulae, colony stumps or stolons (Hayward & Ryland, 1998). Little information was found on the biology and sensitivity of *Bugulina turbinata*.

Please note the molecular taxonomy of the genus *Bugula* (Fehlauer-Ale *et al.*, 2015) identified several clear genera (clades), *Bugula sensu stricto* (30 species), *Bugulina* (24 species), *Crisularia* (23 species) and the monotypic *Virididentulagen*. The following review was derived from information concerning species of *Bugula* prior to their recent revision. The review assumes that, while their taxonomy has changed, the biology of Bugulidae remains similar. Hence, references to *Bugula* spp. in the text refer to *Bugula sensu stricto*, *Bugulina*, and *Crisularia* species.

Listed by

Further information sources

Search on:

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Biology review

Taxonomy

Phylum	Bryozoa	Sea mats, horn wrack & lace corals
Class	Gymnolaemata	
Order	Cheilostomatida	
Family	Bugulidae	
Genus	Bugulina	
Authority	(Alder, 1857)	
Recent Synonyms	-	

Biology

Typical abundance	Low density
Male size range	
Male size at maturity	
Female size range	Small-medium(3-10cm)
Female size at maturity	
Growth form	Arborescent / Arbuscular
Growth rate	See additional information
Body flexibility	High (greater than 45 degrees)
Mobility	
Characteristic feeding method	Active suspension feeder, Non-feeding
Diet/food source	
Typically feeds on	Phytoplankton (<50µm), macroalgal spores, detritus, and bacteria.
Sociability	
Environmental position	Epibenthic
Dependency	Independent.
Supports	None
Is the species harmful?	No

Biology information

Growth form

Bugula species form erect tufted growths, characterized by continuous branching. The holdfast is composed of encrusting rhizoids. The exact nature of branching and colony form varies with species, active growth occurring at the branch apices. In *Bugulina turbinata*, the branches form spirally around a central axis (Dyrynda & Ryland, 1982; Hayward & Ryland, 1998).

Growth rates

Growth rates in bryozoans have been shown to vary with environmental conditions, especially water flow, food supply, temperature, competition for food and space, and genotype. For example:

- Wendt (1998) reported that the length of time larvae spent in the plankton affected subsequent growth and reproduction of colonies of *Bugula neritina*, i.e. although specific growth rates were probably the same, colonies developing from 24hr old larvae were 35% smaller, began reproduction about 1.5 days later and had about 50% fewer brood chambers than those growing from 1hr larvae.

- Wendt (1998) also noted that colonies growing on upward facing surfaces in the laboratory were about 40% smaller than colonies growing on downward facing surfaces.

Growth in numbers of zooids is exponential. Wendt (1998) reported a mean number of 74-113 zooids 14 days after larval settlement in *Bugula neritina*, depending on the length of time the larvae spent in the plankton. Note, however, that *Bugula neritina* is a warm temperate species probably only remotely related to the NE Atlantic species (P. Hayward, pers. comm.). Schneider (1963) reported that buds grew at about 12 µm /hr (a maximum of 25 µm/hr) in the laboratory. Schnieder's estimates probably represent optimal growth under laboratory conditions, however, growth in *Bugula* species is likely to rapid.

Feeding

The structure and function of the bryozoan lophophore was reviewed by Ryland (1976), Winston (1977), and Hayward & Ryland (1998). Ambient water flow is important for bringing food-bearing water within range of the colonies own pumping ability (McKinney, 1986), however, increased water flow reduces feeding efficiency in small colonies but not of large colonies (Okamura, 1984). Curiously , upstream zooids dominated feeding in slow flow (1-2 cm/s) and central zooids in fast flow (10-12cm/s) (Okamura, 1984). Bryozoa probably feed on small flagellates (<50 µm), bacteria, algal spores and small pieces of abraded macroalgae (Winston, 1977; Best & Thorpe, 1994).

