Light bulb sea squirt (*Clavelina lepadiformis*)

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

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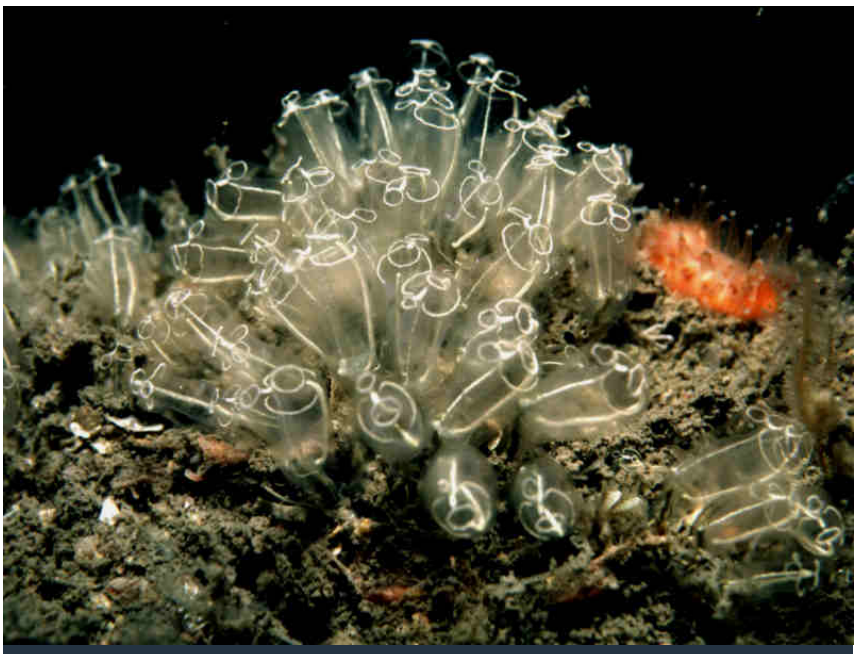

Clavelina lepadiformis.
Photographer: Keith Hiscock
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See online review for distribution map

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

Researched by	Karen Riley	**Refereed by**	Dr Xavier Turon
Authority	(Müller, 1776)		
Other common names	-	**Synonyms**	-

Summary

Description

Clavelina lepadiformis is a colonial sea squirt that grows up to 20 mm high. Groups of transparent zooids are joined at the base by short stolons. Eggs and larvae vary in colour and are visible in the atrial cavity. In the Mediterranean the eggs and embryos are most often yellowish white and sometime pink (X. Turon, pers. comm.) although in other areas in NW Europe they can also be red (Fish & Fish, 1996). Zooids possess a white ring around the pharynx, and have pale yellow or white longitudinal lines along the endostyle and dorsal lamina, which gives this species its 'light-bulb' appearance. In some areas colonies regress in winter and re-grow in spring although in the Mediterranean this may not be the case. De Caralt *et al.* (2002) looked at the differences in *Clavelina lepadiformis* between populations inside and outside of harbours and found that the population inside the harbour remained all year (albeit often at very low abundances). In contrast, the population in a rocky littoral area outside the harbour aestivated (regressed) for up to 7 months over the summer period (De Caralt *et al.*, 2002).

Recorded distribution in Britain and Ireland

Clavelina lepadiformis occurs around most coasts of Britain and Ireland.

Global distribution

Its distribution extends from southern Norway to the Mediterranean.

Habitat

Clavelina lepadiformis attaches itself to rocks, stones and seaweed in the sublittoral, to a depth of about 50 m.

Depth range

Down to 50 m

Identifying features

- Colonies of individual, transparent zooids are attached to one another at the base by stolons.
- Zooids possess a white ring around the pharynx, and have pale yellow or white longitudinal lines along the endostyle and dorsal lamina.
- Siphons are close together and the pharyngeal region is short.
- The gut loop is below the branchial sac, and zooids are taller than wide.
- Reaches a maximum height of 20 mm.

Additional information

The light bulb sea squirt attaches itself to rocks, stones and seaweed in the sublittoral, down to a depth of about 50 m. Individual zooids are small in spring growing to full size by about the end of May in Britain.

