Montagu's stellate barnacle (*Chthamalus montagui*)

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

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Close up of *Chthamalus montagui* from High Water of Spring Tide level seen dry.
Photographer: Alan J. Southward
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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	Karen Riley	**Refereed by**	Prof. Alan J. Southward
Authority	Southward, 1976		
Other common names	-	**Synonyms**	-

Summary

Description

An intertidal barnacle with six coarsely ridged wall plates, a kite-shaped opercular opening, and a membranous base. The rostral plate is relatively narrow and plates are of roughly equal size. The rostral plate is not fused with rostrolaterals. The tissue inside the opercular aperture is blue (paler than in *Chthamalus stellatus*) with brown and black markings. Usually conical in shape, however when crowded may become tubular. It reaches a maximum diameter of approximately 14 mm, depending on habitat, food availability and level on shore.

Recorded distribution in Britain and Ireland

A warm-water species recorded on the south and west coasts of Britain as far north as Orkney and along the Scottish east coast south to Aberdeen. The Isle of Wight is its eastern limit in the English Channel. It is relatively abundant on Irish coasts.

Global distribution

Crisp *et al.* (1981) noted that its distribution extends through the western and eastern Mediterranean and down the north African coast to Mauritania.

Habitat

Recorded in the high to mid eulittoral zone on exposed to moderately exposed rocky shores. Its vertical distribution overlaps with that of *Chthamalus stellatus* and *Semibalanus balanoides*.

Depth range

Not relevant

Identifying features

- Shell wall of six solid plates.
- Kite-shaped operculum opening.
- The joint between the terga and scuta crosses the centre line less than one third of the way down towards the rostrum.
- Tissue inside opercular aperture is usually blue/pale blue with brown and black markings.
- Junction between terga and scuta is concave towards rostral plate.
- Shell base is membranous.

Additional information

Before 1976 *Chthamalus montagui* was considered a variety of *Chthamalus stellatus*, but in 1976 was identified as a distinct species due to differences in its vertical zonation on the shore and morphology, particularly in the shape of the opercular plates, setation of the smaller cirri, the more sheltered locations in which it was found and its different pattern of zonation (Southward, 1976).

Listed by

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Biology review

Taxonomy

Order	Sessilia	Sessilia
Family	Chthamalidae	
Genus	Chthamalus	
Authority	Southward, 1976	
Recent Synonyms	-	

Biology

Typical abundance	High density
Male size range	Up to 1.4cm
Male size at maturity	
Female size range	Small(1-2cm)
Female size at maturity	
Growth form	
Growth rate	10 - 55
Body flexibility	
Mobility	
Characteristic feeding method	Active suspension feeder, See additional information
Diet/food source	
Typically feeds on	Plankton.
Sociability	
Environmental position	Epifaunal
Dependency	Independent.
Supports	No information
Is the species harmful?	No

Biology information

Feeding

Chthamalus stellatus / *Chthamalus montagui* generally feed on small plankton. They can consume diatoms, but were found not to grow under a regime dominated by diatoms (Barnes & Barnes, 1965). Normal feeding of chthamalids involves a cirral beat. This cirral beat is also noted to be a respiratory mechanism (Anderson & Southward, 1987). However, in high wave exposure they tend to hold their cirri out stiffly against the water current for a long period of time, retracting when food is captured (Crisp, 1950). Barnacles living in wave exposed conditions may benefit from this passive suspension feeding habit where cirral beating and consequent energy expenditure are minimised (Crisp, 1950).

Rates of cirral beat decrease with age and size, but increase with temperature (Anderson & Southward, 1987). Green (1961) reported that barnacles higher up on shore had a higher cirral beat frequency than those at lower levels. However, Southward (1955; 1964(b)) found no similar trends.

