Green crenella (*Musculus discors*)

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

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2001-12-20

A report from:
The Marine Life Information Network, Marine Biological Association of the United Kingdom.

Please note. This MarESA report is a dated version of the online review. Please refer to the website for the most up-to-date version [https://www.marlin.ac.uk/species/detail/1645]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

This review can be cited as:
Tyler-Walters, H., 2001. *Musculus discors* Green crenella. In Tyler-Walters H. and Hiscock K. (eds) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom.
DOI https://dx.doi.org/10.17031/marlinsp.1645.2

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Musculus discors **living in bryozoan turf collected from dead *Eunicella verrucosa*.**
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**	This information is not refereed.
Authority	(Linnaeus, 1767)		
Other common names	-	**Synonyms**	*Modiolaria discors* (Linnaeus, 1767)

Summary

Description

A small bivalve, usually up to 12 mm in length. The shell is brittle, equivalved but inequilateral and rhomboidal in outline. The beaks and umbones slightly raised and a short distance from the anterior end. The anterior and posterior portions of the shell bear different numbers of radiating ribs, while the middle region lacks ribs. Where the ribs meet the shell margin, the margin is crenulated but is smooth elsewhere. The shell is yellow to brownish in colour with a pale green to olive periostracum. The inside of the shell is pearly (nacreous) with a narrow pallial line and distinct anterior and posterior adductor scars. This genus is unusual in that the byssus threads used to fix it to the substratum are woven into a nest or cage, that may incorporate macroalgae (e.g., *Fucus* spp. and *Laminaria* spp.). This species lays its eggs in mucus strings that are retained within the byssal nest.

Recorded distribution in Britain and Ireland

Common around most of the British Isles from Shetland to the Channel Isles.

Global distribution

A panartic bivalve, found from the Arctic Circle south through the Bering Sea to Japan or to the Puget Sound in the Pacific or south to New York or Madeira in the Atlantic, including the western Baltic and Mediterranean.

Habitat

Found in scattered, gregarious clumps growing epiphytically on the holdfasts of seaweeds and amongst faunal turfs from the lower intertidal to the circalittoral subtidal on most substrata. It occasionally forms extensive, dense aggregations covering upward facing rock surfaces.

Depth range

Intertidal to ca 50m deep.

Identifying features

- Shell rhomboidal in outline usually up to 12 mm in length.
- Shell brittle, equivalve, and inequilateral.
- Yellow to brownish in colour with a pale green to olive periostracum.
- Beaks short distance from anterior end.
- External ligament deeply inset and hinge teeth simple.
- Anterior region of shell with 9-12 radiating ribs.
- Posterior region with 30-45 finer, radiating ribs and fine concentric lines.
- Posterior adductor scar fat, anterior scar long and thin.
- Pallial line narrow.
- Margin smooth but crenulate where radiating ribs meet the margin.

Additional information

The nest completely encloses the adult so that *Musculus discors* is only visible when its valves are open and it is feeding. Smooth specimens, lacking ribs, were reported from Oban and Staffa, in the Hebrides (Jeffreys, 1863).

Listed by

Further information sources

Search on:

NBN WoRMS

Biology review

Taxonomy

Phylum	Mollusca	Snails, slugs, mussels, cockles, clams & squid
Class	Bivalvia	Clams, cockles, mussels, oysters, and scallops
Order	Mytilida	Mussels & crenellas
Family	Mytilidae	
Genus	Musculus	
Authority	(Linnaeus, 1767)	
Recent Synonyms	Modiolaria discors (Linnaeus, 1767)	

Biology

Typical abundance	High density
Male size range	
Male size at maturity	
Female size range	Small(1-2cm)
Female size at maturity	
Growth form	Bivalved
Growth rate	See additional text
Body flexibility	None (less than 10 degrees)
Mobility	
Characteristic feeding method	Active suspension feeder
Diet/food source	
Typically feeds on	Phytoplankton, bacteria, organic particulates and dissolved organic matter (DOM).
Sociability	
Environmental position	Epilithic
Dependency	Independent.
Supports	Host ciliate parasites or commensals and trematode metacercariae.
Is the species harmful?	No information

Biology information

Abundance

Musculus discors usually occurs as distinct clumps but occasionally forms dense, extensive beds (Könnecker & Keegan, 1983; Cartlidge & Hiscock, 1980; Hiscock, 1984b; Baldock *et al.*, 1998).

