MarLIN

Marine Information Network

Information on the species and habitats around the coasts and sea of the British Isles

Dulse (*Palmaria palmata*)

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/1405]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

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***Palmaria palmata* fronds on lower eulittoral rock.**
Photographer: Keith Hiscock

See online review for distribution map

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

Researched by	Jacqueline Hill	**Refereed by**	Dr Thomas Wiedemann
Authority	(Linnaeus) Weber & Mohr, 1805		
Other common names	-	**Synonyms**	-

Summary

Description

A foliose red algae with a tough flat frond usually between 20 and 50 cm in length, but sometimes up to 1m. The algae grows directly from a small discoid holdfast gradually widening and subdividing. The stipe is inconspicuous, rarely to 5 mm long. Older parts may have small 'leaflets' along the margin especially where damaged. Dark red, with purple tints under water.

Recorded distribution in Britain and Ireland

Generally distributed throughout Britain and Ireland, but apparently absent from significant stretches of coast in eastern England.

Global distribution

Arctic Russia to Portugal; Baltic. Artic Canada to USA (New Jersey); USA (Alaska to California); Japan, Korea.

Habitat

Epilithic and epiphytic, especially on *Laminaria hyperborea* stipes. Littoral and sublittoral to a depth of 20 m in both sheltered and moderately exposed areas.

Depth range

To a depth of 20m

Identifying features

- Blade leathery-membranous without midrib, the total length usually between 20 cm and 50c m long, but sometimes up to 1 m. Blade width about 3-8 cm rarely up to 16 cm.
- Fronds solitary or a few together, simple below or branching from the base, stipe inconspicuous, blade gradually expanding above, dichotomously or palmately divided into broad segments. Blade sometimes simple, with marginal proliferations often dichotomous and large, resembling primary blade.
- Thallus with a discoid holdfast and erect fronds, purplish red in colour.

Additional information

Sometimes the blade divisions are wedge-shaped and finely dissected above or the blade has numerous linear divisions throughout. This phenomenon seems to occur under fairly sheltered, silty conditions. Such plants are difficult to identify without examining the anatomical structure and the cortical cells in surface view, and have been confused with *Callophyllis cristata* (L. ex Turn.) Kütz. and *Gracilaria foliifera* (Forsk.) Børk (Irvine, 1983). *Palmaria palmata* has a multiaxial, pseudoparenchymatous construction and, in section, can be seen to consist of a large-celled medulla bounded on each side by a small-celled cortex.

Listed by

Further information sources

Search on:

NBN WoRMS

Biology review

Taxonomy

Phylum	Rhodophyta	Red seaweeds
Class	Florideophyceae	
Order	Palmariales	
Family	Palmariaceae	
Genus	Palmaria	
Authority	(Linnaeus) Weber & Mohr, 1805	
Recent Synonyms	-	

Biology

Typical abundance	
Male size range	up to 50cm
Male size at maturity	
Female size range	Large(>50cm)
Female size at maturity	
Growth form	Crustose soft
Growth rate	100% body wt/week
Body flexibility	High (greater than 45 degrees)
Mobility	
Characteristic feeding method	Autotroph
Diet/food source	
Typically feeds on	Not relevant
Sociability	
Environmental position	Epilithic
Dependency	Independent. Often epiphytic - see additional information.
Supports	Substratum algal epiphytes and endophytes and a number of marine fungi.
Is the species harmful?	No *Palmaria palmata* is an edible species.

Biology information

- The life-cycle of *Palmaria palmata* is diplohaplontic and strongly heteromorphic, with a reduced crustose female gametophyte and a macroscopic foliose male gametophyte.
- Where competition for space and light restricts the occurance of *Palmaria palmata* on rock the species often has an epiphytic habit on other algae, especially kelps.