Southward (1955) found that there was no cirral beat of *Chthamalus stellatus* / *Chthamalus*

montagui in still water and that cirral beating was only induced at a current of approximately 10 cm / sec. The cirral beating frequency is also related to temperature, shown by experiments by Southward (1955). *Chthamalus stellatus* / *Chthamalus montagui* barnacles kept at a temperature of 0 °C did not react to touch after an hour. He also found that they remained inactive at a temperature up to 5 °C. Between 5 and 30 °C there was a linear increase to 10 beats every 10 seconds. This slowly declined above 33 °C and dropped rapidly at 36 °C. Although the species resisted coma above a temperature of 40 °C, all cirral beating ceased at 37.5 °C.

Respiration
Sessile barnacles have a pair of gills: pleats of the mantle wall, attached to the mantle cavity (Stubbings, 1975). Rainbow (1984) also stated that the cirri might also play an important role in respiration. There is usually a slow respiratory pumping beat, with varied emergence of the cirri.

Moulting
Barnacles need to moult in order to grow. Feeding rate and temperature determine the frequency of moulting. Moulting does not take place during winter when phytoplankton levels and temperatures are low (Crisp & Patel, 1960).

Growth
Once the barnacle is fixed in place it is unable to detach again (Crisp, 1955). All species grow faster in early life and slower in later life, and chthamalids tend to become tubular when crowded (Southward & Crisp, 1965). The growth rate varies with a variety of biological and environmental factors, including current flow, orientation with respect to current, food supply, wave exposure, shore height, surface contour, and intra- or inter-specific competition. Growth in *Chthamalus* spp. takes place along the whole internal surface of the one layered plates (Bourget, 1977). The growth rate for *Chthamalus stellatus* / *Chthamalus montagui* has been reported by Barnes (1956; Crisp & Bourget (1985) as between 10 - 55 µm per day (relatively slow) in the linear phase. Crisp (1950) noticed that *Chthamalus stellatus* / *Chthamalus montagui* reached a maximum size of 0.2 to 1.4 cm. *Chthamalus stellatus* / *Chthamalus montagui* was found to have a lower growth rate than many other species of barnacles (Relini, 1983). The species reached a basal diameter of 2-2.5 mm in 3 months, 3.5-4 one year later, up to 8 mm in the 2nd year of growth, but generally no more than about 5-6 mm (Relini, 1983). Sometimes a decrease in size was noticeable, due to abrasion. This low growth rate was found to be associated with a low metabolic rate, or low oxygen consumption, by Barnes & Barnes (1965).

Parasites and epizoites
Healy (1986, in O'Riordan *et al.*, 1992) observed the parasitic isopod, *Hemioniscus balani* in *Chthamalus stellatus* and *Chthamalus montagui* in Ireland, although it was never present in Lough Hyne populations. However, Southward & Crisp (1954) found that although it attacks and sterilises *Semibalanus balanoides* individuals, it does not normally attack chthamalids on British shores.

Further Information

- The dog whelk, *Nucella lapillus*, feeds on barnacles. The species of *Chthamalus* spp. are less at risk from dogwhelks due to their smaller size in comparison with *Semibalanus balanoides* and often higher position on the shore. Other predators which pull shells or cirri of barnacles off the rock, include crabs, amphipods, shore fish such as shanny *Lipophrys pholis*, and sometimes herring gulls (Moore & Kitching, 1939). Another possible predator is the polychaete, *Eulalia viridis* (Moore & Kitching, 1939). *Chthamalus* spp. is also known to

be displaced by *Patella* spp. and smothered by *Mytilus* spp. and algae at lower shore levels (Moore & Kitching, 1939).
- Empty barnacle cases provide homes for small periwinkles, small bivalves and the isopod, *Campecopea hirsuta* (Fish & Fish, 1996).
- Gubbay (1983) showed that *Chthamalus montagui* could withstand a compressive force of 42 N and a much lower tensile force of 7.4 N, and that a membranous base adhered to the substrate better than a calcified base.
- In order to protect themselves from changes in temperature/desiccation and a lowering of salinity, intertidal barnacles are usually able to close their aperture tightly (Moore & Kitching, 1939)