Habit

Adults attach to their substratum using byssus threads. They then weave a 'nest' of several thousand of fine byssus threads around their shell, so that the shell is suspended in a network of byssus threads, similar to a 'ball of twine' . The byssus threads are not attached to the shell but only emanate from the byssal aperture. The nest completely encloses the adult so that the crenella is only visible when its valves are open and it is feeding with siphons extended (MacGinitie, 1955; Merrill & Turner, 1963). An adult may produce between 200 -500 threads/ week (Merrill & Turner, 1963). Nest construction is detailed by Merrill & Turner (1963).

The nest may incorporate a variety of pieces of seaweeds or detritus or may be fouled by epifauna, the exact composition depending on the location and habitat, which provide camouflage. For example, the nest may incorporate; the stolons of hydroids, bryozoans, small bivalves and annelids (MacGinitie, 1955; Merrill & Turner, 1963); fragments of *Flustra foliacea* (Forbes & Hanley, 1853), or fragments or blades of fucoids and laminarians (Thorson, 1935).

MacGinitie (1955) noted that specimens from East Greenland >20mm were nearly always covered by a byssal nest. However, in British Columbia Merrill & Turner (1963) noted that the smallest specimens with nests were 8.1mm in length and most specimens over 15mm had nests, although some specimens up to 18mm in length were without a nest.

Growth
Thorson (1935) reported that *Musculus discors* was 5-7mm in length by the first growth ring (presumably Ist year), 10 -11mm by the second and 13 -16mm by the third (presumably 3rd year) in east Greenland, however, growth rates will probably depend on environmental conditions.

Little other information on the biology of *Musculus discors* was found.

Habitat preferences

Physiographic preferences	Open coast, Strait / sound, Sea loch / Sea lough, Ria / Voe, Enclosed coast / Embayment
Biological zone preferences	Lower eulittoral, Lower infralittoral, Sublittoral fringe, Upper circalittoral, Upper infralittoral
Substratum / habitat preferences	Macroalgae, Bedrock, Gravel / shingle, Large to very large boulders, Mud, Small 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, Extremely sheltered, Moderately exposed, Sheltered, Very sheltered
Salinity preferences	Full (30-40 psu), Variable (18-40 psu)
Depth range	Intertidal to ca 50m deep.
Other preferences	No text entered
Migration Pattern	Non-migratory / resident

Habitat Information

Musculus discors forms gregarious clumps on the holdfasts of seaweeds, especially *Corallina officinalis*, *Fucus* spp. *Laminaria* spp. and *Desmarestia* sp. On laminarians, *Musculus discors* may cover the holdfast and bottom part of the stipe (Jeffreys, 1863; Ockelmann, 1958; Tebble, 1976). Small specimens (<20mm) were reported nestled in interstices between barnacles and the old holdfasts of tunicates (MacGinitie, 1955). Merrill & Turner (1963) found *Musculus discors* fouling the upper surface of the sea scallop *Placopecten magellanicus*.

Most records reported *Musculus discors* in the shallow subtidal to depths of up to 50m in the British

Isles. However, it has been reported to be abundant above 30-40m in east Greenland, to form a well developed community at 60-100m in the Fosse de la Hague in the English Channel (Cabioch, 1968), to occur from 0 -374m in the Barents Sea (Ockelmann, 1958), and to be common in most trawls from 130-741 ft (ca 39-225m) at Point Barrow, Alaska (MacGinitie, 1955).

Musculus discors occasionally forms dense aggregations, especially in strong tidal streams, covering rock surfaces, forming the biotope MCR.Mus.

Life history

Adult characteristics

Reproductive type	Protandrous hermaphrodite
Reproductive frequency	Annual episodic
Fecundity (number of eggs)	No information
Generation time	2-5 years
Age at maturity	See additional text
Season	Insufficient information
Life span	2-5 years

Larval characteristics

Larval/propagule type	-
Larval/juvenile development	Direct development
Duration of larval stage	Not relevant
Larval dispersal potential	See additional information
Larval settlement period	Not relevant

Life history information

Musculus discors is a protandrous hermaphrodite, male when small then becoming female when larger and older. One year olds are functionally male. In the following year eggs begin to develop and individuals pass through a hermaphroditic phase (2-3years olds) becoming functional females by the third year of life (Thorson, 1935; Ockelmann, 1958). Some third year individuals were found to be functionally male, suggesting that reversion may occur (Thorson, 1935).