Habitat preferences

Physiographic preferences	Open coast, Strait / sound, Enclosed coast / Embayment
Biological zone preferences	Lower eulittoral, Sublittoral fringe, Upper infralittoral

Substratum / habitat preferences	Macroalgae, 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.), Weak < 1 knot (<0.5 m/sec.)
Wave exposure preferences	Moderately exposed, Sheltered
Salinity preferences	Full (30-40 psu)
Depth range	To a depth of 20m
Other preferences	No text entered
Migration Pattern	Non-migratory / resident

Habitat Information

No text entered

Life history

Adult characteristics

Reproductive type	Oogamous
Reproductive frequency	Annual episodic
Fecundity (number of eggs)	No information
Generation time	Insufficient information
Age at maturity	See additional text.
Season	
Life span	Insufficient information

Larval characteristics

Larval/propagule type	-
Larval/juvenile development	Spores (sexual / asexual)
Duration of larval stage	Not relevant
Larval dispersal potential	<10 m
Larval settlement period	Not relevant

Life history information

- **Lifespan.** *Palmaria palmata* is a perennial species with new growth every year. Therefore, the holdfast could remain for several years..

The unusual life cycle of *Palmaria palmata* is diplohaplontic and strongly heteromorphic, with a reduced female gametophyte, a macroscopic male gametophyte and a foliose tetrasporophyte. The foliose plants seen on the shore and in the shallow subtidal are generally tetrasporophytes and scarcer male gametophytes.

- The female is a small crust-like plant, in which the carpogonia are borne directly by the vegetative cells.
- The male gametophyte, on the other hand, is blade-like and produces spermatia that can

fertilize the carpogonia of the female crusts.
- After fertilization the carpogonium does not produce carpospores but instead develops into a blade-like tetrasporophyte.
- When young, the tetrasporophyte grows attached to the female gametophyte, later its own basal system develops and completely overgrows the tiny female thallus.
- The adult foliose tetrasporophyte, which is diploid, produces tetraspores meiotically and these in turn develop into crust-like female gametophytes and foliose male gametophytes.
- Male plants became fertile within 9-12 months. Females need only a few days to become sexually mature.
- Dispersal distances are short. Females do not release carpospores so male gametophytes release spermatia that then sink rapidly so that male and female gametes can come into contact for fertilization.

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	High	Moderate	High

Palmaria palmata will be removed with the substratum, unable to re-attach and it is therefore highly intolerant of substratum loss. There is little information on recruitment or recolonization rates. However, in kelp canopy removal experiments in the Isle of Man, Hawkins & Harkin (1985) observed a rapid increase in the number of *Palmaria palmata* sporelings and the species came to dominate cleared plots within five months. Rhodophyceae have non flagellate, and non-motile spores that stick on contact with the substratum. Norton (1992) noted that algal spore dispersal is probably determined by currents and turbulent deposition. However, red algae produce large numbers of spores that may settle close to the adult especially where currents are reduced by an algal turf or in kelp forests. It is likely that this species could recolonize an area from adjacent populations within a short period of time in ideal conditions. However, since the dispersal range of spores is limited because the female does not release carpospores and needs to be close to the adult male population, recolonization from distant populations would probably take much longer.

	Intolerance	Recoverability	Sensitivity	Confidence
Smothering	Intermediate	High	Low	Moderate

Adult plants are usually about 20cm in height and will probably survive smothering to a depth of 5cm by sediment. Smaller germlings and juveniles are likely to be more intolerant of smothering. Algal spores and propagules are adversely affected by a layer of sediments, which can exclude up to 98% of light (Vadas *et al*., 1992), and is likely to interfere with settlement and attachment of spores.

	Intolerance	Recoverability	Sensitivity	Confidence
Increase in suspended sediment	Low	High	Low	High

Palmaria palmata is likely to have low intolerance to siltation because it is often found in areas of high siltation. In the Bay of Fundy for example, where the tidal flux of nutrients from the marshes includes a high level of suspended sediment, there is luxurious growth of *Palmaria palmata*. Irvine (1983) has also observed morphological adaptation of the plant in fairly sheltered, silty conditions. Sometimes the blade divisions are wedge-shaped and finely dissected above or the blade has numerous linear divisions throughout. It is likely that this form reduces possible smothering that may result from increased siltation.