Listed by

Further information sources

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Biology review

Taxonomy

Phylum	Chordata	Sea squirts, fish, reptiles, birds and mammals
Class	Ascidiacea	Sea squirts
Order	Aplousobranchia	
Family	Clavelinidae	
Genus	Clavelina	
Authority	(Müller, 1776)	
Recent Synonyms	-	

Biology

Typical abundance	High density
Male size range	Up to 20mm
Male size at maturity	
Female size range	Small(1-2cm)
Female size at maturity	
Growth form	Cylindrical
Growth rate	See additional information.
Body flexibility	Low (10-45 degrees)
Mobility	Sessile
Characteristic feeding method	Active suspension feeder, See additional information
Diet/food source	Planktotroph
Typically feeds on	Suspended detritus and plankton
Sociability	
Environmental position	Epibenthic
Dependency	Independent.
Supports	None
Is the species harmful?	No *Clavelina lepadiformis* has been noted to be markedly toxic towards invertebrate larvae and bacteria (Teo & Ryland, 1995). Extracts of the species produced high mortality in invertebrates experimentally (Teo & Ryland, 1994). The species is also known to contain the cytotoxic alkaloid, lepadin A (Steffan, 1991). Tarjuelo *et al.* (2002) studied the defence mechanisms of six species of colonial ascidians and found *Clavelina lepadiformis* to be the least palatable when pieces of the tunic and zooid were offered to predators, Mature larvae were also reported to be highly unpalatable (Tarjuelo *et al.*, 2002).

Biology information

- The light bulb sea squirt grows to a maximum height of 20 mm (Fish & Fish, 1996; Picton, 1997).

- Colonies grow rapidly in spring and are full size after about two months (K. Hiscock, pers. comm.).
- The growth rate for settled specimens of *Clavelina lepadiformis* was found to be high (Tursi *et al*., 1977), although measures of growth rate were not found.
- *Clavelina lepadiformis* is an active suspension feeder, feeding on suspended detritus and plankton present in water passing through the branchial basket (Fish & Fish, 1996). It actively pumps water and can therefore thrive in very still conditions. The structure of the branchial sac for *Clavelina lepadiformis* is in its simplest form; the gill sheet is formed by a single screen with slits (Fiala-Medioni, 1978). Fiala-Medioni (1974) showed that filtration efficiency decreased with an increase in simplicity of this structure.
- The zooids of *Clavelina lepadiformis* are seldom fouled, other than at the base, either because of possible chemical defences or because of the delicate texture of its tunic (Teo & Ryland, 1994).
- Predators include bottom-feeding fish, carnivorous gastropods and starfish (Millar, 1970). Flatworms are also predators, *Prostheceraeus moseleyi* being a significant predator of *Clavelina lepadiformis* is the Mediterranean (X. Turon, pers. comm.).

A study by de Caralt *et al*. (2002) revealed significant differences in certain aspects of the biology of *Clavelina lepadiformis* between harbour and open rocky littoral populations in the Mediterranean. Although no morphological differences were found, the abundance in the harbour populations were an order of magnitude higher than at the open littoral population. Furthermore, the harbour population did not experience aestivation (a period of inactivity and reduced metabolic activity), unlike the rocky littoral population, and reproduction also varied greatly. The littoral population only produced larvae for 2-3 months over winter and only had one gonadal cycle per year. By contrast, larvae were present in the harbour population from November to June with several gonadal cycles within this time. They concluded that there was marked ecotypic variation between populations of both habitat types and that the harbour population showed more opportunistic traits (Caralt *et al*., 2002).

Habitat preferences

Physiographic preferences	Enclosed coast / Embayment, Estuary, Offshore seabed, Open coast, Strait / sound
Biological zone preferences	Lower infralittoral, Sublittoral fringe, Upper infralittoral
Substratum / habitat preferences	Artificial (man-made), Bedrock, Large to very large boulders, Overhangs, Pebbles, Small boulders
Tidal strength preferences	
Wave exposure preferences	Exposed, Extremely sheltered, Moderately exposed, Sheltered, Very exposed, Very sheltered
Salinity preferences	Full (30-40 psu), Variable (18-40 psu)
Depth range	Down to 50 m
Other preferences	
Migration Pattern	Non-migratory / resident

Habitat Information

- The species is absent in the Bristol Channel, between Morecambe Bay and Colwyn Bay on the west coast of England, between the Firth of Forth and Newcastle upon Tyne, and the

Humber Estuary and Dover on the east coast of Britain. It also has a variable abundance in Ireland.