Large eggs (300 by 220 µm) are laid in 3-4 rows in mucus strings within the adult nest. Embryos of 400µm in length are found in the mucus strings. Development is direct, there is no pelagic phase, the juveniles leave the egg string as free-living crawl-aways (Thorson, 1935; Ockelmann, 1958).

Eggs are laid throughout summer, with a peak in August in east Greenland (Thorson, 1935; Ockelmann, 1958). Egg strings were found in May in the Holbaek fjord in the &#216resund Sound, Denmark (Thorson, 1946). Martel & Chia (1991) reported a peak of juveniles in British Columbia during summer. However, no information on reproduction in the UK was found.

Brooding of offspring is a common trait in boreal and arctic marine benthic invertebrates

(Ockelmann, 1958; 1965). Small juvenile *Musculus discors* often remain within the nest, near the edge of the adult shell, feeding in the currents produced by the adult, and larger juveniles may be found in the outer fringes of the nest (Merrill & Turner, 1963). Brooding and low levels of vagility may explain the dense aggregation and gregarious clumps of individuals found in this species but suggests that dispersal is poor. However, Martel & Chia (1991) reported that juvenile *Musculus discors* (<1 mm) were caught in off-bottom intertidal collectors and one specimen in offshore collectors. Therefore, juvenile *Musculus discors* are probably capable of drifting on fine byssal threads (bysso-pelagic transport) and may be carried considerable distances, albeit in small numbers.

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	Moderate	Moderate	Low

Removal of the substratum whether the macroalgae to which *Musculus discors* was attached, or the rocky substratum itself will result in loss of the population. Therefore, an intolerance of high has been recorded.
Recoverability will depend on recruitment from adjacent or nearby population and may take many years (see additional information below).

Smothering	High	Moderate	Moderate	Low

Musculus discors lives in fixed nests of byssus threads on the surface of the substratum. While the nest will protect the bivalve from the direct effects of smothering, they are unlikely to be able to burrow up through deposited spoil or other smothering agent. Smothered individuals will probably succumb to the effects of anoxia. Individuals on raised substrata such as the stipe of kelps may escape the effects of smothering. However, overall an intolerance of high has been recorded.
Recoverability will depend on recruitment from adjacent or nearby population and may take many years (see additional information below).

Increase in suspended sediment	Low	Immediate	Not sensitive	Low

Dense beds of *Musculus discors* in the north of the Lleyn Peninsula and Holy Island, Anglesey were reported to covered by a thick layer of mucous congealed fine silt and their own pseudofaeces (Hiscock, 1984; Brazier *et al.*, 1999). The byssus nest probably provides protection from accumulating silt. Brazier *et al.* (1999) reported that the waters around Holy Island where the *Musculus discors* beds were found, were highly turbid, and restricted kelps to the level of chart datum and red algae to depths of only 3-4m. Other dense aggregations of *Musculus discors* were reported from areas of strong tidal streams and presumably low levels of suspended sediment and siltation. Therefore, *Musculus discors* is probably tolerant of a wide range of suspended sediment levels and an intolerance of low has been recorded.

Decrease in suspended sediment	Low	Immediate	Not sensitive	Low

Musculus discors probably occurs in a wide range of suspended sediment conditions (see above). It is partly dependant on suspended sediment for food, so that a decrease may reduce food availability and hence, growth and reproduction but is unlikely to be lethal. In areas of strong tidal streams water flow probably carries adequate food particles. Therefore, an intolerance of low has been recorded.

Dessication	Intermediate	High	Low	Low

Intertidal populations of *Musculus discors* are likely to be affected by desiccation. The nest and attached debris and fauna probably provide protection from desiccation by retaining moisture. Individuals occupying interstices or the holdfasts of seaweeds will gain additional protection. For example, the fronds of *Corallina officinalis* retain water at low tide and support

a more diverse fauna than the surrounding habitat (see species review). However, an increase in desiccation at the benchmark level is likely to reduce the upper shore extent of the population, and an intolerance of intermediate has therefore been recorded.
Recovery will probably take up to 5 years (see additional information below).