Decrease in suspended sediment

	Intolerance	Recoverability	Sensitivity	Confidence
Dessication	Intermediate	High	Low	High

Extending into the intertidal *Palmaria palmata* is exposed to regular periods of emersion and so is probably tolerant of a limited amount of desiccation. Perhaps surprisingly, the flux of water vapour from flat laminae, such as those of *Palmaria palmata*, is less than from cylinders constructed of similar material (Schonbeck & Norton, 1979). *Palmaria palmata* grew more abundantly higher up the shore following the massive mortality of molluscan grazers after the *Torrey Canyon* oil spill suggesting the upper limit is set by grazing rather than desiccation

(Hawkins & Hartnoll, 1983). Spores and developing germlings are particularly susceptible to desiccation as they have very large surface-to-volume ratios, although they benefit from the film of water that persists in concavities on the substratum (Kain & Norton, 1990). An increase in desiccation at the benchmark level is likely to result in the death of the upper portion of the population depressing the upper limit of the species. Recovery is high because sub-tidal populations of the species are likely to remain unaffected and will constitute a reservoir from which recruitment can occur. Conversely, a decrease in desiccation may enable the population to extend its range up the shore.

Increase in emergence regime	Intermediate	High	Low	Moderate

Palmaria palmata is a low shore and shallow sub-tidal species and is therefore, likely to be tolerant of a degree of emergence. A change in emergence time of one hour for a period of a year is likely to affect the distribution range of the species because of changes in desiccation, insolation and competition from other algae. An increase in emergence may result in the death of plants at the upper limit and will depress the extent of the population up the shore. Conversely, a decrease is likely to enable the population to extend its range up the shore. Recovery is high because sub-tidal populations of the species are likely to remain unaffected and will constitute a reservoir from which recruitment can occur.

Decrease in emergence regime

Increase in water flow rate	Intermediate	High	Low	Moderate

Moderate water movement is beneficial to seaweeds. It carries a supply of nutrients and gases to the plants, removes waste products, and prevents settling of silt. Seaweeds in still water rapidly deplete the nutrients in the immediate vicinity (Kain & Norton, 1990). In contrast, plants growing in moving water have a steady supply of nutrients. *Palmaria palmata* is found in a range of water flow regimes from moderately strong to weak. In increasing water flow rate the downstream deflection of the thallus caused by flowing water increases the plants rate of growth by presenting the thallus perpendicular to the incident light. As a result *Palmaria palmata* can achieve a remarkable stature when growing in steady tidal streams, growing up to a meter long (Jorde, 1966). However, an increase to very strong flows may inhibit settlement of spores and may remove adults or germlings although flow rates experienced within kelp forests will be reduced.

Decrease in water flow rate

Increase in temperature	Intermediate	High	Low	Moderate

Palmaria palmata does well in low temperatures, with an optimum between 6 and 15°C, consistent with a distribution in northern temperate and arctic waters. In the laboratory, plants only became fertile if left at temperatures between 5-7°C with a short light period (Meer van der, 1979). In tank cultures of the species at 20°C and above, all plants were dead within a week (Morgan *et al*., 1980). Such high temperature, however, are unlikely in most parts of Britain and Ireland. However, Kain & Norton (1990) suggest that a widely distributed species like *Palmaria palmata* reacts less strongly to temperature differences than some other red algae.

Decrease in temperature

Increase in turbidity	Low	Very high	Very Low	Low

Red algae are well adapted to low light conditions and so may be tolerant of increased turbidity. In the Bay of Fundy for example, where the tidal flux of nutrients from the marshes includes a high level of suspended sediment *Palmaria palmata* grows well despite high turbidity. In the absence of nutrients short term increase in turbidity may affect growth and reproduction, however, as a perennial, the adults will probably survive. *Palmaria palmata* is likely to be intolerant of large scale long term (years) increases in turbidity limiting the maximum depth to which it can survive.