Habitat preferences

Physiographic preferences	Open coast, Enclosed coast / Embayment
Biological zone preferences	Mid eulittoral, Upper eulittoral
Substratum / habitat preferences	Artificial (man-made), Bedrock, Large to very large 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.), Very Strong > 6 knots (>3 m/sec.), Weak < 1 knot (<0.5 m/sec.)
Wave exposure preferences	Exposed, Moderately exposed, Sheltered, Very exposed
Salinity preferences	Full (30-40 psu)
Depth range	Not relevant
Other preferences	No text entered
Migration Pattern	Non-migratory / resident

Habitat Information

Geographical distribution

- Crisp *et al.* (1981) have described the distribution of *Chthamalus stellatus* and *Chthamalus montagui*. *Chthamalus montagui* occurs all around the western seaboard of Britain and all around Ireland. It is absent from part of Liverpool Bay. It occurs in Orkney but not Shetland and extends south down the east coast of Scotland to Aberdeen. On the east coast is more or less continuous, extending from the north of Scotland, along the west coasts of Britain and along all coasts of the Irish Sea.
- Records detailing its worldwide distribution are limited, but it is probably that their range extends further south to Mauritania, through western and eastern parts of the Mediterranean Sea. It is rare or absent from offshore islands. It is common in the northern Adriatic and occurs at locations in the Aegean and Black Seas.

Vertical distribution

- *Chthamalus montagui* is dominant over *Chthamalus stellatus* in more sheltered sites (Southward, 1976; Crisp *et al.*, 1981; Burrows *et al.*, 1992). Where their distributions overlap *Chthamalus montagui* has a greater vertical distribution above that of *Chthamalus stellatus* (Burrows *et al.*, 1992) and, while *Chthamalus montagui* is more common between MHWS & MHWN, *Chthamalus stellatus* is abundant lower down at MTL and below (Pannacciulli & Relini, 2000). Near its northern limit in Scotland *Chthamalus montagui* is limited to a narrow band at the top of the shore due to competition with *Semibalanus*

balanoides (Kendall & Bedford, 1987), and the influence of lower temperatures. Poor settlement of *Chthamalus* spp. also usually occurs. The higher the species occurs up on the shore, the more resistant to desiccation influences they tend to be (Southward, 1955b).

- Physical factors such as exposure to seawater, desiccation and poor food supply limit the distribution of barnacles on the upper shore, whereas competition for space, predation and strong wave action limit the distribution at low and mid shore levels (Pannacciulli & Relini, 2000).
- The distribution of *Chthamalus* spp. is not affected by small increases in algal cover. However, rapid increases to 100 % can lead to a massive decline in barnacle populations, declining to almost zero in a year or two (Southward, 1991). Hawkins & Hartnoll (1982) found that the lower shore level limit was controlled by the presence of algal turf.

Substratum preference

- Barnacles attach themselves to hard, rough surfaces and are rarely found on chalk cliffs (Moore & Kitching, 1939). Moore & Kitching (1939) also suggested that this may be because the surface is smooth, washed away easily, or too porous (making it possible to be dried out from below).

Temperature dependence / competition

- *Chthamalus* spp. are warm water species, with their northern limit of distribution in Britain. They tend to be more tolerant to temperature increases and desiccation than *Semibalanus balanoides*. Southward (1976) found that in Cornwall and Devon, where the barnacle is common, it dominates the upper half of the barnacle zone.
- *Chthamalus* spp. prefer warm temperatures, whereas *Semibalanus balanoides* prefers low temperatures. This is reflected by the changes in their distribution with changes in climate. For example, in the severe winter of 1962-63 *Chthamalus* populations declined (Southward, 1967) while *Semibalanus balanoides* increased, and in the temperature rise of 1988-89 the trend was reversed (Southward, 1991). Long-term trends are also evident. A decline in *Chthamalus* populations and an increase in *Semibalanus balanoides* occurred between 1962 and 1980, corresponding with a temporary decrease in sea temperatures (Southward, 1991). Since 1981 there has been a general increase in *Chthamalus* (Southward, 1991), maybe corresponding with gradual climate warming. Southward & Crisp (1954) noted that in 1948-51, during high temperatures in the British Isles *Chthamalus* dominated over *Semibalanus balanoides*, and during 1951-52, during lower temperatures there was a resurgence of *Semibalanus balanoides*. Southward (1991) noted a two year phase lag between temperature trends and changes in barnacle abundance in Plymouth.
- *Chthamalus* spp. Are more abundant in waters where the mean temperatures are above 10 °C for several months of the year (Southward, 1955b).