- *Clavelina lepadiformis* is a very common shallow water sea squirt that is usually found on vertical rock faces and on the sides of boulders, to about 50 m depth down (Picton & Costello, 1998; Berrill, 1950). It is also found on shells, stones and seaweeds (Picton & Costello, 1998), is a typical species of harbour areas, commonly found growing on artificial surfaces.
- Naranjo *et al.* (1996) found that the light bulb sea squirt preferred light, shallow environments and was tolerant of salinities as low as 14 psu (Fish & Fish, 1996). It occurs in a wide range of exposure, but is most abundant in moderately exposed sites in the infralittoral zone (Picton, 1997).
- Naranjo *et al.* (1996) found that the species was dominant in a low rate of water renewal, excess silting and high suspended solid concentrations, although the species also occurred in other more wave exposed sites.
- In a study comparing Mediterranean and Atlantic populations of *Clavelina lepadiformis* in interior (harbours, marinas and fjords) and exterior (open rocky littoral) areas, Turon *et al.* (2003) found strong evidence that the interior Mediterranean clade (group of organisms sharing the same common ancestry) originated from the Atlantic clade. The Atlantic forms were not found to be divided between interior and exterior clades (Turon *et al.*, 2003).

Life history

Adult characteristics

Reproductive type	Budding
Reproductive frequency	Annual protracted
Fecundity (number of eggs)	11-100
Generation time	<1 year
Age at maturity	2-3 months
Season	June - September
Life span	1-2 years

Larval characteristics

Larval/propagule type	-
Larval/juvenile development	Ovoviviparous
Duration of larval stage	2-10 days
Larval dispersal potential	100 -1000 m
Larval settlement period	Late summer

Life history information

Sea squirts are permanent hermaphrodites that undergo both sexual and asexual reproduction.

Sexual Reproduction:

- Fish & Fish (1996) state that it is not easy to determine the age of ascidians, particularly that of colonial forms but that the lifetime is probably around one or two years. Each zooid reproduces sexually once, with the production of eggs possibly going on for weeks or months (Berrill, 1975). Breeding tends occur during June to September in temperate and cold seas (Picton, 1997; Millar, 1970), but in tropical waters it may continue throughout the year (Millar, 1970). In the Mediterranean, the breeding season is winter/spring (X. Turon, pers. comm.).
- Fertilisation takes place internally, in the atrium, where development into the tadpole larvae stage also takes place (Fish & Fish, 1996; Berril, 1950). This process is most likely to occur by cross-fertilization. Brunetti (1987) recorded up to about 50 embryos present in the atrium at one time whereas Tarjuelo & Turon (2004) gave an estimate of 66 embryos.
- *Clavelina lepadiformis* brood a large number of small undifferentiated larvae (Tarjuelo & Turon, 2004).
- After release, the larvae are free-swimming for about three hours (Fish & Fish, 1996; Brunetti, 1987). After this time the larvae settle on suitable substratum and metamorphosis into an adult sea squirt takes place. Development of the oozoid takes up to 3 days, and after 2-3 months of post-developmental growth they become sexually mature (Berrill, 1950).

Asexual reproduction:

- *Clavelina lepadiformis* undergoes stolonic asexual budding. At the end of the sexual breeding season, towards the end of the summer, zooids disappear or are resorbed. Over the winter period the colony survives as 'winter buds' from which new zooids develop in spring (Berrill, 1950; Fish & Fish, 1996; Picton & Costello, 1998). In the winter months, when the zooids undergo de-differentiation, the resulting cylindrical bodies of many species of *Clavelinidae* are often found on rocky shores (Millar, 1970). In the Mediterranean the species reproduces in winter/spring and aestivates (aestivation is a period of inactivity / reduced metabolic activity) in summer (X. Turon, pers. comm.).

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

Clavelina lepadiformis is permanently attached to the substratum. Removal of substratum will result in loss of the population. Adults are unlikely to be able to reattach, therefore recovery depends upon dispersal of larvae during the breeding season. Intolerance to substratum loss is assessed as high. Recoverability is likely to be moderate (see Additional Information below).

Smothering	High	Moderate	Moderate	High

Clavelina lepadiformis reaches up to 20 mm in height and often colonizes vertical surfaces and overhangs. Smothering by 5 cm depth of sediment will completely cover the majority of the population, with only those colonizing overhangs and vertical surfaces not being affected. Therefore, intolerance is assessed as high. Recoverability is likely to be moderate (see Additional Information below).

