MACROALGAE FACT SHEETS

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2ND EDITION

Credits

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The first edition has been revised in terms of content and format by the authors. Additionally, the students from Bromangymnasiet, Nature Science specialisation course (Sweden) and from VAL (Norway) helped with valuable feedback to improve it. As a result new information has been added, and eight new fact sheets have been created.The authors would like to thank the ERASMUS+ Macroalgae Initium consortium, and especially Halvor Mortensen from VAL and Magnus Johansson from Bromangymnasiet for their input.

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Icon guide

Type of seaweed

Brown algae | Green algae | Red algae

Harvest and Cultivation Methods

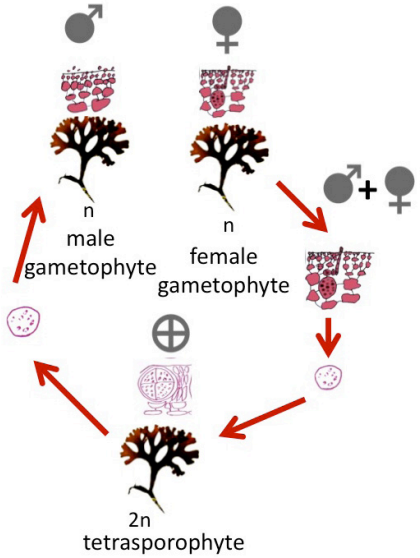
Hand harvest | Sea Cultivation | Tank Cultivation

Abundance

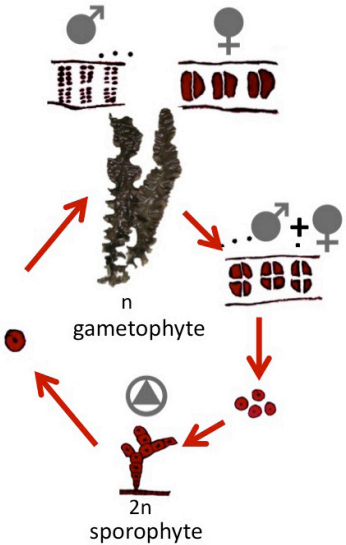
Occasional | Frequent | Common

Life cycles

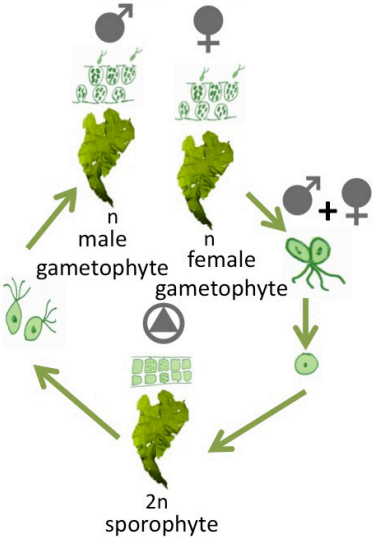
LC1: Red alga (e.g. *Chondrus*)



LC2: Red alga (e.g. *Porphyra*)

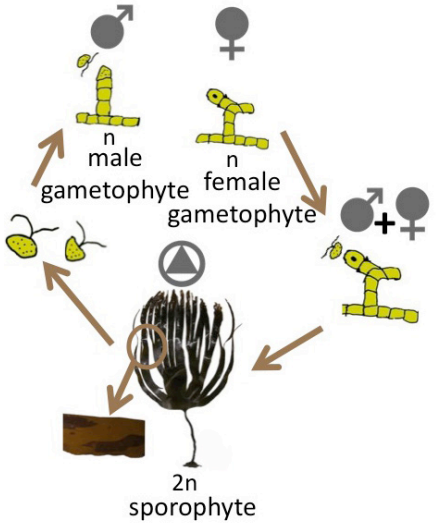


LC3: Green alga (e.g. *Ulva*)

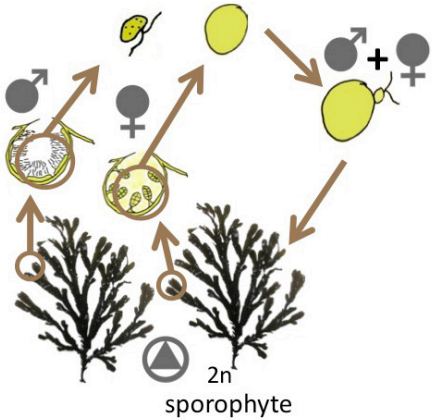


Life cycles

LC4: Brown alga (e.g. *Laminaria*)



LC5: Brown alga (e.g. *Fucus serratus*)



Life-cycles created by Jazmin Hernández-Kantún

Index

BROWN ALGAE

RED ALGAE

GREEN ALGAE

Alaria esculenta

Common names: Atlantic wakame, Dabberlocks.
Irish names: Láir, Láracha, Sraoilleach.