Habitat preferences

Physiographic preferences	Enclosed coast / Embayment, Open coast, Ria / Voe, Sea loch / Sea lough, Strait / sound
Biological zone preferences	Lower eulittoral, Lower infralittoral, Sublittoral fringe, Upper infralittoral
Substratum / habitat preferences	Artificial (man-made), Bedrock, Caves, Cobbles, Crevices / fissures, Large to very large boulders, Overhangs, Small boulders, Under boulders
Tidal strength preferences	Moderately Strong 1 to 3 knots (0.5-1.5 m/sec.), Strong 3 to 6 knots (1.5-3 m/sec.), Weak < 1 knot (<0.5 m/sec.)
Wave exposure preferences	Exposed, Moderately exposed, Sheltered, Very exposed, Very sheltered
Salinity preferences	Full (30-40 psu)
Depth range	Lower shore to ca 21m.
Other preferences	No text entered
Migration Pattern	

Habitat Information

Bugulina turbinata has been reported on the lower shore to al least 21 m in Lundy (Hiscock, 1985b; Hayward & Ryland, 1998). Although found in a variety of wave exposed habitats, the microhabitat occupied by *Bugulina turbinata*, under boulders, overhangs and crevices is probably protected from direct wave action. Although found in wave sheltered situations or weak tidal streams, some water flow is probably important to bring food and nutrient-laden water to the colonies and ensure an adequate supply of hard substrata. The abundance of bryozoans is positively correlated with supply of hard substrata and hence with current strength (Eggleston, 1972b; Ryland, 1976). *Bugula* spp. are characteristic fouling bryozoans, and may be found in the intake pipes of ships or power stations, and on ships hulls. The geographic distribution of *Bugula* species has been extended by transportation by shipping (Ryland, 1967). However, no information on transportation of *Bugulina turbinata* was found.

Life history

Adult characteristics

Reproductive type	Protogynous hermaphrodite
Reproductive frequency	Annual protracted
Fecundity (number of eggs)	See additional information
Generation time	<1 year
Age at maturity	Less than 1 month.
Season	May - October
Life span	Insufficient information

Larval characteristics

Larval/propagule type	-
Larval/juvenile development	Viviparous
Duration of larval stage	< 1 day
Larval dispersal potential	<10 m
Larval settlement period	Summer and autumn

Life history information

The reproductive biology of *Bugula* sp. has been extensively studied and reviewed. Gametogenesis and embryology are detailed by Ryland (1976), Franzén, (1977), Dyrynda & King (1983) and Reed (1991). The fronds of *Bugula* species are ephemeral, large colonies present in summer, dying back in late autumn and overwintering as perennial, dormant, holdfasts or ancestrulae (Eggleston 1972a; Dyrynda & Ryland, 1982). *Bugula* species are placental ovicell brooders, producing small embryos that are brooded in conspicuous hyperstomial ovicells, increasing in size considerably during development due to nutrition derived from the inside of the ovicell, which acts as a placenta. For example, the *Bugulina turbinata* embryo grows 33 fold in embryogenesis (Dyrynda & Ryland, 1982; Dyrynda & King, 1983). The reproductive cycle of *Bugulina flabellata* is summarised below and may be similar in other *Bugula* spp., although Eggleston (1972a) noted that the number of generations in the other species was not known.