Life history

Adult characteristics

Reproductive type	Self-fertilization
Reproductive frequency	Annual episodic
Fecundity (number of eggs)	1,000-10,000
Generation time	1-2 years

Age at maturity	9 - 10 months
Season	May - August
Life span	2-5 years

Larval characteristics

Larval/propagule type	-
Larval/juvenile development	Planktotrophic
Duration of larval stage	11-30 days
Larval dispersal potential	Greater than 10 km
Larval settlement period	Insufficient information

Life history information

Before 1976 there was no distinction between *Chthamalus stellatus* and *Chthamalus montagui*. Since 1976 the existence of two separate species was recognised (Southward, 1976). Therefore, papers pre-1976 on *Chthamalus stellatus* have been recorded as for both *Chthamalus stellatus* and *Chthamalus montagui*, below.

Fertilization

- Sexual maturity of *Chthamalus montagui* was attained at a rostro-carinal diameter of 4.4.5-6.4 mm (O'Riordan *et al.*, 1992). *Chthamalus montagui* is able to breed in its first year (Burrows, 1988; Southward & Crisp, 1954), after 9 to 10 months of settlement (Southward & Crisp, 1954). Sperm is activated by the oviducal gland and transferred to the oviducal sac via the penis of a neighbouring barnacle (Barnes, 1989). The barnacle penis is substantially longer than the body and is capable of searching an area around the adult to find a receptive 'functional female' (Rainbow, 1984).
- Barnacles generally reproduce by cross-fertilization, but *Chthamalus* has been shown to self-fertilize when isolated (Barnes & Barnes, 1958; Barnes, 1989); this usually occurs high up on shore. However, it has been noted that in self-fertilized individuals oviposition is delayed (Barnes & Barnes, 1958; Barnes, 1989) and the resulting eggs can be slightly abnormal and are considered less viable (Barnes, 1989). Egg masses (egg lamellae) are brooded in the mantle cavity (O'Riordan *et al.*, 1995; Barnes, 1989).

Breeding season

- Southward (1978) suggested that *Chthamalus montagui* breeds one to two months later than *Chthamalus stellatus*. However, Crisp *et al.* (1981) found little difference in SW Britain, with the main breeding peak in June/July and August. Throughout the breeding season most individuals produce several broods (Burrows *et al.*, 1992; O'Riordan *et al.*, 1992), with a small percentage of the population remaining reproductively active throughout the year (O'Riordan *et al.*, 1995); Barnes, 1989). After maturation of each brood ovarian and penis re-development takes place (O'Riordan *et al.*, 1995; Barnes & Barnes, 1965; Burrows, 1988; Anderson, 1994).
- According to Hines (1978) temperature and food availability are the main factors controlling the duration of the breeding season and the embryonic development rate of other *Chthamalus* species. In fact, Burrows (1988, in Kendall & Bedford, 1987) found the onset of the breeding season to be correlated with a sea temperature of 10 °C or above

(Burrows *et al.*, 1992). Southward & Crisp (1956) noted that the interval between broods in *Chthamalus stellatus* and *Chthamalus montagui* became shorter at higher temperatures.