Increase in suspended sediment	Intermediate	High	Low	Moderate

Increased siltation can cause clogging of ascidians respiratory organs (Bakus, 1968). Although *Clavelina lepadiformis* has relatively wide apertures which help prevent clogging from particles (Naranjo *et al.*, 1996), the structure of its branchial sac is in its simplest form; a gill sheet is formed by a single screen with slits (Fiala-Medioni, 1978). This means that they are less efficient in expelling particles, and more likely to suffer from clogging of feeding apparatus than other forms of sea squirts, such as *Ciona intestinalis*. Nevertheless, Naranjo *et al.* (1996) found that *Clavelina lepadiformis* was dominant in a low rate of water renewal, excess silting and high suspended solid concentrations Therefore, intolerance to siltation is assessed as intermediate. Recoverability is likely to be high (see Additional Information below).

Decrease in suspended sediment

Dessication	High	Moderate	Moderate	High

The sea squirt is a delicate animal, so exposure to desiccating influences for one hour will probably result in death of a proportion of the population. Therefore, intolerance is assessed as high. Recoverability is likely to be moderate (see Additional Information below).

Increase in emergence regime	High	Moderate	Moderate	Low

Clavelina lepadiformis is a sublittoral species. Changes in the emergence regime, where the lower shore becomes exposed for longer, are likely to result in a proportion of the population dying. Intolerance to the emergence regime is assessed as high. Recoverability is likely to be moderate (see Additional Information below).

Decrease in emergence regime

Increase in water flow rate	Low	Very high	Very Low	Moderate

Clavelina lepadiformis thrives in areas where there is very little, if any, water movement (for instance, Abereiddy Quarry, Pembrokeshire (Hiscock & Hoare, 1975) as it is an active suspension feeder. Naranjo *et al.* (1996) found that the species was dominant in a low rate of water renewal, excess silting and high suspended solid concentrations. High water flow rates may be detrimental to feeding ability and posture but are unlikely to cause detachment. On resumption of normal energy expenditure, condition should be restored rapidly. Intolerance is assessed as low. Recoverability is likely to be very high (see Additional Information below).

Decrease in water flow rate

Increase in temperature	Intermediate	High	Low	Moderate

As the breeding season is temperature dependant (Berrill, 1975; Millar, 1970), a change in temperature is likely to result in a change in its time and duration. The distribution of the light bulb sea squirt extends to waters which lie to the north and south of Britain, and therefore to lower and higher temperatures. Long term changes in temperature can probably be accommodated, whereas acute short term changes may cause a proportion of the population to die. During the severe winter of 1962-63, although no significant mortality was noted, Crisp *et al.* (1964) found that many compound ascidians were retarded in renewal of the colony after 'winter budding', and some individuals may have been killed. Intolerance is assessed as intermediate. Recoverability is likely to be high (see Additional Information below).

Decrease in temperature

Increase in turbidity	Tolerant	Not relevant	Not sensitive	Moderate

The species is frequently dominant in areas such as harbours with high levels of suspended solids and low light penetration. Naranjo *et al.* (1996) found that the species was dominant in a low rate of water renewal, excess silting and high suspended solid concentrations. However, Moore (1977) found populations of *Clavelina lepadiformis* replacing *Botryllus schlosseri* in clear water creeks near West Mersea. It is therefore likely that *Clavelina lepadiformis* is tolerant to changes in turbidity. A number of ascidians have been shown to spawn in response to a sharp increase in light (Berrill, 1975; Whittingham, 1967). Therefore, it is possible that spawning in *Clavelina lepadiformis* could be triggered by low turbidity.

Decrease in turbidity

Increase in wave exposure	Intermediate	High	Low	Moderate

Clavelina lepadiformis is tolerant of a wide range of exposure, but is most abundant in moderately exposed sites (Picton, 1997). Therefore, changes in wave exposure are not likely to have any significant effect. However, increases above moderately exposed are likely to have adverse effects on the population resulting in loss of colonies, therefore, intolerance is assessed as intermediate. Recoverability is likely to be high (see additional Information below).

Decrease in wave exposure

Noise	Tolerant	Not relevant	Not sensitive	Low

It is unlikely that sea squirts can detect noise vibrations.

Visual Presence	Tolerant	Not relevant	Not sensitive	Low

It is unlikely that sea squirts are able to detect visual presence or lower light intensities due to shading.

