Poli's stellate barnacle (*Chthamalus stellatus*)

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

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2002-01-28

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

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This review can be cited as:
Riley, K. 2002. *Chthamalus stellatus* Poli's stellate barnacle. 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.1323.1

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Close up of *Chthamalus stellatus* from about Mid Tide Level seen underwater.
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	(Poli, 1791)		
Other common names	-	**Synonyms**	-

Summary

Description

An intertidal barnacle with six solid wall plates, an oval-shaped operculum opening, and a membranous base. Juveniles have a kite-shaped opercular opening. The rostral plate is relatively narrow, plates are of roughly equal size, and its rostral plate is not fused with the rostrolateral plates. Usually conical in shape, however when crowded may become tubular. It may reach a diameter of approximately 14 mm, depending on habitat, food availability and level on the shore. The tissue inside the opercular aperture is bright blue with black and orange markings.

Recorded distribution in Britain and Ireland

A southern, warm-water species recorded on the south and west coasts of the British Isles as far north as the Shetland Isles. The species is less abundant along the channel towards The Isle of Wight, its eastern limit.

Global distribution

Occurs in The Black Sea, along most of the Mediterranean coast, and further south in Tunisia, Madeira, the Azores, and Cape Verde Islands. No recorded exist further south of this point.

Habitat

Recorded in the mid to low eulittoral zone on exposed rocky shores. Its vertical distribution overlaps with *Chthamalus montagui* and *Semibalanus balanoides*.

Depth range

Not relevant

Identifying features

- Shell wall of six solid plates.
- Oval-shaped operculum opening.
- Joint between the terga and scuta crosses the centre line at one third or more of the distance towards the rostrum.
- Tissue inside the operculum opening is usually bright blue with brown and orange markings.
- Junction between the terga and scuta is convex 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. (Southward, 1976).

Listed by

Further information sources

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Biology review

Taxonomy

Order	Sessilia	Sessilia
Family	Chthamalidae	
Genus	Chthamalus	
Authority	(Poli, 1791)	
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	ca. 10-55
Body flexibility	None (less than 10 degrees)
Mobility	
Characteristic feeding method	Active suspension feeder, See additional information
Diet/food source	
Typically feeds on	Generally feeds on plankton.
Sociability	
Environmental position	Epifaunal
Dependency	Independent.
Supports	None
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 cirrial beat frequency than those at lower levels. However, Southward (1955; 1964(b)) found no similar trends.

Southward (1955) found that there was no response of *Chthamalus stellatus / Chthamalus montagui* in still water and that cirrial beating was only induced at a current of approximately 10 cm / sec. The extension response was also sometimes shown. The cirrial 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 cirrial 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). Benedetti-Cecchi *et al.* (2000) observed that *Chthamalus stellatus* barnacles in the north west Mediterranean were significantly larger the higher up shore that they were found. However, no significant difference in growth rate was noted by Benedetti-Cecchi *et al.* (2000), with the growth rate of juveniles being between 0.4 and 0.8 mm per year, and that greater mortality of young and adults in a low shore environment.

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 of this due to their smaller size in comparison with *Semibalanus balanoides*, but nevertheless it can still have a negative impact on their abundance.
- Other predators which pull shells or cirri of barnacles off the rock, include crabs, amphipods, shore fish such as wrasse and sometimes herring gulls (Moore & Kitching, 1939), in particular, the shanny *Blennius pholis* (Kendall & Bedford, 1987). 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).
- 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
Biological zone preferences	Lower eulittoral, Mid 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.)
Wave exposure preferences	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) described the distribution of *Chthamalus stellatus* and *Chthamalus montagui*. *Chthamalus stellatus* is abundant along western coasts of Britain and Ireland. It does not occur in the central Irish Sea. It occurs in northern and north-eastern Scotland including at exposed locations in Shetland..
- In France it is abundant westwards from Roscoff, is absent from the Bay of St. Malo, and is

less common east of Roscoff. *Chthamalus stellatus* occurs along Irish coasts from Antrim around to Wexford, although it only occurs in abundance along the west coast. The species is less abundant along the channel towards the Isle of Wight, its eastern limit. Individuals recorded as *Chthamalus stellatus* in the Indian and Pacific Ocean are, in fact, other species of the *stellatus* group.

Vertical zonation

- *Chthamalus stellatus* is dominant over *Chthamalus montagui* at exposed sites (Southward, 1976; Crisp *et al.*, 1981). Where the species overlap, *Chthamalus montagui* has a greater vertical distribution, extending above and below 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). *Chthamalus stellatus* inhabits the lower half of the intertidal, but in wave-exposed or wet and shady places they occur higher up on shore (Crisp *et al.*, 1981; Pannacciulli & Relini, 2000).
- 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 higher the species occurs up on the shore, the more resistant to desiccation influences they tend to be (Southward, 1955).
- The distribution of *Chthamalus* spp. is not affected by small increases in algal cover. Hawkins & Hartnoll (1982) found that the lower shore level limit was controlled by the presence of algal turf. However, rapid increases to 100 % algal cover can lead to a massive decline in barnacle populations to almost zero in a year or two (Southward, 1991).

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. 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 decrease in sea temperatures (Southward, 1991). Since 1980 there has been a general increase in *Chthamalus* spp. (Southward, 1991), maybe corresponding with gradual climate warming. Southward & Crisp (1954) noted that in 1948-51, during high temperatures in the British Isles *Chthamalus* spp. Dominated over *Semibalanus balanoides*, and from 1952, 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, 1955).