- The onset of the breeding season was noticed by Crisp (1950) to spread up the shore level over several months. Brooding in Aberystwyth was noted to be in May/June to August (Kendall & Bedford, 1987), with approximately 80 % containing a naupliar mass. Cyprid settlement occurred in late July to early September at a sea temperature of 15.3 to 18.8 °C (Kendall & Bedford, 1987). In northern Spain the brooding period tends to be longer, between April and early October, with 30 % containing a naupliar mass (Kendall & Bedford, 1987).
- The breeding period, period of larval settlement and density of recruits are all reduced near the northern limits of its distribution. Crisp (1950) suggested that for *Chthamalus montagui* and *Chthamalus stellatus* in the United Kingdom, breeding commenced earlier with decreasing longitude and easterly longitude. Breeding of *Chthamalus stellatus*and *Chthamalus montagui* usually takes place earlier in the year in continental Europe than in the British Isles (Relini & Matricardi, 1979; Relini, 1983; Miyares, 1986, all in O'Riordan *et al.*, 1995). In the Mediterranean the breeding season usually occurs in July and August (Mizrahi & Achituv, 1990, in O'Riordan *et al.*, 1995).
- Experiments by O'Riordan *et al.* (1995) showed that in their first year *Chthamalus stellatus* and *Chthamalus montagui* breed once or more, and more than once thereafter.

Embryonic development

- In both *Chthamalus stellatus* and *Chthamalus montagui* it took approximately 23 days for embryos to develop completely in vivo at 15 °C (Burrows *et al.*, 1992; Burrows, 1988, in Kendall & Bedford, 1987). *Chthamalus montagui* will only breed if temperatures exceed 15 degrees C (Patel & Crisp, 1960).

Recruitment and lifespan

- Towards the northern limits of the species distribution annual recruitment is low (Kendall & Bedford, 1987) and individuals have an increased longevity (Lewis, 1964). The normal lifespan of *Chthamalus stellatus* / *Chthamalus montagui* at mid-shore level is considered to be approximately 2-3 years (Southward & Crisp, 1956). However, growth is more rapid and the mortality rate is greater lower down on the shore (Southward & Crisp, 1956).

Fecundity

- (Burrows *et al.*, 1992) found that the number of eggs per brood for *Chthamalus montagui* ranged between 1,030 to 1803 in Britain, depending on body size and weight. It was also noted by (Burrows *et al.*, 1992) that the fecundity generally increased with lower shore levels colonized, with estimations of 1-2 broods per year at high shore levels, 2 to over three at mid shore levels, and over 2 to over 4 at low shore levels.

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

Barnacles are permanently attached to hard rough surfaces. Therefore, loss of substratum due to activities such as spoil dumping or land claim will result in loss of individuals in the area. If suitable substrata remains within the area, colonization of juvenile barnacles is possible. Intolerance is assessed as high. Recoverability is likely to be moderate (see Additional Information section below).

Smothering	Intermediate	High	Low	Moderate

Chthamalus stellatus / *Chthamalus montagui* have been shown to be relatively unaffected by smothering by oil. Monterosso (1930) showed experimentally that the species can survive complete smothering by petroleum jelly for approximately two months, by respiring anaerobically. Complete smothering caused by the Torrey Canyon oil spill yielded similar results; A few *Semibalanus balanoides* died, yet *Chthamalus stellatus* / *Chthamalus montagui* seemed unaffected, while at Booby's bay more than 90 % had managed to clear an opening in the oil film (Smith, 1968). Although oil had very little effect on individuals, it is likely that smothering by sediment can clog breathing apparatus. Recruitment to the smothered area will also be reduced. Therefore intolerance is assessed as intermediate. Recoverability is likely to be high (see Additional Information section below).

Increase in suspended sediment	Low	Very high	Very Low	Low

Barnacles are likely to be able to tolerate a slight increase in siltation. A large increase in siltation to 100 mg/l for one month is may block breathing apparatus and impose an energetic cost of cleaning the gills. Intolerance is therefore, assessed as low. Recoverability is likely to be very high as feeding and respiratory structures are likely to be clear of particles within a short space of time.

Decrease in suspended sediment	Tolerant	Not relevant	Not sensitive	Not relevant

A decrease in siltation is unlikely to affect *Chthamalus montagui* populations.