Zooids are protogynous hermaphrodites, developing eggs then sperm. Gametogenesis begins as the new zooid has formed. Egg maturation, ovulation and transfer of a single egg to the ovicell occurs halfway through the life of the first polypide. Embryogenesis continues through to the life of the second polypide, and larvae are released prior to ovulation of the next egg, taking about 3 weeks in July at Oxwich Point, Swansea. Sperm are produced after the egg has transferred to the ovicell, during the last half of the first polypide's life, and are released through the terminal pore in the tips of the tentacles (Dyrynda & Ryland, 1982). Fertilization probably occurs at ovulation, within the zooid (internal fertilization) (Dyrynda & Ryland, 1982; Reed, 1991). Once completed the cycle is repeated. Dyrynda & Ryland (1982) reported 4 cycles of polypides within zooids, after which frond death is simultaneous. Zooids may be found at different stages all the length of the frond (Eggleston, 1972a; Dyrynda & Ryland, 1982). In bryozoans, released sperm are entrained by the tentacles of feeding polypides and may not disperse far, resulting in self-fertilization. However, genetic cross-fertilization is assumed in oviparous and brooding bryozoans based partly on the proximity of other colonies and genetic data, although there is evidence of self fertilization (Reed, 1991; Hayward & Ryland, 1998).

Overall, *Bugulina flabellata* exhibits two generations of ephemeral fronds each summer. Each fronds begins to produce larvae soon after initiation, within 1 month. At Oxwich, Swansea, the first frond generation appeared in June and died in August, the second generation arising in August and dying back in late October (Dyrynda & Ryland, 1982). In the Isle of Man, Eggleston (1972c) noted rapid growth in March, with eggs and embryos by May, dying back in September, with a second generation in mid September to late October. Eggleston (1972a) also noted that offspring of the first generation grew rapidly and contributed to the second generation.

Ryland (1970) noted that in British waters bryozoan reproduction was generally maximal in late summer, declining into autumn. Dyrynda & Ryland (1982) concluded that *Bugulina flabellata* was adapted to rapid growth and reproduction (*r*-selected), taking advantage of the spring/summer phytoplankton bloom and more favourable (less stormy) conditions.

Fecundity
While each individual zooid is not prolific, the fecundity of the colony is probably directly proportional to the number of functional zooids (Bayer *et al*., 1994) and is probably high.

Longevity
The fronds of *Bugula* sp. are ephemeral, surviving about 3-4 months but producing two frond generations in summer before dying back in winter. However, the holdfasts are probably perennial (Dyrynda & Ryland, 1982). No information concerning the longevity of holdfasts was found.

Dispersal
The lecithotrophic coronate larva of *Bugula* species is free-swimming for a short period of time (<1 to 36 hrs) and colonies developing from later settling larvae (24 hr old) have significantly reduced growth and reproduction (Wendt, 1998, 2000). Therefore, dispersal is likely to be limited, resulting in poor gene flow and population subdivision(Wendt, 1998). *Bugula* species are common members of the fouling community of shipping and harbour installations but are far less abundant on buoys (Ryland, 1967). Keough & Chernoff (1987) noted that post settlement mortality of *Bugula neritina* was high, ca 70% in the first week after settlement on a Florida seagrass bed. Populations showed substantial spatial and temporal variation and Keough & Chernoff (1987) concluded that this variation was due to poor dispersal by the lecithotrophic larvae. Similarly, Castric-Fey (1974) noted that *Bugulina turbinata*, *Crisularia plumosa* and *Bugula calathus* did not recruit to settlement plates after ca two years in the subtidal even though present on the surrounding bedrock. Ryland (1976) reported that significant settlement in bryozoans was only found near a reservoir of breeding colonies. The short larval life and large numbers of larvae produced probably results in good local but poor long-range dispersal depending on the hydrographic regime.

Sensitivity review

This MarLIN sensitivity assessment has been superseded by the MarESA approach to sensitivity assessment. MarLIN assessments used an approach that has now been modified to reflect the most recent conservation imperatives and terminology and are due to be updated by 2016/17.

Physical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Substratum Loss	High	High	Moderate	High

Removal of the substratum will result in removal of the attached colonies of *Bugulina turbinata*. Therefore, an intolerance of high has been recorded. Recovery will probably take more than a year in most cases, and has been assessed as high (see additional information below).