Increase in emergence regime	Intermediate	High	Low	Low

An increase in emergence may move a normally subtidal population into the intertidal or increase the desiccation risk of a normally intertidal population. Therefore, the extent or abundance of the population may be reduced, and an intolerance of intermediate has been recorded. Recovery will probably take up to 5 years (see additional information below).

Decrease in emergence regime	Tolerant*	Not relevant	Not sensitive*	

A decrease in emergence may allow a formerly intertidal population to expand in extent and/or abundance. Therefore, the population may benefit.

Increase in water flow rate	Intermediate	High	Low	Very low

Musculus discors has been recorded from weak to strong tidal streams. It is, therefore, tolerant of water flow within this range. An increase to very strong tidal streams may result in loss of a proportion of the population physically removed by water flow, either due to removal of the animal itself or removal of the algae to which it was attached. Therefore, an intolerance of intermediate has been recorded. Recovery will probably take up to 5 years (see additional information below).

Decrease in water flow rate	Low	Immediate	Not sensitive	

Musculus discors has been recorded from weak to strong tidal streams. It is, therefore, tolerant of water flow within this range. Therefore an intolerance of low has been recorded. A further decrease in water flow to negligible may result in a stagnant deoxygenated water (see deoxygenation) and increased siltation (see above).

Increase in temperature	Tolerant	Not relevant	Not sensitive	Low

Musculus discors has a wide distribution extending from the Arctic Circle to the Mediterranean in western Europe. It is, therefore, unlikely to be affected by increases in temperature in British waters. Könnecker (1977) also suggested that the *Musculus discors* association was eurythermal. Short term acute change may have adverse effects, however, the nest and associated fauna may buffer the species against rapid change in temperature but no information was found.

Decrease in temperature	Tolerant	Not relevant	Not sensitive	Low

Musculus discors has a wide distribution extending from the Arctic Circle to the Mediterranean in western Europe. It is, therefore, unlikely to be affected by decreases in temperatures or winter temperatures in British waters. Könnecker (1977) also suggested that *Musculus discors* was eurythermal. Short term acute change may have adverse effects, however, the nest and associated fauna may buffer the species against rapid change in temperature but no information was found.

Increase in turbidity	Low	Very high	Very Low	Very low

Increased turbidity will reduce phytoplankton productivity and may reduce food availability for *Musculus discors*, however, it is probably capable of utilizing other organic particulates so that the effects would probably be sub-lethal. Increased turbidity will also decrease the depth to which kelps and other macroalgae can grow, reducing their availability as substratum for *Musculus discors*. However, *Musculus discors* can utilize other substrata such as tunicate holdfasts, animal turfs or hard substrata and is unlikely to be adversely affected. Therefore, an intolerance of low has been recorded.

Decrease in turbidity Tolerant* Not relevant Not sensitive*

Decreased turbidity will result in increased light penetration, macroalgal growth and phytoplankton productivity, both of which may benefit *Musculus discors* by providing additonal substratum for colonization and food respectively.

Increase in wave exposure Intermediate High Low Very low

Musculus discors has been reported from wave exposed to extremely wave sheltered habitats and is therefore relatively insensitive to changes in wave exposure within this range. Populations attached to seaweeds are likely to be more intolerant, where the seaweed itself is removed or damaged by increased wave action. Should the wave exposure increase from exposed to extremely exposed, *Musculus discors* may be removed, even in the shallow subtidal, where the oscillatory water flow generated by wave action is likely to dislodge and remove at least a proportion of the population. Therefore, an intolerance of intermediate has been recorded. Recovery will probably take up to 5 years (see additional information below).

Decrease in wave exposure Not relevant Not relevant Not relevant Low

Musculus discors has been reported from wave exposed to extremely wave sheltered habitats and is therefore relatively insensitive to changes in wave exposure within this range. A further decrease in wave action is unlikely.

Noise Tolerant Not relevant Not sensitive High

Musculus discors can probably detect local vibrations associated with predators, resulting in closure of its valves and nest. However, it is unlikely to respond to noise at the benchmark level.

Visual Presence Tolerant Not relevant Not sensitive High

Musculus discors can probably detect shading but is likely to have only limited visual acuity, if any, and is unlikely to be affected by visual disturbance.