Phylum: Ochrophyta
Class: Phaeophyceae
Order: Laminariales
Family: Alariaceae
Genus: Alaria
Species: A. esculenta

Fig 1. *Alaria esculenta* fronds showing distinctive midrib.

Morphology

- This brown alga has a small holdfast, with a short stipe that extends from the holdfast and continues as a distinct midrib for the length of the blade.
- The blade is elongated, soft, flexible and rounded at the tip.
- Commonly 1-2 m in length, but may be larger, and 5-40 cm in width, tapering slowly towards the tip.
- The colour is generally a dark brown with a paler midrib.
- This species is difficult to mistake for any other in Ireland because of its distinctive midrib.

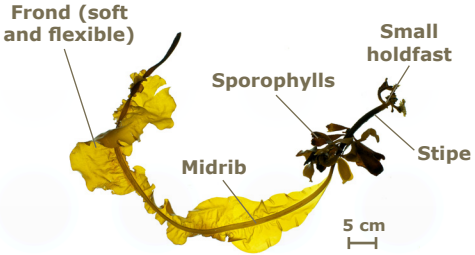


Fig 2. Morphology.

Reproduction

- *Alaria esculenta* sporophytes are the macroscopic phase of the two-stage life-cycle (see LC4*).
- Reproductive structures are located in sporophylls, in dark patches called sori. The sporophylls containing sori form on the stipe, below the base of the blade/frond. They can be numerous, forming a dense bundle between 10 – 20 cm in length.

♀♂ Male and female gametes occur on separate microscopic individuals (gametophytes).

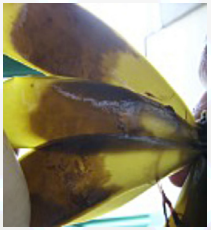
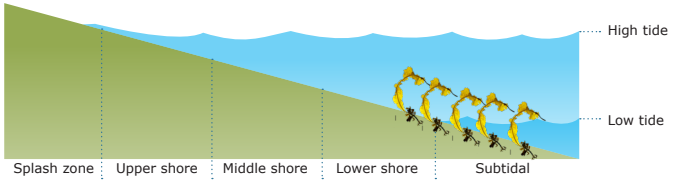


Fig 3. Fertile wing-like sporophylls.

*Note: Life-cycle 4 (LC4) on page 4.

Distribution and habitat

- Occurs throughout the N Atlantic (from Greenland to France) and along both western and eastern Atlantic shores. Also found in the NE Pacific (Alaska).
- It is commonly found between 0-8 m depth but may grow deeper in areas of good light penetration. Prefers rocky substrata in weak or strong currents at exposed to extremely exposed locations.



Seasonality

Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

• Known as Atlantic Wakame due to its similarity to the Asian Wakame species (*Undaria pinnatifida*). This is a tasty seaweed that can be used in many dishes – soups, casseroles, breads, and even in sweet desserts. Like all the kelps, it is rich in vitamins, minerals, and particularly iodine.

• All the kelps contain alginates which are used as for thickeners, stabilizers, and gelling agents for food: E400 – alginic acid, E401 – sodium alginate, E402 – Potassium alginate, E403 – Ammonium alginate, E404 – Calcium alginate, E405- Propylene glycol alginate (PGA).

• This species was first cultivated on longlines in Ireland in the mid 1990's.

• It's holdfast is so strongly attached to the rock that when pulled, sometimes the rock breaks off before the holdfast does!

Ascophyllum nodosum

Common names: Egg wrack, Knotted wrack, Sea yellow tang. **Irish name:** Feamainn bhuí.

Phylum: Ochrophyta
Class: Phaeophyceae
Order: Fucales
Family: Fucaceae
Genus: Ascophyllum
Species: A. nodosum

Fig 1. *Ascophyllum nodosum* fronds showing air bladders.