	Intolerance	Recoverability	Sensitivity	Confidence
Smothering	High	High	Moderate	Low

Smothering by 5 cm of sediment is likely to prevent feeding, and hence growth and reproduction, as well as respiration. In addition, associated sediment abrasion may remove or damage the bryozoan colonies. A layer of sediment will probably also interfere with larval settlement. Therefore, an intolerance of high has been recorded. Recoverability has been assessed as high (see additional information below).

	Intolerance	Recoverability	Sensitivity	Confidence
Increase in suspended sediment	Intermediate	Very high	Low	Moderate

Bryozoans are suspension feeding organisms that may be adversely affected by increases in suspended sediment, due to clogging of their feeding apparatus. Bryozoan turfs form preferentially on steep surfaces and under overhangs and larvae preferentially settle under overhangs, presumably to avoid smothering and siltation (Ryland, 1977; Hartnoll, 1983). Wendt (1998) noted that *Bugula neritina* grew faster on downward facing surfaces than upward facing surfaces, presumably due to siltation and reduced feeding efficiency on upward facing surfaces. However, where water flow is sufficient to prevent siltation, *Bugulina turbinata* may colonize upward facing surfaces (Hiscock & Mitchell, 1980). In addition, a layer of silt may prevent larval settlement and sediment scour may remove colonies. Overall, *Bugulina turbinata* is likely to encounter turbid conditions under boulders which may restrict its abundance in these habitats. An increase in suspended sediment at the benchmark level is likely to at least reduce the population abundance and may exclude some *Bugula* species, therefore, an intolerance of intermediate has been recorded. Recoverability is likely to be very high (see additional information below).

	Intolerance	Recoverability	Sensitivity	Confidence
Decrease in suspended sediment	Tolerant*	Not relevant	Not sensitive*	Moderate

Bryozoan turfs are often abundant in clear, fast flowing waters (Moore, 1977a). A decrease in suspended sediment is likely to increase the abundance of bryozoans, including species of *Bugula*. Therefore, tolerant* has been recorded.

	Intolerance	Recoverability	Sensitivity	Confidence
Dessication	High	High	Moderate	High

Although occurring in the intertidal, *Bugulina turbinata* is restricted to damp underboulder and overhang habitats. Dyrynda & Ryland (1982) noted that rapid growth in *Bugulina flabellata* was associated with light skeletalization. On emersion, the branching form of *Bugulina turbinata* probably holds some water. However, it is probably intolerant of drying and water loss. Therefore, an increase in desiccation at the benchmark level (e.g. by overturning of boulders to which the colonies are attached) is likely to result in loss of the population, including dormant holdfasts, and intolerance of high has been recorded. Recovery is likely to be very high (see additional information below).

Increase in emergence regime	Intermediate	Very high	Low	Moderate

An increase in emergence will increase the risk of desiccation, expose the species to increased extremes of temperature and reduce the time available for feeding, hence reducing growth and reproduction. Therefore, the upper extent and abundance of the population is likely to be reduced and an intolerance of intermediate has been recorded. Recoverability is likely to be very high.

Decrease in emergence regime	Tolerant*	Not relevant	Not sensitive*	Low

A decrease in emergence is likely to allow *Bugulina turbinata* to extend its range further up the shore. Therefore, tolerant* has been recorded.

Increase in water flow rate	Intermediate	Very high	Low	Low

Water flow has been shown to be important for the development of bryozoan communities and the provision of suitable hard substrata for colonization (Eggleston, 1972b; Ryland, 1976). In addition, areas subject to high mass transport of water such as the Menai Strait, or tidal rapids generally support large numbers of bryozoan species. Although, active suspension feeders, their feeding currents are probably fairly localized and they are dependent on water flow to bring adequate food supplies within reach (McKinney, 1986). Okamura (1984) reported that an increase in water flow from slow flow (1-2 cm/s) to fast flow (10-12 cm/s) reduced feeding efficiency in small colonies but not in large colonies of *Bugulina stolonifera*. *Bugulina turbinata* has been recorded from strong to weak tidal streams. However, an increase in water flow from e.g. moderately strong to very strong may result in loss of a proportion of the population or displacement of more tolerant species. Populations on less stable substrata such as pebbles and cobbles will probably be lost but are probably ephemeral, short-lived populations. In addition, very strong water flow may interfere with larval settlement, transporting larvae away from the adult population, and increasing settlement time and larval mortality. Therefore, an intolerance of intermediate has been recorded. Recoverability is probably very high (see additional below).