Abrasion & physical disturbance Intermediate High Low Low

Musculus discors has a reasonably tough shell. The byssus nest is made of fine threads and is likely to afford little protection against abrasion or physical damage. It is likely that physical disturbance at the benchmark level would physically remove some individuals from their substratum and break the shells of some individuals, depending on their size. *Musculus discors* may be affected indirectly by physical disturbance that removes macroalgae to which they are attached. Therefore an intolerance of intermediate has been recorded. Recovery will probably take up to 5 years (see additional information below).

Displacement Low Very high Very Low Low

Once displaced, *Musculus discors*, can re-attach to suitable substrata using its byssal threads and then weave another nest (Merrill & Turner, 1963). Specimens produced between 200 -500 byssus threads per week and the finished nest consists of thousands of byssus threads and attached detritus (Merrill & Turner, 1963). Overall, once displaced onto suitable substratum an individual could rebuild its nest, at energetic cost, within about a month. Therefore, the intolerance has been assessed as low and recoverability as very high.

Chemical Pressures

Intolerance Recoverability Sensitivity Confidence

Synthetic compound contamination Intermediate High Low Very low

No information concerning the effects of contaminants on *Musculus discors* was found. However, PAHs contributed to a reduced scope for growth in *Mytilus edulis* (Widdows *et al.*, 1995) and may have a similar effect in other members of the Mytilidae family but to an unknown degree. Similarly, Tri butyl-tin (TBT) was reported to affect bivalve molluscs as follows: reduced spatfall in *Pecten maximus*, *Musculus marmoratus* and *Limaria hians*; inhibition of growth in *Mytilus edulis* larvae, and inhibition of growth and metamorphosis in *Mercenaria mercenaria* larvae (Bryan & Gibbs, 1991). TBT is an endocrine disrupter and may adversely affect the normal transition from male to female in protandrous development of *Musculus discors*, however, no evidence to this effect was found. It is possible, therefore, that *Musculus discors* is likely to be adversely affected and even killed by synthetic chemical contamination. An intolerance of intermediate has been suggested but at very low confidence. Recovery will probably take up to 5 years (see additional information below).

Heavy metal contamination Not relevant Not relevant

Bryan (1984) stated that Hg is the most toxic metal to bivalve molluscs while Cu, Cd and Zn seemed to be most problematic in the field. In bivalve molluscs Hg was reported to have the highest toxicity, decreasing from Hg > Cu and Cd > Zn > Pb and As > Cr (in bivalve larvae, Hg and Cu > Zn > Cd, Pb, As, and Ni > to Cr). Crompton (1997) reported that adult bivalve mortalities occurred after 4-14 day exposure to 0.1-1 g/l Hg, 1-10 g/l Cu and Cd, 10-100 g/l Zn but 1-10 mg/l for Pb and Ni.
However no information on the effects of heavy metal contamination in *Musculus discors* was found and no assessment could be made.

Hydrocarbon contamination Low Very high Very Low Very low

Suchanek (1993) noted that sub-lethal levels of oil or oil fractions reduce feeding rates, reduce respiration and hence growth, and may disrupt gametogenesis in bivalve molluscs. Widdows *et al.* (1995) noted that the accumulation of PAHs contributed to a reduced scope for growth in *Mytilus edulis*. *Musculus discors* may exhibit similar response to hydrocarbon contamination but no information was found. Intertidal populations may become smothered by oil (see smothering).
In the absence of specific information on *Musculus discors* but with evidence from other bivalve molluscs above, an intolerance of low has been suggested, albeit at very low confidence.

Radionuclide contamination Not relevant Not relevant

Insufficient information

Changes in nutrient levels Tolerant* Not relevant Not sensitive* Very low

Moderate increases in nutrient levels may benefit *Musculus discors* by increasing macroalgal and phytoplankton productivity, increasing the proportion of organic particulates and hence increasing the food supply. However, Shumway (1990) reported the toxic effects of algal blooms on commercially important bivalves. This would suggest that prolonged or acute nutrient enrichment may have adverse effects on suspension feeding bivalves such as *Musculus discors*. Nutrient enrichment may also lead to increased turbidity (see above) and decreased oxygen levels due to bacterial decomposition of organic material (see below). However, *Musculus discors* would probably benefit from increased nutrients at the benchmark level.