Dessication	Low	Very high	Very Low	Moderate

Chthamalus montagui is a warm water species, with its northern limit of distribution in Britain. It tends to be more tolerant to desiccation than *Semibalanus balanoides*. The higher the species occurs up on the shore, the more resistant to desiccation influences they tend to be (Southward, 1955b). Cracks and crevices offer further protection from desiccation. Southward (1958) reported an internal temperature of 28.8 °C in an air temperature of 13.7 °C.

Chthamalids are prevented from growing higher up the shore due to their desiccation tolerance. Therefore, an increase in the level of desiccation would cause a depression in the upper limit of the species vertical distribution. A decrease in the level of desiccation may elevate their upper limit. Therefore, intolerance is assessed as low. Recoverability is likely to

be very high (see Additional Information section below).

Increase in emergence regime Intermediate High Low Moderate

According to Hines (1978) temperature and food availability are the main factors controlling the duration of the breeding season and the embryonic development rate in other species of *Chthamalus*. With an increase in emergence, the period of time covered by the water would decrease, and the time available for feeding and breeding would also decrease. This is likely to reduce the growth rate and annual recruitment. There is also likely to be a shift downwards on the shore due to competition with *Semibalanus balanoides*. Intolerance is assessed as intermediate. Recoverability is likely to be high (see Additional Information section below).

Decrease in emergence regime Low Very high Very Low High

Barnacle populations are likely to be tolerant of an decrease in emergence. According to Hines (1978) temperature and food availability are the main factors controlling the duration of the breeding season and the embryonic development rate in other species of *Chthamalus*. With a decrease in the emergence regime, the feeding time and breeding possibilities are likely to increase. Adults of *Chthamalus stellatus*/ *Chthamalus montagui* can survive permanent submersion (Barnes, 1953). However, competition between *Semibalanus balanoides* is likely to play an important role in the changes in the species distribution. It is likely that the distribution of *Chthamalus montagui* will move further up the shore, with no noticeable difference in the range. Intolerance is assessed as low. Recoverability is likely to be very high (see Additional Information section below).

Increase in water flow rate Low High Low Low

An increase in water flow rate is likely to lead to higher growth rates and annual recruitment. Intolerance is assessed as low. Recoverability is likely to be very high (see Additional Information section below).

Decrease in water flow rate Low Very high Very Low Low

A decrease in the water flow rate is likely to lead to a decrease in growth rate and annual recruitment. Intolerance is assessed as low. Recoverability is likely to be very high (see Additional Information section below).

Increase in temperature Tolerant* Not relevant Not sensitive* High

Chthamalus montagui would be favoured by an increase in temperature based on the following information:

- *Chthamalus montagui* is a warm water species, with its northern limit of distribution in Britain. It tends to be more tolerant to temperature increases than *Semibalanus balanoides*.
- Southward (1958) reported an internal temperature of 28.8 °C in an air temperature of 13.7 °C. Therefore, a slight increase in temperature can lead to a much larger increase in temperature inside the barnacle during exposure to air and the sun.
- Since 1975 there has been a general increase in the abundance of *Chthamalus montagui* and *Chthamalus stellatus* (Southward, 1991), perhaps corresponding with gradual climate warming. Southward (1991) noted a two year phase lag between temperature trends and changes in barnacle abundance in Plymouth.
- *Chthamalus* sp. is most abundant in waters where the mean temperatures are above 10 °C for several months of the year (Southward, 1955b). According to Hines (1978) temperature and food availability are the main factors controlling the duration of the breeding season and the embryonic development rate whilst Burrows (1988, in

O'Riordan *et al.*, 1995) found the onset of the breeding season to be correlated with a sea temperature of 10 °C or above.

- Southward & Crisp (1956) noted that the interval between broods in *Chthamalus stellatus* and Chthamalus montagui became shorter at higher temperatures.
- *Chthamalus montagui* will only breed in temperatures above 15 degrees C (Patel & Crisp, 1960). Therefore intolerance to an increase in temperature is likely to increase reproduction, the rate of larval and embryonic development and, therefore, recruitment.