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 species, below.

Fertilisation

- Sexual maturity of *Chthamalus stellatus* was attained at a rostro-carinal diameter of 4.0-6.8 mm (O'Riordan *et al.*, 1992). A pre-1976 observation by Southward & Crisp (1954) suggests that *Chthamalus stellatus* is able to breed in its first year after 9 to 10 months of settlement. 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). Fertilised egg masses (egg lamellae) are brooded in the mantle cavity (O'Riordan *et al.*, 1995), outside the body (Barnes, 1989).
- Barnacles generally reproduce by cross-fertilisation, but *Chthamalus* spp. have been shown to self-fertilise when isolated (Barnes & Barnes, 1950; Barnes & Crisp, 1956; Barnes, 1989); this usually occurs high up on shore. However, it has been noted that oviposition is delayed (Barnes & Barnes, 1950; Barnes, 1989) and the resulting eggs can be slightly abnormal and are considered less viable (Barnes, 1989).

Breeding season

- The onset of the breeding season in the United Kingdom was noticed by Crisp (1950) to spread up the shore level over several months. 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 and August (O'Riordan *et al.*, 1995). 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; Barnes & Barnes, 1977; 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. 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.

- 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). Crisp (1950) suggested that for *Chthamalus montagui* and *Chthamalus stellatus* in the United Kingdom, breeding commenced earlier with decreasing longitude and easterly longitude. However, in the Mediterranean the breeding season usually occurs in July and August (Mizrahi & Achihuv, 1990, in O'Riordan *et al.*, 1995).
- Breeding of *Chthamalus stellatus* in France occurs in April (Barnes, 1992), and correlates with mean air and sea temperatures of 11 - 12 °C, and maximum temperatures of 14 °C. Barnes (1992) found that at an upper temperature limit of 20 - 21 °C in the sea and 24 - 25 °C in the air reproductive activity decreased. Southward & Crisp (1956) noted that the interval between broods in *Chthamalus stellatus* and *Chthamalus montagui* became shorter at higher temperatures. Barnes & Barnes (1965) found that in high suspended solids and low salinity there was a decrease in the number of eggs per brood of *Chthamalus stellatus* in Europe.
- Older barnacles are able to breed at a smaller size than younger barnacles. For instance, experiments by O'Riordan *et al.* (1992) showed that in their first year *Chthamalus stellatus* and *Chthamalus montagui* breed once or more, and more than once thereafter.
- *Chthamalus stellatus / Chthamalus montagui* are very tolerant of high periods of emersion, yet Patel & Crisp (1960) found that when barnacles which were brooding eggs were kept out of the water, a second batch of eggs was not produced.

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), whereas Burrows (1988, in Kendall & Bedford, 1987) found that at 15 °C it took 26 days, and Achituv & Barnes (1976) reported a value of 25 days, although the temperature is not known.

Fecundity

- Burrows *et al.* (1992) found that the number of eggs per brood of *Chthamalus stellatus* ranged between 1,274 - 3,391 in Britain, depending on body size and weight. It was also noted by Burrows *et al.* (2000) 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. Fecundity in protected areas such as harbours is usually lower, possibly due to increased turbidity (Barnes, 1989). However, in Archachon (France) in highly turbid waters the effect was not so noticeable, probably due to higher nutrient concentrations (Barnes, 1989).

Annual recruitment and lifespan

- Lifespan of *Chthamalus stellatus / Chthamalus montagui* is considered to be approximately 2-3 years (Southward & Crisp, 1950). However, growth is more rapid and the mortality rate is greater lower down on the shore (Southward & Crisp, 1950).Towards the northern

limits of distribution annual recruitment is low (Kendall & Bedford, 1987) and they have an increased longevity (Lewis, 1964).

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	Moderate

Barnacles are likely to be able to tolerate a slight increase in suspended sediment concentration. A large increase in siltation to 100 mg/l for one month is likely to 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 suspended sediment concentration is unlikely to affect *Chthamalus stellatus* populations.

Dessication	Low	Very high	Very Low	Moderate

Chthamalus stellatus 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, 1955). 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. 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. 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 reproduction. There is also likely to be a shift downwards on the shore due to competition between *Semibalanus balanoides*. Intolerance is assessed as intermediate. Recoverability is likely to be high (see Additional Information section below).

Decrease in emergence regime Low High Low High

Barnacle populations are likely to be tolerant to a decrease in emergence. With a decrease in the emergence regime, the feeding time and breeding possibilities are likely to increase. Adults of *Chthamalus stellatus* can survive permanent submersion (Barnes, 1953). However, competition between *Semibalanus balanoides* is likely to play an important role in the changes in species distribution. It is likely that the distribution of *Chthamalus stellatus* 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). *Chthamalus stellatus* / *Chthamalus montagui* are very tolerant of high periods of emersion, yet Patel & Crisp (1960) found that when barnacles which were brooding eggs were kept out of the water, a second batch of eggs was not produced.

Increase in water flow rate Low Very high Very Low Moderate

An increase in water flow rate is likely to lead to a higher growth rate 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 Moderate

A decrease in the water flow rate is likely to lead to a decrease in food availability and 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 stellatus would be favoured by an increase in temperature based on the following information:

- *Chthamalus stellatus* 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 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). 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* became shorter at higher temperatures. Therefore intolerance to an increase in temperature is likely to increase reproduction, the rate of larval and embryonic development and, therefore, recruitment.