Thick top shell (*Phorcus lineatus*)

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

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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/1324]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

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Phorcus lineatus **on intertidal rock.**
Photographer: Keith Hiscock
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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	Nova Mieszkowska	**Refereed by**	This information is not refereed.
Authority	(da Costa, 1778)		
Other common names	-	**Synonyms**	*Monodonta lineata* (da Costa, 1778), *Trochocochlea lineata* , *Turbo lineatus* , *Osilinus lineatus*

Summary

Description

Phorcus lineatus is the largest intertidal trochid in Britain. The shell is a turbinate spire consisting of up to six whorls. The last whorl dominates the shell and ends in a circular aperture, with a prominent 'tooth' or bulge on the nacreous (mother-of-pearl) inner shell layer. The outer lip of the aperture is thinner than the rest of the shell. Shell colour varies between dark green, grey and black, with complex brown or purple zigzag markings. The shell can reach up to 3cm in height (Graham, 1988) and 3cm basal diameter and is thicker and heavier than other species of topshell found in Britain. Shell growth lines are visible (Desai, 1966; Fretter & Graham, 1977; Williamson & Kendall, 1981). Erosion of the outer layer of the shell at the apex is common in older animals and the pearly inner layer of the shell can show through. The animal itself is mostly pink in colour. Two stalked eyes and a pair of sensory tentacles are located on the head above a well developed snout. The grey muscular foot lies underneath and slightly ventral to the head. Three pairs of sensory tentacles are present on the outside of the foot and are extended when the animal is active (Crothers, 2001).

Recorded distribution in Britain and Ireland

Abundant on rocky shores in Britain reaching its northern limits on Anglesey & eastern limits at Osmington Mills, Dorset (pers. obs.). Absent from Scotland & the east coast of England. Range from Churchtown to Malin Head in Ireland.

Global distribution

Found in the north eastern Atlantic from Morocco to Cap de la Hague, France on mainland Europe (Crisp & Southward, 1958; Fretter & Graham 1977). Northern limits reached in North Wales and North Ireland.

Habitat

Occurs in the midshore region of moderately exposed rocky shores in England and Wales. Requires a stable boulder field or broken shore with available bare rock.

Depth range

MHWS to MLWS

Identifying features

- Pronounced tooth or notch on aperture.
- Shell has up to 6 whorls.
- Shell dark green, grey or black with brown or red zigzag markings
- Underside pearly-white.

Additional information

Also commonly known as the toothed top shell. Irregular damage lines may be visible on the shell if the animal has experienced environmental shock or has been attacked by predators.

Listed by

Further information sources

Search on:

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Biology review

Taxonomy

Phylum	Mollusca	Snails, slugs, mussels, cockles, clams & squid
Class	Gastropoda	Snails, slugs & sea butterflies
Order	Trochida	
Family	Trochidae	
Genus	Phorcus	
Authority	(da Costa, 1778)	
Recent Synonyms	Monodonta lineata (da Costa, 1778)Trochocochlea lineata Turbo lineatus Osilinus lineatus	

Biology

Typical abundance	High density
Male size range	13-30mm
Male size at maturity	13+ mm
Female size range	13+ mm
Female size at maturity	
Growth form	Turbinate
Growth rate	See additional information
Body flexibility	None (less than 10 degrees)
Mobility	
Characteristic feeding method	
Diet/food source	
Typically feeds on	Microalgae
Sociability	
Environmental position	Epilithic
Dependency	Independent. None
Supports	None
Is the species harmful?	No

Biology information

Growth Rate

Initially rapid, *Phorcus lineatus* can grow up to 7-8mm in diameter between spawning and December (Fretter & Graham, 1977; Kendall *et al.*,1987), although the average size of newly settled animals is around 3mm (pers. obs.). Growth slows down and may stop in the first winter and every successive winter, before increasing in spring (Williams, 1965). One year post settlement, juveniles can reach 11-15mm (Fretter & Graham 1977, Fretter, 1988). Growth slows in adults when they become sexually mature but continues throughout the life of the animal.