Increase in salinity Not relevant Not relevant Not relevant Not relevant

Musculus discors occurs in variable and full salinity conditions. Therefore, a further increase in salinity is unlikely.

Decrease in salinity Intermediate High Low

Musculus discors occurs in variable and full salinity conditions. Könnecker (1977) suggested that *Musculus discors* associations were euryhaline but without explanation. *Musculus discors* was recorded from fjordic waters in East Greenland that varied between 25-30 psu (Ockelmann, 1958) and from Loch Strom, Shetland that varied between 18-35psu (Thorpe, 1998). Intertidal populations of *Musculus discors* are probably exposed to freshwater runoff and rainfall. Therefore, *Musculus discors* is probably tolerant of a reduction in salinity from full to variable, and a short term decrease to reduced but would probably be adversely affected by a long term reduction in salinity. Therefore an intolerance of intermediate has been recorded in the absence of further evidence. Recovery will probably take up to 5 years (see additional information below).

Changes in oxygenation Intermediate High Low Very low

De Zwaan & Mathieu (1992) suggested that members of the family Mytilidae were facultative anaerobes (capable of anaerobic respiration but preferring aerobic respiration) and were tolerant of a wide range of oxygen concentrations (euryoxic). The majority of evidence is derived from the study of *Mytilus* spp. and no information was found on *Musculus* spp. However, *Musculus discors* probably exhibits facultative anaerobiosis and is probably tolerant of a degree of hypoxia. Therefore, an intolerance of intermediate has been recorded albeit at very low confidence. Recovery will probably take up to 5 years (see additional information below).

Biological Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Introduction of microbial pathogens/parasites	Low	Very high	Very Low	Low

Musculus discors was reported to host the ciliate *Hypocomides musculus*, which was either parasitic or commensal. The metacercariae of the trematode *Gymnophallus*spp. were also reported to use *Musculus discors* as a secondary host (Lauckner, 1983). However, no effects were given. It is likely that any parasitic infestation will result in at least sub-lethal effects, therefore an intolerance of low has been recorded.

	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

Musculus discors is not known to be subject to extraction.

	Intolerance	Recoverability	Sensitivity	Confidence
Extraction of other species	Intermediate	High	Low	Low

Musculus discors is often found epiphytically on fucoids, laminarians and *Desmarestia* sp. Fucoids and laminarians are subject to harvesting and aquaculture (see *Laminaria hyperborea* for example). Therefore, removal of the macroalgae will result in removal of substratum and attached *Musculus discors*. However, members of the population on the surrounding rocky substratum may be unaffected, and removal of macroalgae may provide new substratum for colonization. Therefore, an intolerance of intermediate has been recorded at the benchmark level. Recovery will probably take up to 5 years (see additional information below).

Additional information

Recoverability

No information concerning recruitment or recovery in *Musculus discors* was found. Brooding *Musculus discors* produces relatively few offspring; tens of eggs and offspring rather than hundreds of thousands of eggs in the spawning mytilids such as *%Mytilus edulis%*. However, brooding probably results in relatively lower levels of juvenile mortality. Therefore, within populations recruitment is likely to be good.

Martel & Chia (1991) suggested that in species that brood their offspring (such as *Musculus discors*) bysso-pelagic drifting probably contributed to rapid local dispersal and recruitment and could be one factor responsible for the wide geographical distribution of many species with direct development. Therefore, local recruitment in *Musculus discors* may be rapid, depending on the hydrographic regime. Hence, within a population or between adjacent populations recruitment and recovery is probably fairly rapid, and it is suggested that prior abundance may recover within up to 5 years.

However, where recovery is dependant on recruitment from distant populations recruitment may take longer. Colonization by bysso-pelagic drifting may partly explain the wide boreal distribution of this species, however, it is probably a slow, and random process, primarily dependant on the hydrographic regime. Where a population is removed, recovery will depend on recruitment from nearby populations by drifting, followed by subsequent expansion of the population. The species is widespread so that a ready supply of juveniles will probably be present, albeit in small numbers. Therefore, it is suggested that recovery after removal of a population may take about 5 to 10 years.

Importance review

Policy/legislation

- no data -

Status

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

Non-native

Native	-		
Origin	-	**Date Arrived**	Not relevant

Importance information

The extensive, dense aggregations formed occasionally by *Musculus discors* were considered to be uncommon in the British Isles (see MCR.Mus; Connor *et al.*, 1997a).