Morphology

- Brown alga with long, leathery, irregularly branched fronds carrying large egg-shaped, single air bladders at intervals along the main axis and branches.
- Growing up to 2 m long, with fronds up to 1 cm wide.
- Plants are attached to the substratum by a discoidal holdfast.
- The colouration ranges from olive-green to yellow-brown (depending on time of year and wave exposure), turning greenish black when dried.
- It should not be confused with *Fucus vesiculosus* which has pairs of bladders at intervals along the branches.

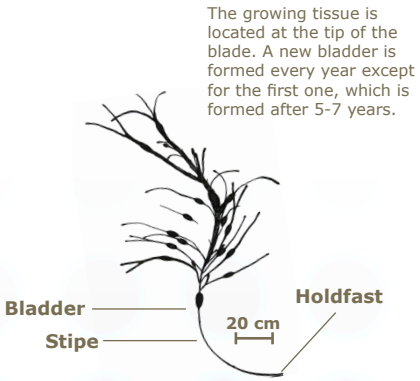


Fig 2. Morphology.

Reproduction

- *Ascophyllum nodosum* has a direct life-cycle (see LC5*).
- Male and female structures occur on different individuals. The reproductive structures known as receptacles grow out laterally from the sides of the fronds, usually in pairs.
  - ♀ Fertile female receptacles are green.
  - ♂ Fertile male receptacles are green to golden brown.

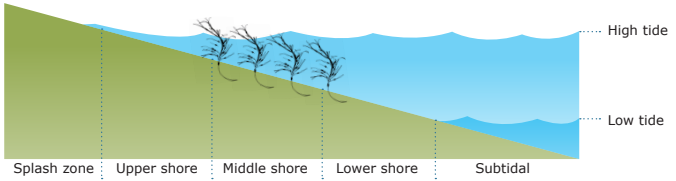
*Note: Life-cycle 5 (LC5) on page 4.

Fig 3. Detail of the reproductive receptacles (male).

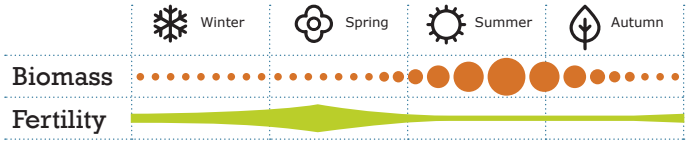
Ascophyllum nodosum

Distribution and habitat

- It is found in the NE Atlantic (from the Arctic shores to Portugal) and NW Atlantic (from Arctic to New Jersey).
- It grows in the mid-littoral zone in wave sheltered rocky shores.



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

- Individual fronds can grow for up to 15 years before breakage. It has been suggested that some stands may be over 400 years old.
- Up to 25,000 wet tonnes are harvested sustainably in Ireland by hand each year.
- It is used as a livestock feed additive. It may make up to 5% of the diet for poultry, sheep, cattle, pigs and horses.

- In some areas it is used as packing material for shellfish transport.
- It is listed in France as a species allowed for human consumption, as a good source of vitamins and trace elements.
- It is known to have anti-coagulant, anti-thrombotic and anti-inflammatory properties.

Colpomenia peregrina

Common names: Oyster thief, Bladder weed, Balloons.
Irish name: Gadaí oisrí.

Phylum: Ochrophyta
Class: Phaeophyceae
Order: Ectocarpales
Family: Scytosiphonaceae
Genus: Colpomenia
Species: C. peregrina

Fig 1. Underwater plants of *Colpomenia peregrina.*

Morphology

- Brown alga shaped like a hollow sphere or ball when young. As the plants get older the cavity fills with air and the round shape becomes amorphous and collapses.
- The plant has thin walls, with a smooth texture and is non- gelatinous.
- Colour is brown to olive brown, 3 to 7 cm in diameter.
- Often confused with *Leathesia marina* of thicker shiny walls and gelatinous.

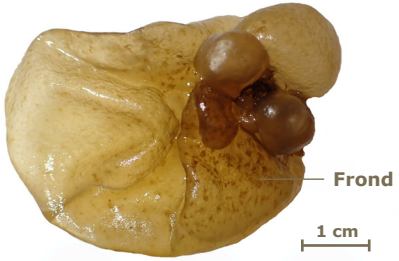


Fig 2. Morphology.