Decrease in water flow rate	High	Very high	Low	Low

Water flow has been shown to be important for the development of bryozoan communities and the provision of suitable hard substrata for colonization (Eggleston, 1972b; Ryland, 1976). In addition, areas subject to high mass transport of water such as the Menai Strait and tidal rapids generally support large numbers of bryozoan species. Although, active suspension feeders, their feeding currents are probably fairly localized and they are dependent on water flow to bring adequate food supplies within reach (McKinney, 1986). A decrease in water flow, e.g. from moderately strong to very weak will probably result in impaired growth due to a reduction in food availability, and an increased risk of siltation (see above). Therefore, an intolerance of high has been recorded with a recoverability of very high (see additional information below). However, *Bugulina turbinata* may occur in areas of weak tidal streams, where wave action is adequate to maintain water movement (see below).

Increase in temperature	Tolerant	Not relevant	Not sensitive	Moderate

Although species of *Bugula* grow and reproduce in the summer months, day length and/or the phytoplankton bloom characteristic of temperate waters are probably more important cues than temperature (Ryland, 1967; 1970). *Bugulina turbinata* is a predominantly southern species in British waters (Lewis, 1964; Hayward & Ryland, 1998) but has been recorded as far north as Shetland. A long term increase in temperature may increase its abundance in northern British waters and allow the species to extend its range. As an intertidal species it is likely to be exposed to extremes of temperature when emersed, and is presumably tolerant of acute temperature changes. It occurs as far south as the Mediterranean and is, therefore, probably tolerant to increases of temperature, at the benchmark level, within British waters.

Decrease in temperature	Intermediate	Very high	Low	Low

Bugulina turbinata is a predominantly southern species extending in range to the Mediterranean (Lewis, 1964; Hayward & Ryland, 1998). Although it has been recorded as far north as Shetland, a long term decrease in temperature may reduce its extent in British waters, probably by interfering with growth and reproduction. Similarly a decreased temperature may reduce its extent or abundance in the intertidal. Therefore, an intolerance of intermediate has been recorded. Recoverability is probably very high (see additional below)

Increase in turbidity	Low	Immediate	Not sensitive	Low

An increase in turbidity is likely to result in a decrease in phytoplankton and macroalgal primary production, which may reduce food available to *Bugulina turbinata*. Therefore, an intolerance of low has been recorded.

Decrease in turbidity	Tolerant	Not relevant	Not sensitive	Low

A decrease in turbidity may increase phytoplankton productivity and increase food availability for growth and reproduction. However, it is unlikely to adversely affect *Bugulina turbinata* and tolerant has been recorded.

Increase in wave exposure	Intermediate	Very high	Low	Moderate

Bugula spp. produce flexible erect tufts, which are likely to move with the oscillatory flow created by wave action. *Bugulina turbinata* has been recorded from very wave exposed to very wave sheltered habitats. However, populations on unstable substrata such as cobbles and pebbles will probably be destroyed by increased wave action or storms. In addition, increased wave action may result in increased scour in the presence of sediments and resultant loss of colonies. Therefore, an intolerance of intermediate has been recorded. Recoverability is probably very high (see additional below).

Decrease in wave exposure	Tolerant*	Not relevant	Not sensitive*	Low

A decrease in wave action is unlikely to adversely affect colonies of *Bugula* spp. in areas where water flow (see above) is sufficient to provide food bearing water and prevent siltation. A decrease in wave action may allow *Bugula* spp. to colonize more ephemeral habitats such as pebbles, cobbles and shells, Therefore, tolerant* has been recorded.