Bibliography

Baldock, B.M., Mallinson, J.M. & Seaward, D.R., 1998. Observations on extensive, dense populations of the bivalve mollusc *Musculus discors* (L. 1758). *Journal of Conchology*, **36**, 43-46.

Brazier, D.P., Holt, R.H.F., Murray, E. & Nichols, D.M., 1999. *Marine Nature Conservation Review Sector 10. Cardigan Bay and North Wales: area summaries.* Peterborough: Joint Nature Conservation Committee. [Coasts and seas of the United Kingdom. MNCR Series.]

Bruce, J.R., Colman, J.S. & Jones, N.S., 1963. *Marine fauna of the Isle of Man.* Liverpool: Liverpool University Press.

Bryan, G.W. & Gibbs, P.E., 1991. Impact of low concentrations of tributyltin (TBT) on marine organisms: a review. In: *Metal ecotoxicology: concepts and applications* (ed. M.C. Newman & A.W. McIntosh), pp. 323-361. Boston: Lewis Publishers Inc.

Bryan, G.W., 1984. Pollution due to heavy metals and their compounds. In *Marine Ecology: A Comprehensive, Integrated Treatise on Life in the Oceans and Coastal Waters*, vol. 5. *Ocean Management*, part 3, (ed. O. Kinne), pp.1289-1431. New York: John Wiley & Sons.

Cartlidge, D. & Hiscock, K., 1980. South west Britain sub-littoral survey: field survey of sublittoral habitats and species in North Pembrokeshire. *Nature Conservancy Council, Peterborough, CSD Report*, no. 295.

Connor, D.W., Dalkin, M.J., Hill, T.O., Holt, R.H.F. & Sanderson, W.G., 1997a. Marine biotope classification for Britain and Ireland. Vol. 2. Sublittoral biotopes. *Joint Nature Conservation Committee, Peterborough, JNCC Report* no. 230, Version 97.06., *Joint Nature Conservation Committee, Peterborough, JNCC* Report no. 230, Version 97.06.

Crompton, T.R., 1997. *Toxicants in the aqueous ecosystem.* New York: John Wiley & Sons.

Fish, J.D. & Fish, S., 1996. *A student's guide to the seashore.* Cambridge: Cambridge University Press.

Forbes, E. & Hanley, S., 1853. *A history of British Mollusca and their shells, vol. 1-4.* London: John van Voorst.

Hiscock, K., 1984b. Sublittoral surveys of Bardsey and the Lleyn peninsula. August 13th to 27th, 1983. *Report prepared by the Field Studies Council, Oil Pollution Research Unit, Pembroke for the Nature Conservancy Council, CSD Report*, no. 612.

Howson, C.M. & Picton, B.E. ed., 1999. *The species directory of the marine fauna and flora of the British Isles and surrounding seas. CD-ROM Edition.* Ulster Museum and The Marine Conservation Society, Belfast and Ross-on-Wye., Belfast: Ulster Museum. [Ulster Museum publication no. 280.]

Jeffreys, J.G., 1863. *British conchology, or an account of the mollusca which now inhabit the British Isles and surrounding seas, vol. 1-5.* London: John van Voorst.

Könnecker, G., 1977. Epibenthic assemblages as indicators of environmental conditions. In *Proceedings of the 11th Symposium on Marine Biology, Galway, October 1976. Biology of Benthic Organisms* (ed. B.F. Keegan, P.O. Ceidigh, & P.J.S. Boaden), pp. 391-395. Oxford: Pergamon Press.

Könnecker, G.F. & Keegan, B.F., 1983. Littoral and benthic investigations on the west coast of Ireland - XVII. The epibenthic animal associations of Kilkieran Bay. *Proceedings of the Royal Irish Academy Section B*, **83B**, 309-324.

Lauckner, G., 1983. Diseases of Mollusca: Bivalvia. In *Diseases of marine animals.* Vol. II. *Introduction, Bivalvia to Scaphopoda* (ed. O. Kinne), pp. 477-961. Hamburg: Biologische Anstalt Helgoland.

MacGinitie, G.E., 1955. Distribution and ecology of the marine invertebrates of Point Barrow, Alaska. *Smithsonian Miscellaneous Collections*, **128**, 1-201.