Feeding

Phorcus lineatus feeds on microscopic algae, which it grazes from rock surfaces using a brush-like radula on the tongue. Feeding is assumed to occur at night or during high water (Crothers, 2001) as

no observations of feeding during daylight or at low water have been published.

Respiration
Phorcus lineatus has a gill for respiration in water and a well vascularised mantle cavity which allows the animal to breathe in air (Crothers, 2001).

Sensory
Phorcus lineatus detects its environment by means of two stalk eyes and a pair of sensory tentacles on the head, and three pairs of sensory tentacles on the foot.

Habitat preferences

Physiographic preferences	Open coast, Strait / sound, Sea loch / Sea lough, Estuary, Enclosed coast / Embayment
Biological zone preferences	Lower eulittoral, Mid eulittoral, Upper eulittoral
Substratum / habitat preferences	Bedrock, Large to very large boulders, Rockpools, 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.)
Wave exposure preferences	Exposed, Moderately exposed
Salinity preferences	Full (30-40 psu), Variable (18-40 psu)
Depth range	MHWS to MLWS
Other preferences	No text entered
Migration Pattern	Seasonal (reproduction)

Habitat Information

Phorcus lineatus is widely distributed on rocky shores between the 20 °C summer isotherm off Africa and the 6.5 °C winter isotherm off Anglesey. Northern limits are primarily set by reproductive failure (Lewis *et al.*, 1982; Lewis 1986; Kendall, 1986) but may also be determined by hydrography or unsuitable habitat (Crisp & Knight-Jones, 1953)

Juvenile *Phorcus lineatus* are found in nursery areas underneath boulders or in fissures. Adults crawl out of these damp areas onto the sides of boulders during warm, dry periods but tend to retreat to the lower surfaces of rocks when the weather is colder.

In early summer *Phorcus lineatus*adults migrate up shore to the high eulittoral prior to spawning. Once spawning has occurred the animals migrate back down shore to the mid to lower eulittoral zone to overwinter.

Life history

Adult characteristics

Reproductive type	Gonochoristic (dioecious)
Reproductive frequency	Annual protracted
Fecundity (number of eggs)	100-1,000

Generation time	2-5 years
Age at maturity	2 years
Season	May - August
Life span	11-20 years

Larval characteristics

Larval/propagule type	-
Larval/juvenile development	Lecithotrophic
Duration of larval stage	2-10 days
Larval dispersal potential	No information
Larval settlement period	Insufficient information

Life history information

Reproductive Cycle
Sexes are separate but the two sexes cannot be differentiated between by external examination (Fretter & Graham, 1977; Hickman, 1992). *Phorcus lineatus* has five stages to its reproductive cycle (Orton*et al.*, 1956; Desai, 1966). Onset of gonad maturation has been correlated with rising sea temperatures.

Stage I Late summer the gonad is inactive. Both male and female gonads are brown in colour and appear as loose, sac-like structures. Any oocytes present are smaller than 25 µm in diameter.
Stage II. In October the ovaries and testis both take on a greenish hue. Oocytes of up to 50 micrometres are present in females and spermatogonia are present in males.
Stage III. In early January, ovaries and testis are green, oocytes have grown to diameters greater than 50 µm. Spermatocytes and spermatids are present in males.
Stage IV. In February to May, ovaries are deep green in pigment and contain a mixture of mature and immature oocytes. Testis become pink in colour and contain spermatozoa.
Stage V. In May, ovaries are deep green and distended, oocytes are mostly mature. Testis are pink/cream and contain fully active spermatozoa.

Spawning
Adult *Phorcus lineatus*migrate upshore to the high eulittoral zone in early summer prior to spawning. It is thought that this migration brings the animals into a region of higher temperature required for spawning. Desai (1966) found that adults that had migrated furthest upshore were the first to spawn, supporting this idea.
Phorcus lineatus is a broadcast spawner (Underwood, 1972; Hickman, 1992). Males release clouds of white spermatozoa into the water column and females undergo repeated spasms, releasing a few eggs at a time from the mantle cavity into the water (Fretter & Graham 1977). Fertilization occurs externally.