Noise	Tolerant	Not relevant	Not sensitive	High

The species is unlikely to be sensitive to changes in noise vibrations.

Visual Presence	Tolerant	Not relevant	Not sensitive	High

The species is unlikely to be sensitive to changes in visual perception.

Abrasion & physical disturbance	Intermediate	Very high	Low	Moderate

Physical disturbance by fishing gear has been shown to adversely affect emergent epifaunal communities. For example, emergent epifauna were indicative of scallop dredge damage on *Modiolus modiolus* beds (see species review), and hydroid and bryozoan matrices were reported to be greatly reduced in fished areas (Jennings & Kaiser, 1998 and references therein). Mobile gears also result in modification of the substratum, including removal of shell debris, cobbles and rocks, and the movement of boulders (Bullimore, 1985; Jennings & Kaiser, 1998).

Therefore, physical disturbance by an anchor or passing dredge (see benchmark) is likely to damage fronds and remove colonies. However, some colonies and connecting stolons are likely to survive, suggesting an intolerance of intermediate. Colonies on hard substrata are probably less vulnerable to fishing activity but would probably be damaged or partially removed. Colonies growing on rocks, cobbles and shells on coarse grounds, may be removed by the dredge (see substratum loss above) and therefore, highly intolerant. Recovery is likely to be very high (see additional information below)

Displacement	High	High	Moderate	Moderate

Colonies of *Bugula* spp. that are displaced with their substratum, e.g. shell debris, cobbles or boulders, will probably survive if moved to a suitable habitat and not crushed in the process. However, if removed from its substratum, *Bugula* spp. colonies can not reattach and will probably be washed to deep water or be deposited on the strand line and die. Therefore, an intolerance of high has been recorded, with a recoverability of high (see additional information below).

Chemical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Synthetic compound contamination	High	High	Moderate	Low

Bryozoans are common members of the fouling community, and amongst those organisms most resistant to antifouling measures, such as copper-containing anti-fouling paints (Soule & Soule, 1979; Holt *et al.*, 1995). Bryan & Gibbs (1991) reported that there was little evidence regarding TBT toxicity in Bryozoa with the exception of the encrusting *Schizoporella errata*, which suffered 50% mortality when exposed for 63 days to 100ng/l TBT. Rees *et al.* (2001) reported that the abundance of epifauna (including bryozoans) had increased in the Crouch estuary in the five years since TBT was banned from use on small vessels. This last report suggests that bryozoans may be at least inhibited by the presence of TBT. Moran & Grant (1993) reported that settlement of marine fouling species, including *Bugula neritina* was significantly reduced in Port Kembla Harbour, Australia, exposed to high levels of cyanide, ammonia and phenolics. Note, however, that *Bugula neritina* is a warm temperate species probably only remotely related to the NE Atlantic species (P. Hayward, pers. comm.). Hoare & Hiscock (1974) suggested that polyzoa were amongst the most sensitive species to acidified halogenated effluents in Amlwch Bay, Anglesey and noted that *Bugulina flabellata* did not occur within the bay.
Although physiological tolerances vary between species, other *Bugula* sp. may have a similar intolerance. Therefore, an intolerance of high has been recorded with a low confidence. Recoverability would probably be high (see additional information below).