Decrease in turbidity

Increase in wave exposure	Intermediate	High	Low	Moderate

Although *Palmaria palmata* is most abundant on moderately exposed to sheltered shores it has been recorded from highly exposed shores in Norway (Jorde, 1966) in association with *Alaria esculenta* stipes. Rock dwelling plants were abundant only on moderately exposed and sheltered shores. Therefore an increase in wave exposure is likely to limit the species to an epiphytic habit where plants are sheltered from the worst effects of wave action by depth or kelp plants. On return to normal conditions recovery is likely to be high with recolonization of rock by *Palmaria palmata* plants possible within 5 months (Hawkins & Harkin, 1985).

Decrease in wave exposure

Noise	Not relevant	Not relevant	Not relevant	Not relevant

Marine algae have no known sound or vibration receptors.

Visual Presence	Not relevant	Not relevant	Not relevant	Not relevant

Marine algae have no known response to visual stimuli.

Abrasion & physical disturbance	Intermediate	High	Low	Low

Little information is available on the effects of abrasion on intertidal red algae. However, the growth form of *Palmaria palmata*, which is leathery and membranous, suggests it would be damaged by abrasion but not entirely removed. Although there are no reports of the effects of trampling on British shores, Brosnan & Crumrine (1994) found that the foliose red algae *Mastocarpus papillatus* was intolerant of moderate levels of trampling. Therefore, an intolerance of intermediate has been suggested. Recovery from abrasive damage is good because growth can continue from the production of small leaflets at damaged margins and recolonization is rapid on cessation of trampling.

Displacement	High	High	Moderate	High

If *Palmaria palmata* is removed from the substratum it is unable to reattach and so intolerance is very high. However, it is likely that this species could recolonize an area from adjacent populations within a short period of time in ideal conditions. In kelp canopy removal experiments in the Isle of Man, for example, Hawkins & Harkin (1985) observed a rapid increase in the number of *Palmaria palmata* sporelings on bare rock and the species came to dominate cleared plots within five months. Recolonization from distant populations would probably take longer, however, because dispersal distances are limited, with spores sinking and attaching close to adult plants.

Chemical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Synthetic compound contamination	High	High	Moderate	Moderate

O'Brien & Dixon (1976) suggested that red algae were the most sensitive group of algae to oil contamination, although the filamentous forms were the most sensitive. Laboratory studies of the effects of oil and dispersants on several red algae species, including *Palmaria palmata* (Grandy, 1984 cited in Holt *et al.*, 1995) concluded that they were all intolerant of oil/ dispersant mixtures, with little differences between adults, sporelings, diploid or haploid life stages. Cole *et al.* (1999) suggested that herbicides, such as simazina and atrazine were very toxic to macrophytes. Hoare & Hiscock (1974) noted that all red algae was excluded from Amlwch Bay, Anglesey by acidified halogenated effluent discharge. Such evidence suggests *Palmaria palmata* has high intolerance to synthetic chemicals.

Heavy metal contamination Intermediate High Low Low

Bryan (1984) suggested that the general order for heavy metal toxicity in seaweeds is: Organic Hg > inorganic Hg > Cu > Ag > Zn > Cd > Pb. Cole *et al.* (1999) reported that Hg was very toxic to macrophytes. The sub-lethal effects of Hg (organic and inorganic) on the sporelings of another intertidal red algae, *Plumaria elegans*, were reported by Boney (1971), where 100% growth inhibition was caused by 1 ppm Hg in his study. However, little information concerning the effects of heavy metals on *Palmaria palmata* was found. Heavy metals have the potential to accumulate in plant tissue, therefore it may take some time for tissue levels to fall before recovery can begin.