The breeding season is shorter near to northern range limits, with a single spawning period. Towards the centre of the range the breeding season is longer and multiple spawning events occur (Garwood & Kendall, 1985, Bode *et al*,1986).

Larval Development

Eggs of diameters between 165-250 µm are released individually (Desai, 1966; Fretter & Graham, 1994). The external jelly coating swells on contact with water, making the egg initially buoyant. After 20 minutes the jelly coating disintegrates and the egg sinks. The eggs are lecithotrophic (contain yolk) and provide food for larval development until the larvae hatch as free swimming veligers after 29-30 hours. Six days after fertilization the larva has grown to approximately 1mm in diameter and has fully developed its crawling ability (Desai 1966, Fretter & Graham 1977). Larvae settle on the shore in the low eulittoral zone under boulders and in cracks and crevices.

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	High

Osilinus lineatus is epifaunal so loss of the substratum would result in the loss of the population, and an intolerance of high has been recorded. *Osilinus lineatus* cannot survive on or move over substrate consisting of fine, mobile sediment. Recolonization, recruitment and recovery are possible once the substrate is restored, or to neighbouring areas of suitable habitat as the adults are capable of migration and the planktonic stage of the lifecycle will facilitate limited dispersal from neighbouring populations (see additional information below).

Smothering	High	Moderate	Moderate	High

Smothering by 5 cm of sediment is highly likely to cause death. Respiration would be prevented and the microalgal food source would not grow under such conditions. Smothering of nursery areas under boulders would also prevent survival of juvenile recruits which depend on a coarse grained substrate to settle and over-winter on. Recruitment failure may result from a chronic deposition over a year or an acute episode coinciding with the peak juvenile settlement season in autumn. This is evident in Aberaeron, where regular recruitment occurred throughout the 1970s and 1980s (Kendal, 1987) but the population was severely reduced in 2002 due to heavy sedimentation of the habitat (Kendal *et al.* in submission). Recoverability is likely to be moderate (see additional information below).

Increase in suspended sediment	Intermediate	High	Low	Low

Deposition of suspended sediment may cause siltation of nursery areas, removing required habitat including nooks and crevices and prevent juveniles from settling and surviving. Recruitment failure may result from a chronic deposition over a year or an acute episode coinciding with the peak juvenile settlement season in autumn (see smothering above). Overall, an intolerance of intermediate has been recorded. Recoverability is likely to be high (see additional information below).

Decrease in suspended sediment	Tolerant	Not relevant	Not sensitive	Low

Osilinus lineatus is unlikely to be adversely affected by a decrease in suspended sediment (editors addition).

Dessication	Intermediate	High	Low	High

Osilinus lineatus can fully retract into its shell and seal the opening with an operculum to minimize desiccation. This species can be mobile, feeding and walking during periods of low tide when the animal is exposed to air if conditions are damp or it is disturbed. It is tolerant of extended periods (days) exposed to air, and positions itself on the tops of boulders during sunny days when the desiccation risk is higher. It migrates upshore in the spring prior to spawning and remains there until the end of summer. This is an active movement into an area of increased desiccation stress which suggests that this species has a high tolerance. Therefore, an intolerance of intermediate has been recorded. Recoverability is likely to be

high (see additional information below).

Increase in emergence regime Low High Low Low

Adults migrate upshore prior to spawning to a region where the emergence period is greater than lower down the shore. When specimens are returned to the laboratory they can survive for a week without submergence in seawater. The species can therefore tolerate a wide emergence regime.

Decrease in emergence regime

Increase in water flow rate Intermediate High Low High

Water flow rates may become high enough to prevent animals from maintaining contact with the rock surface when moving and feeding at high tide. Increased flow rates may also move the boulder substrate around more, causing dislodgement and abrasion of the animals. Therefore, an intolerance of intermediate has been recorded. Recoverability is likely to be high (see additional information below).