Abrasion & physical disturbance	High	Moderate	Moderate	High

The light bulb tunicate is permanently attached to the substratum and is unable to move out of the way from abrasive objects. The body of the species is soft and delicate, so abrasion is likely to cause physical damage and possibly death. Intolerance is assessed as high. Recoverability is likely to be moderate (see additional information below).

Displacement	High	Moderate	Moderate	Moderate

After displacement, adults may not be able to reattach to the substratum. Intolerance is assessed as high. Recoverability is likely to be moderate (see Additional Information section below).

Chemical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Synthetic compound contamination		Not relevant		Not relevant

TBT and PCBs are generally considered to be toxic to marine invertebrates (Cole *et al.*, 1999). However, there is insufficient information with respect to effects on *Clavelina lepadiformis*.

Heavy metal contamination	Tolerant	Not relevant	Not sensitive	Moderate

Several species of tunicate are known to accumulate high concentrations of trace metals. De Caralt *et al.* (2002) studied differences in certain aspects of the biology of *Clavelina lepadiformis* between harbour and open rocky littoral populations in the Mediterranean. They reported that *Clavelina lepadiformis* accumulated copper, lead and vanadium (vanadium is used in ascidian metabolism). The harbour population contained significantly more copper and lead than open littoral population despite its abundance being an order of magnitude higher in the

harbour, suggesting that both adults and larvae are tolerant to this kind of contamination. Tolerant has been suggested.

Hydrocarbon contamination		Not relevant		Not relevant

Cole *et al.* (1999) stated that polycyclic aromatic hydrocarbons are of moderate toxicity to marine organisms. However there is insufficient information with regard to effects of hydrocarbons on *Clavelina lepadiformis*.

Radionuclide contamination		Not relevant		Not relevant

Insufficient Information.

Changes in nutrient levels		Not relevant		Not relevant

There is some suggestion that there are possible benefits to the adults from increased organic content of water (Naranjo *et al.* 1996).

Increase in salinity	Low	Immediate	Not sensitive	Low

Clavelina lepadiformis is tolerant of a wide range of salinities; Fish & Fish (1996) found that they could tolerate salinities as low as 14 psu. However, colonies in areas of full salinity are likely to be adversely affected by a short term acute change in salinity. Intolerance to salinity is assessed as low. Recoverability is likely to be immediate (see Additional Information below), when conditions return to normal or the sea squirt has adapted to the new levels.

Decrease in salinity

Changes in oxygenation	Low	Immediate	Not sensitive	Low

Cole *et al.* (1999) suggest possible adverse effects on marine species below 4 mg/l and probable adverse effects below 2 mg/l. No information was found concerning the tolerance of *Clavelina lepadiformis* to changes in oxygenation. However, the species lives in extremely sheltered conditions where oxygen depletion may occur. Therefore, intolerance has been assessed as low. Recoverability is likely to be immediate (see Additional Information below), once conditions return to normal or the species has adapted to the new oxygen concentration levels.

Biological Pressures

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

Insufficient Information.

Introduction of non-native species	Tolerant	Not relevant	Not sensitive	Low

No alien or non-native species are known to affect *Clavelina lepadiformis* in Britain and Ireland.

Extraction of this species	Not relevant	Not relevant	Not relevant	Moderate

It is extremely unlikely that *Clavelina lepadiformis* will be subject to extraction.

Extraction of other species	Tolerant	Not relevant	Not sensitive	Moderate

Adult *Clavelina lepadiformis* are not known to depend on other species. Therefore, the species is assessed as not sensitive.

Additional information

Clavelina lepadiformis most likely has a short life span, of approximately 2 years. Each zooid reproduces once during June to September in temperate and cold seas (Picton & Costello, 1998; Millar, 1970) but in tropical waters it may continue throughout the year (Millar, 1970). In the Mediterranean, the breeding season is winter/spring (X. Turon, pers. comm.). Brunetti (1987) recorded up to about 50 embryos present in the atrium at one time. The larval phase is short, and metamorphosis into adults is rapid, so dispersal may be limited. Recolonization following incident is likely to be within a year providing that other nearby populations have survived. Rafting by adults attached to floating objects or shipping may form an important mechanism for recolonization.

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

Clavelina lepadiformis is dominant over other organisms (Teo & Ryland, 1994).

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