Reproduction

- *Colpomenia peregrina* has an heteromorphic life cycle with an alternation of the ball-like gametophytes and sporophytes in the form of an easily overlooked loosely filamentous crust (see LC4*).
- Extensive asexual reproduction also takes place from unfertilised female gametes, zoospores and fragmentation.
- Fertile *Colpomenia* has an irregular sori evident as slightly darker areas.

♀♂ Male and female structures occur on separate filamentous individuals.

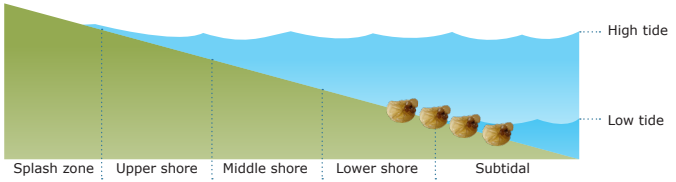
- Asexual reproduction takes place from unfertilized female gametes, zoospores and fragmentation.

*Note: Life-cycle 4 (LC4) on page 4.

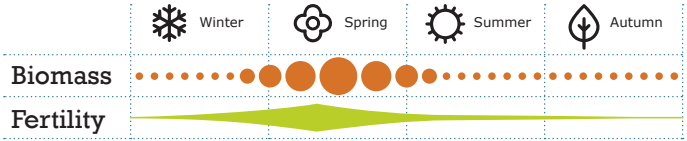
Fig 3. *Colpomenia peregrina* plants exposed at low tide.

Distribution and habitat

- Occurs in the NE Atlantic, from Norway to Canary Islands; Eastern Mediterranean, Israel and Turkey; NW Pacific, Japan; NE Pacific from Alaska to California, Australia and New Zealand.
- Found as an epiphyte on seaweeds in the intertidal zone, in pools and also on wave-exposed rocks.



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

• At the beginning of the 20th century, *Colpomenia* was introduced on the Atlantic coast of France, possibly by the Gulf stream drift and migrated to most Atlantic and Mediterranean shores.

• It was reported to have caused considerable damage to the oyster industry in France. Plants of *Colpomenia* attached themselves to the oysters and when bladders became old they filled with air and caused the oysters to float away and be lost, - hence the common name Oyster thief.

• The tissue of the hollow ball tears like paper and is a good way to distinguish it from *Leathesia marina* which breaks into gelatinous pieces.

Fucus serratus

Common names: Serrated wrack, Saw wrack, Toothed wrack. **Irish names:** Feamainn dhubh, Míoránach, Dulamán, Múrach dhubh.

Phylum: Ochrophyta
Class: Phaeophyceae
Order: Fucales
Family: Fucaceae
Genus: Fucus
Species: F. serratus

Fig 1. Fronds of *Fucus serratus*.

Morphology

- Brown alga with an irregular branched frond and a distinct midrib. The leaves are flat and smooth with characteristic serrated edges.
- The fronds have an olive-yellow-brown colour when fresh to a green-black when dried and can be up to 80 cm long.
- Other species of this genus found in Ireland are *F. vesiculosus, F. spiralis, F. ceranoides, F. macroguiryi* and very rarely *F. distichus* and *F. cottonii*.

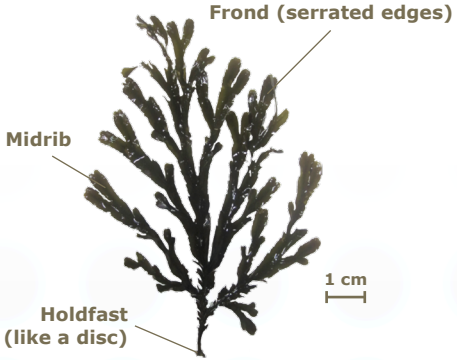


Fig 2. Morphology.

Reproduction

- *Fucus serratus* has a direct life-cycle (see LC5*).
- Reproductive individuals can be easily identified. The tips of the fronds bearing reproductive structures have a thick and granulated texture.

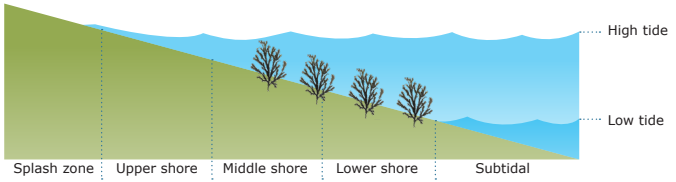
♀♂ Male and female structures occur on separate thalli.