Decrease in water flow rate Intermediate High Low High

Osilinus lineatus is found in habitats with a range of flow rates including sheltered bays where flow rates are reduced. If the flow rate is too low and sediment drops out of suspension the habitat may be unsuitable for this species due to smothering of adults and nursery areas of juveniles (see smothering above). Therefore, an intolerance of intermediate has been recorded. Recoverability is likely to be high (see additional information below).

Increase in temperature Tolerant* Not relevant Not sensitive* High

Increasing air and sea temperatures allows *Osilinus lineatus* to colonize areas previously too cold. This is evident around British coasts as this species has increased its range during the current period of climate warming (Kendal *et al.*, in submission). *Osilinus lineatus* has a distribution range from Morocco to North Wales, where it reaches its northern limits. The average temperature gradient is approximately 6 °C between these locations. *Osilinus lineatus* can also tolerate the wide range of air and sea temperatures it is exposed to in the intertidal zone.

Decrease in temperature High Moderate Moderate Moderate

A decrease in temperature may prevent regular successful recruitment within a population and could lead to a localized extinction. A sudden, sharp decrease in temperatures during the winter of 1962/63 resulted in the loss of many populations in Britain (Crisp, 1964). Some populations close to the northern limits have still not recovered. Overall, an intolerance of high to acute temperature decrease has been recorded. Recoverability is likely to be moderate (see additional information below).

Increase in turbidity Low High Low Low

Increases in turbidity will probably not have much of a direct effect on this species. Reduced irradiance may decrease the productivity of the microalgal food source.

Decrease in turbidity Not relevant Not relevant

Insufficient information

Increase in wave exposure Intermediate High Low Moderate

Osilinus lineatus is typically found on moderately exposed shores but also occurs in small numbers on some shores where wave exposure is high. Individuals may survive an increase in wave exposure by becoming more cryptic in their habitat selection. If wave action is too strong

the animals may not be able to maintain their hold on the rock surface and may be washed off. Therefore, an intolerance of intermediate has been recorded. Recoverability is likely to be high (see additional information below).

Decrease in wave exposure Low High Low Moderate

Osilinus lineatus is also found in sheltered bays where there is little wave action. If the water movement is too low and sediment drops out of suspension the habitat may be unsuitable for this species due to smothering of adults and nursery areas of juveniles (see smothering above).

Noise Low Immediate Not sensitive Low

There is no evidence that noise adversely affects this species. They move towards localized drilling noise made by researchers on the shore (pers. obs.).

Visual Presence Low Immediate Not sensitive High

Adults do respond to visual presence by fully retracting into the shell, both when submerged and emersed. They do not close the operculum but remain attached to the rock by their foot. However, they re-emerge after a few minutes.

Abrasion & physical disturbance Low Moderate Low Moderate

Abrasion can cause shell damage. The outer, thinner, dark layer of the shell is often abraded in older animals to the extent that the mother-of-pearl inner layer is evident on the top two or three whorls. Abrasion marks are more common on animals living on more exposed shores. Overall, an intolerance of low has been recorded.

Displacement Intermediate High Low Moderate

Animals displaced from the rock surface quickly reattach themselves if not carried away in the water column, when they may be lost. Animals that are displaced will attach to nearby substrate providing that it is suitable. Therefore, an intolerance of intermediate has been recorded. Recoverability is likely to be high (see additional information below).

Chemical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Synthetic compound contamination		Not relevant		Not relevant

Insufficient information

Heavy metal contamination		Not relevant		Not relevant

Insufficient information

Hydrocarbon contamination	Intermediate	High	Low	Moderate

Adult *Osilinus lineatus* were seen to decline further in Milford Haven after the *Sea Empress* oil spill in 1996 (Little, 1999).

Radionuclide contamination		Not relevant		Not relevant

Insufficient information

Changes in nutrient levels	Low	High	Low	Low

It is unlikely that changes in nutrient levels will have a large effect on this species. Increase in the nutrient load of the water may lead to an increase in the microalgal food source. It has been suggested that toxic algal blooms may adversely affect this species but no direct evidence of this has been found.