Martel, A. & Chia, F.S., 1991b. Drifting and dispersal of small bivalves and gastropods with direct development. *Journal of Experimental Marine Biology and Ecology*, **150**, 131-147.

Merrill, A.S. & Turner, R.D., 1963. Nest building in the bivalve genera *Musculus* and *Lima*. *Veliger*, **6**, 55-59.

Morton, B., 1992. The evolution and success of the heteromyarian form in the Mytiloida. In *The mussel* Mytilus*: Ecology, physiology, genetics and culture,* (ed. E.M. Gosling), pp. 21-52. Amsterdam: Elsevier Science Publ. [Developments in Aquaculture and Fisheries Science, 25]

Murray, E., Dalkin, M.J., Fortune, F. & Begg, K., 1999. *Marine Nature Conservation Review Sector 2. Orkney: area summaries.* Peterborough: Joint Nature Conservation Committee. [Coasts and sea of the United Kingdom. MNCR Series.]

Ockelmann, W.K., 1958. The zoology of east Greenland. Marine Lamellibranchiata. *Meddelelser om Grønland*, **122**, 1-256.

Phorson, J.E., 1996. Observations on the development of dentition in small juveniles of certain species of Mytilidae. *The Conchologists Newsletter*, **136**, 603-623.

Seaward, D.R., 1990. *Distribution of marine molluscs of north west Europe.* Peterborough: Nature Conservancy Council.

Suchanek, T.H., 1993. Oil impacts on marine invertebrate populations and communities. *American Zoologist*, **33**, 510-523.

Tebble, N., 1976. *British Bivalve Seashells. A Handbook for Identification,* 2nd ed. Edinburgh: British Museum (Natural History), Her Majesty's Stationary Office.

Thorpe, K., 1998. *Marine Nature Conservation Review, Sectors 1 and 2. Lagoons in Shetland and Orkney*. Peterborough: Joint Nature Conservation Committee. [Coasts and seas of the United Kingdom. MNCR Series.]

Thorson, G. von, 1935. Biologische Studien über die Lamellibranchier *Modiolaria discors* L. und *Modiolaria nigra* Gray in Ostgrönland. *Zoologischer Anzeiger*, **111**, 297-304.

Thorson, G., 1946. Reproduction and larval development of Danish marine bottom invertebrates, with special reference to the planktonic larvae in the Sound (Øresund). *Meddelelser fra Kommissionen for Danmarks Fiskeri- Og Havundersögelser, Serie: Plankton*, **4**, 1-523.

Zwaan de, A. & Mathieu, M., 1992. Cellular biochemistry and endocrinology. In *The mussel* Mytilus*: ecology, physiology, genetics and culture*, (ed. E.M. Gosling), pp. 223-307. Amsterdam: Elsevier Science Publ. [Developments in Aquaculture and Fisheries Science, no. 25]

Datasets

Centre for Environmental Data and Recording, 2018. Ulster Museum Marine Surveys of Northern Ireland Coastal Waters. Occurrence dataset https://www.nmni.com/CEDaR/CEDaR-Centre-for-Environmental-Data-and-Recording.aspx accessed via NBNAtlas.org on 2018-09-25.

Conchological Society of Great Britain & Ireland, 2018. Mollusc (marine) data for Great Britain and Ireland - restricted access. Occurrence dataset: https://doi.org/10.15468/4bsawx accessed via GBIF.org on 2018-09-25.

Conchological Society of Great Britain & Ireland, 2018. Mollusc (marine) data for Great Britain and Ireland. Occurrence dataset: https://doi.org/10.15468/aurwcz accessed via GBIF.org on 2018-09-25.

Environmental Records Information Centre North East, 2018. ERIC NE Combined dataset to 2017. Occurrence dataset: http://www.ericnortheast.org.uk/home.html accessed via NBNAtlas.org on 2018-09-38

Manx Biological Recording Partnership, 2018. Isle of Man historical wildlife records 1990 to 1994. Occurrence dataset:https://doi.org/10.15468/aru16v accessed via GBIF.org on 2018-10-01.

NBN (National Biodiversity Network) Atlas. Available from: https://www.nbnatlas.org.

OBIS (Ocean Biogeographic Information System), 2019. Global map of species distribution using gridded data. Available from: Ocean Biogeographic Information System. www.iobis.org. Accessed: 2019-03-21