*Note: Life-cycle 5 (LC5) on page 4.

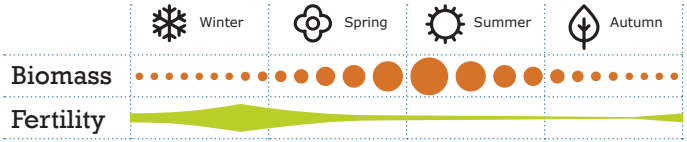
Fig 3. Reproductive thallus (tips) of *Fucus serratus*.

Distribution and habitat

- This species is found in the NE Atlantic, from northern Norway to northern Portugal, N Sea and W Baltic. It has been introduced into the NW Atlantic.
- A common seaweed of wave-exposed shores, widely distributed, growing on rocky substrata. However it is not present on very wave-exposed shores.



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

- *Fucus serratus* is used in Ireland in bodycare products, seaweed baths and, with other *Fucus* species as a land fertiliser.
- It is also used as packing material for transporting shellfish.
- A wide range of bioactivities have been described for species of *Fucus* e.g. antioxidant, antitumor, antivenom, and anticoagulant properties.

Fucus spiralis

Common name: Spiralled wrack.
Irish names: Feamainn bharr chladaigh, Casfheamainn.

Phylum: Ochrophyta
Class: Phaeophyceae
Order: Fucales
Family: Fucaceae
Genus: Fucus
Species: F. spiralis

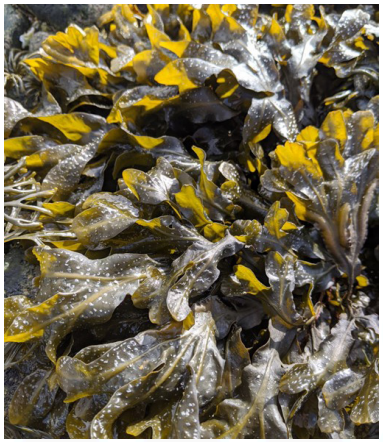


Fig 1. Plants of *Fucus spiralis*.

Morphology

- Brown alga with somewhat irregular branched fronds. Dichotomous flattened fronds evenly forked with a distinct midrib. Fronds are often twisted or 'spiral'.
- The fronds are olive green to light brown in colour when fresh. Fronds can be up to 30 cm long and 2 cm thick.
- Finger-shaped swellings may occur on the frond; this is not an air bladder but a buildup of gases within the thallus.
- Other species of this genus found in Ireland are *F. vesiculosus, F. serratus, F. ceranoides, F. macroguiryi,* rarely *F. distichus* and *F. cottonii*.

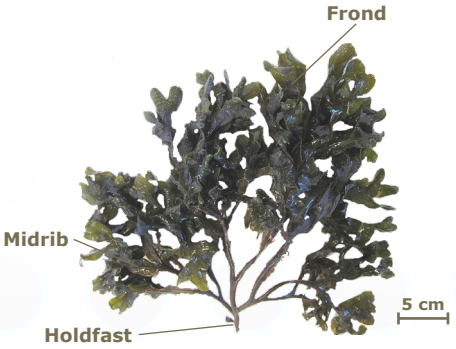


Fig 2. Morphology.

Reproduction

- *Fucus spiralis* reproduces both through self-fertilisation as well as cross-fertilisation when gametes are released externally (see LC5*).
- Reproductive individuals can be easily identified. The tips of the fronds with the reproductive structures have a knobbly appearance, and are usually found in pairs.

♀ ♂ Male and female structures occur in the same individual (hermaphroditic).

*Note: Life-cycle 5 (LC5) on page 4.