Heavy metal contamination	Low	Immediate	Not sensitive	Low

Bryozoans are common members of the fouling community, and amongst those organisms most resistant to antifouling measures, such as copper-containing anti-fouling paints (Soule & Soule, 1979; Holt *et al.*, 1995). Most of the information found concerning the toxicity of metals to this genus concerned *Bugula neritina*. Lee & Trot, (1973) reported that *Bugula neritina* colonized wooden panels treated with copper based antifouling paints and dominated the succession after 5-7 weeks. *Bugula neritina* was reported to survive but not grow exposed to ionic Cu concentrations of 0.2-0.3 ppm, while larvae died above 0.3ppm (Soule & Soule, 1979). Similarly, Ryland (1967) reported that *Bugula neritina* died where the surface leaching rate of Cu exceeded 10µg Cu/cm^2/day, while ancestrulae may recover from prolonged Cu exposure if transferred to clean sea water. Ryland (1967) also noted that *Bugula neritina* was less intolerant of Hg than Cu. Copper ion concentrations greater than 2.5mg $CuCl_2$/l stimulated a change from positive to negative phototactic response in *Bugula simplex* (Ryland, 1967). Overall, *Bugula* spp. are likely to be relatively tolerant of copper contamination, and may be tolerant of other heavy metals. Therefore, an intolerance of low has been recorded but with low confidence given the lack of information on *Bugula turbinata*.

Hydrocarbon contamination	High	High	Moderate	Moderate

Soule & Soule (1979) reported that *Bugula neritina* was lost from breakwater rocks in the vicinity of the December 1976 Bunker C oil spill in Los Angeles Harbour, and had not recovered within a year. However, it had returned to a nearby area within 5 months (May 1977) even though the area was still affected by sheens of oil. Similarly, Mohammad (1974) reported that *Bugula* spp. and *Membranipora* spp. were excluded from settlement panels near a Kuwait oil terminal subject to minor but frequent oil spills.
Therefore, although they may tolerate some hydrocarbon pollution, it is likely that *Bugula* species will be adversely affected by oil spills . Hence, an intolerance of high has been recorded. Recoverability is likely to be high (see additional information below).

Radionuclide contamination		Not relevant		Not relevant

Insufficient information

Changes in nutrient levels	Low	Immediate	Not sensitive	Very low

A moderate increase in nutrient levels may increase the food available to *Bugula* spp., either in the form of phytoplankton or detritus. *Bugula stolonifera* was reported to occur in areas of the Port of Genoa harbour, heavily affected by domestic sewage pollution (Soule & Soule, 1979). Other species of *Bugula* may shown similar tolerance. Therefore, an intolerance of low has been recorded, albeit with very low confidence.

Increase in salinity	Not relevant	Not relevant	Not relevant	Not relevant

Lynch (cited in Hyman, 1959) reported that increasing salinity hastened metamorphosis in *Bugula* spp. larvae, resulting in a reduced swimming time of 3-30 minutes. However, little other information was found, and *Bugula* spp. are unlikely to be exposed to hypersaline effluents in British waters.

Decrease in salinity	Intermediate	Very high	Low	Moderate

Ryland (1970) stated that, with a few exceptions, the Gymnolaemata were fairly stenohaline and restricted to full salinity (ca 35 psu) and noted that reduced salinities result in an impoverished bryozoan fauna. Soule & Soule (1979) suggested that some species of *Bugula* may be considered euryhaline, e.g. *Bugula neritina* and *Bugula californica* occur in harbours subject to large freshwater runoff. Lynch (cited in Hyman, 1959) reported that reduced salinity delayed metamorphosis in larvae of *Bugula neritina* but not in *Bugulina flabellata* or *Crisularia turrita*. *Bugulina turbinata* populations in the intertidal, are likely to be exposed to freshwater runoff and rainfall. Therefore, based on the above evidence, *Bugulina turbinata* may not be adversely affected by exposure to variable salinities in the short or long term (see glossary). However, it is probably intolerant of an acute change or reduction in salinity in the short term, which may result in a reduction of the extent of the population. Therefore, an intolerance of intermediate has been recorded. Recoverability is likely to be very high (see additional information below).

	Intolerance	Recoverability	Sensitivity	Confidence
Changes in oxygenation		Not relevant		Not relevant

No information on the tolerance of *Bugula* spp. to changes in oxygenation was found.

Biological Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Introduction of microbial pathogens/parasites		Not relevant		Not relevant

No information found.