Increase in salinity	Low	High	Low	Moderate

This species is found on open ocean coasts adjacent to oceanic waters and can tolerate salinities of around 33-35, which are typical of large water bodies. They also inhabit rockpools in the high mid shore zone. These pools are exposed for around 6 hours every day and evaporation can cause the salinity of the remaining water to become very high. *Osilinus lineatus* can tolerate such an increase in salinity and an intolerance of low has been recorded.

Decrease in salinity	Low	High	Low	Moderate

This species is found in large estuaries such as the Bristol Channel where salinities are less than at open coast locations. It is also found higher up the shore where small trickles of freshwater occur on the rock.

Changes in oxygenation	High	Moderate	Moderate	Moderate

Osilinus lineatus has the ability to breathe in air as well as water, due to a well vascularised mantle cavity used for respiration along with their gill (Crothers, 2001). It actively removes itself from the water when the tide is retreating and the oxygen content of residual water decreases. This behaviour suggests a high intolerance to low oxygen content in water which has resulted in a behavioural adaptation.

Biological Pressures

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

Lichomolgid copepods have been recorded inside *Osilinus lineatus*. However, no information concerning the effect of such infestation was found.

Introduction of non-native species	Intermediate	Not relevant		Low

Introduction of non-native topshells occupying a similar zone on the shore (e.g. *Gibbula pennanti*) may increase competition for food resources. Depending on which species is the competitive dominant, *Osilinus lineatus* may reduce the width of its zone or maintain its distribution and force the invasive species further down the shore into the low shore zone. Therefore, an intolerance of intermediate has been recorded. Recoverability would be dependent on the removal of the non-native species, which is probably unlikely to occur.

Extraction of this species	Intermediate	High	Low	Low

It is possible that *Osilinus lineatus* may be removed from the shore as misidentified *Littorina littorea* by winkle collectors due to their similar external appearance. On shores where *Osilinus lineatus* is rare or absent the topshell *Steromphala umbilicalis* can become more abundant in the mid shore zone where *Osilinus lineatus* would otherwise occur. This is likely to be the result of decreased competition for the detrital scraps of microalgae.

Extraction of other species	Intermediate	High	Low	Low

It is possible that *Osilinus lineatus* may be removed from the shore as misidentified *Littorina littorea* by winkle collectors due to their similar external appearance.

Additional information

Recoverability

Osilinus lineatus was severely affected on shores throughout Britain and Ireland during the cold

winter of 1962/63 (Crisp (ed.), 1964a). Populations were completely wiped out at many sites in north and south Wales (Crisp, 1964b, Moyse & Nelson-Smith 1964), and north east Ireland (Boaden *et al.*, 1964) and some have yet to become re-established. Recoverability has been low due to the latitudinal extent of the mortality, as this species has localized recruitment and there have been no neighbouring populations in the north of Wales to facilitate recolonization of these locations. It is highly likely that the range of *Osilinus lineatus* is temperature limited in Britain as range extensions past historical limits have occurred during the recent period of rapid climate warming (Kendal *et al.* in submission).

Osilinus lineatus is widely distributed on rocky shores between the 20 °C summer isotherm off Africa and the 6.5 °C winter isotherm off Anglesey. Northern limits are primarily set by reproductive failure (Lewis *et al.*, 1982; Lewis, 1986; Kendall, 1987) but may also be determined by hydrography or unsuitable habitat (Crisp & Knight-Jones, 1953). *Osilinus lineatus* shows increased reproductive success under warmer conditions. Research suggests that the reproductive cycle is lengthened and multiple spawning events occur in locations with consistently higher temperatures of approximately 6 °C than Britain, typical of the coastal waters of Spain (Bode *et al.*, 1986).

If a population can reproduce successfully on a regular basis then it should be able to recover from detrimental physical alterations in the environment once the factor has been removed and conditions revert to their previous state. This is provided that enough mature adults survive or sufficient recruits from neighbouring populations settle in that location.

Importance review

Policy/legislation

- no data -

Status

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

Non-native

Native	-		
Origin	-	**Date Arrived**	-

Importance information

Phorcus lineatus may be taken as bycatch by people collecting the winkle *Littorina littorea*.

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