Hydrocarbon contamination High High Moderate Moderate

O'Brien & Dixon (1976) suggested that red algae were the most sensitive group of algae to oil or dispersant contamination, possibly due to the susceptibility of phycoerythrins to destruction, but that the filamentous forms were the most sensitive. Laboratory studies of the effects of oil and dispersants on several red algae species, including *Palmaria palmata* (Grandy 1984 cited in Holt *et al.* 1995) concluded that they were all sensitive to oil/ dispersant mixtures, with little differences between adults, sporelings, diploid or haploid life stages.

Radionuclide contamination Not relevant

Insufficient information.

Changes in nutrient levels Intermediate High Low High

Marine algae are often nutrient limited, by nitrogen in particular, so an increase in nutrient levels usually results in increase growth and fecundity. In the Bay of Fundy, for example, where there is a tidal flux of nutrients from the marshes there is luxurious growth of *Palmaria palmata*. However, very high levels of nutrients can be toxic to macroalgae. Plants placed in tanks with continuous immersion in high nutrients over several weeks stopped growing (Morgan *et al.*, 1980). In general, the great majority of reports refer to an increase in the number of green algae associated with eutrophicated waters, usually at the expense of red and brown algae. In *Palmaria palmata* luxury nitrogen accumulates in the blades when growth does not keep up with uptake (Morgan *et al.*, 1980). Such storage can be particularly important at high latitudes where nutrient availability and light are limited at certain times of the year.

Increase in salinity Intermediate High Low Moderate

In laboratory experiments maximum rates of photosynthesis and respiration in *Palmaria palmata* were observed at a salinity 32psu (Robbins, 1978) although photosynthetic rates were high down to a salinity of 21psu. *Palmaria palmata* is likely to be tolerant of small changes in salinity because as an intertidal species it is regularly exposed to precipitation. However, the species is not recorded as inhabiting reduced salinity habitats and intolerance has therefore been assessed as intermediate.

Decrease in salinity

Changes in oxygenation Low Immediate Not sensitive Low

Little information on the effects of oxygen depletion on macroalgae was found although Kinne (1972) reports that reduced oxygen concentrations inhibit both photosynthesis and respiration which may affect growth and reproduction. The effects of decreased oxygen concentration equivalent of the benchmark would be greatest during the dark when the kelps are dependant on respiration. However, *Palmaria palmata* extends into the intertidal and will be able to respire during periods of emersion. Therefore, it is likely that intolerance to low oxygenation (2mg/l) in seawater for a week is low. Effects are likely to be short lasting on return to normal oxygen concentrations so recovery is assessed as immediate.

Biological Pressures

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

Fronds frequently bear algal epiphytes and endophytes and a number of marine fungi but more rarely the parasite *Halosacciocolax kjellmanii* Lund (Guiry). Galls are produced by nematodes, copepods and bacteria (Irvine, 1983). The effect of such organisms however, is not known.

	Intolerance	Recoverability	Sensitivity	Confidence
Introduction of non-native species	Not relevant	Not relevant	Not relevant	Not relevant

No non-native species were identified that compete with *Palmaria palmata*.

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

Palmaria palmata is used as a vegetable substitute or animal fodder although harvesting on a commercial scale only takes place in Ireland and France. Recovery from extraction of 50% of the species is likely to be high because remaining plants constitute a reservoir from which recruitment can occur. In the Isle of Man recruitment of new plants to kelp cleared plots occurred within five months (Hawkins & Harkin, 1985).

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

Light is important for photosynthesis and shading from kelps can limit the growth of understorey algae. Clearances of *Laminaria* spp. allowed dramatic increases in growth of *Palmaria palmata* (Hawkins & Harkin, 1985).

Additional information

Importance review

Policy/legislation

- no data -

Status

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

Non-native

Native	-		
Origin	-	**Date Arrived**	-

Importance information

In North America and Europe (Brittany, Ireland and Iceland) the fronds of *Palmaria palmata* are eaten raw as a vegetable substitute or dried and eaten as a condiment (Guiry & Blunden, 1991). The species is also used as fodder for a variety of animals in many countries.

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