	Intolerance	Recoverability	Sensitivity	Confidence
Introduction of non-native species		Not relevant		Not relevant

No information found.

	Intolerance	Recoverability	Sensitivity	Confidence
Extraction of this species	Not relevant	Not relevant	Not relevant	Not relevant

Bugula turbinata is not known to be subject to specific extraction. However, many bryozoans have been recently found to contain pharmacologically active substances, e.g. bryostatin extracted from *Bugula neritina* may have anti-cancer properties (Hayward & Ryland, 1998). Therefore, species of *Bugula* may be subject to harvesting in the future.

	Intolerance	Recoverability	Sensitivity	Confidence
Extraction of other species	Not relevant	Not relevant	Not relevant	Not relevant

Bugulina turbinata is not known to be associated with species or habitats subject to extraction.

Additional information

Recoverability

The lecithotrophic coronate larva of *Bugula* species is free-swimming for a short period of time (<1 to 36 hrs). Therefore, dispersal is likely to be limited, resulting in poor gene flow and population subdivision (Wendt, 1998, 2000). Keough & Chernoff (1987) noted that *%Bugula neritina%* was absent from areas of seagrass bed in Florida even though substantial populations were present <100m away. In addition, they noted that post settlement mortality was high, ca 70% in the first week after settlement (Keough & Chernoff, 1987). *Bugula* spp. are common members of the fouling community of shipping and harbour installations but are far less abundant on buoys (Ryland, 1967). Ryland (1976) reported that significant settlement in bryozoans was only found near a reservoir of breeding colonies.

Jensen *et al.* (1994) reported the colonization of an artificial reef in Poole Bay, UK. They noted that erect bryozoans, including *%Bugula plumosa%*, began to appear within 6 months, reaching a peak in the following summer, 12 months after the reef was constructed. In a similar experiment in Poole Bay, Hatcher (1998) reported colonization of slabs, suspended 1 m above the sediment, by *Bugula fulva* within 363 days. However, Castric-Fey (1974) noted that *Bugula turbinata*, *%Bugula plumosa%* and *%Bugula calathus%* did not recruit to settlement plates after ca two years in the subtidal even though present on the surrounding bedrock.

Therefore, short larval life and large numbers of larvae produced probably results in good local but poor long-range dispersal. Species of *Bugula* are opportunistic, capable of colonizing most hard substrata, and will probably colonize quickly in the vicinity of reproductive colonies, especially in the summer months in temperate waters. Once established, population abundance will probably also increase rapidly. Where the erect parts of colonies have been removed, regrowth from stolons may occur, resulting in rapid recovery. Therefore, populations reduced in extent or abundance will probably recover within between 6 to 12 months in most cases due to local recruitment.

New substrata or areas isolated by distance or hydrographic regime will probably take longer to recruit new individuals, perhaps several years or never depending on distance (see Castric-Fey, 1974; Jensen *et al.*, 1994; Hatcher, 1998). Within coastal waters, however, even prolonged recovery will probably take less than 5 years.

Importance review

Policy/legislation

- no data -

Status

National (GB) importance	-	Global red list (IUCN) category	-

Non-native

Native	-		
Origin	-	Date Arrived	-

Importance information

Bryozoans, including *Bugula* spp. are grazed by sea urchins such as *Echinus esculentus* and *Psammechinus miliaris* in the subtidal. Bryozoans are also preyed on by pycnogonids (sea spiders) and nudibranchs (sea slugs). For example, *Pycnogonum littorale* or *Achelia* spp. (Ryland, 1976). Although *Achelia echinata* has been reported from the tufts of *Bugulina turbinata* it feeds on the detritus accumulated within the older parts of the colony (Ryland, 1976). *Bugulina turbinata* is a preferred food of the sea slug *Greilada elegans* and *Bugula* spp. are prey for *Thecacera pennigera*, and *Janolus* spp. (Picton & Morrow, 1994).

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