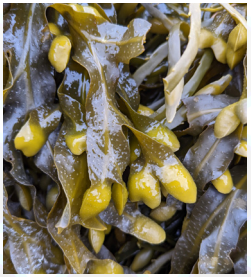
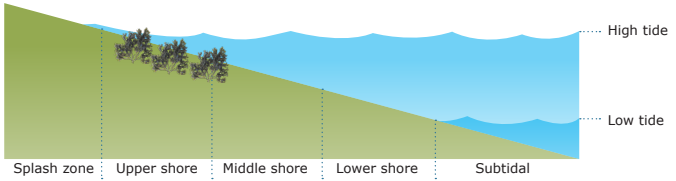


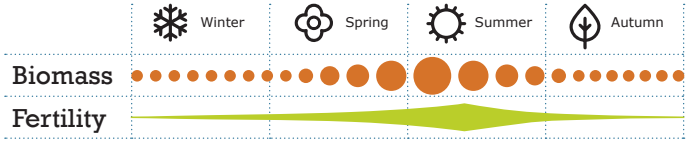
Fig 3. Fertile receptacles of *Fucus spiralis*.

Distribution and habitat

- It is found on the Atlantic coasts of Europe and North America; W Mediterranean, Spain to Morocco and NE Pacific from Alaska to Washington.
- A common seaweed found on the upper shore of sheltered rocky shores. Also can be found in very sheltered shores like the head of sea lochs and in salt marsh vegetation.



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

- *Fucus spiralis* is used in Ireland in body care products, seaweed baths and as fertiliser.
- It has the ability to provide protection against oxidative stress.
- *Fucus spiralis* spends 90 % of the time out of the water. It can tolerate a high level of dessication, being able to survive 70 to 80 % water loss.
- On the shore, it usually forms a recognisable band below Channelled Wrack (*Pelvetia canaliculata*).

Fucus vesiculosus

Common name: Bladder wrack.
Irish name: Feamainn bhoilgíneach.

Phylum: Ochrophyta
Class: Phaeophyceae
Order: Fucales
Family: Fucaceae
Genus: Fucus
Species: F. vesiculosus

Fig 1. Plants of *Fucus vesiculosus*.

Morphology

- Large brown alga with forked, branching fronds supporting many pairs of air bladders either side of a distinct midrib.
- This is the most morphologically diverse of the fucoid species, with individuals varying greatly in size and shape. For example, plants can reach up to 1 m on sheltered shores with many pairs of bladders while at the other extreme on exposed shores, plants seldom exceed 20 cm and have no bladders.
- Different morphologies develop in response to the salinity and wave action e.g. the bladderless forms.

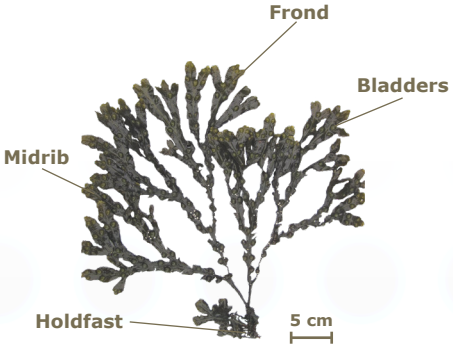


Fig 2. Morphology.

Reproduction

- *Fucus vesiculosus* has a direct life cycle (see LC5*).
- Reproductive individuals can be easily identified. The tips of the fronds bearing the reproductive structures (receptacles) have a bloated, rounded to oval appearance.

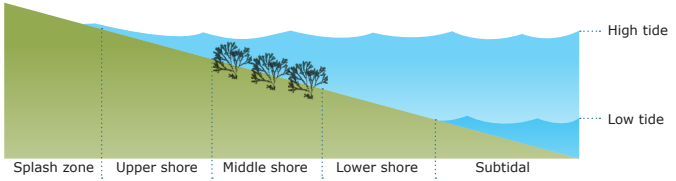
♀♂ Male and female structures occur in separate plants.

*Note: Life-cycle 5 (LC5) on page 4.

Fig 3. Fertile receptacles of *Fucus vesiculosus*.

Distribution and habitat

- This species occurs in NE Atlantic from Greenland to Canary Islands, NW Atlantic from Canadian Arctic to Caribbean, and W Mediterranean.
- A very common seaweed on rocky shores in the mid-intertidal. Can also be found in a wide variety of shores from exposed rocky to sheltered lagoons.



Seasonality

Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

- Many uses of *Fucus vesiculosus* include fertiliser, body care products like shower gels and body creams, and health supplements such as kelp tablets.
- It can be made into a boiled broth and used as a health drink; reported use as a herbal remedy for treating thyroid problems as it is a good source of iodine.
- Reported bioactive ingredients like free radical phlorotannin antioxidants, bioactive polysaccharides, amino acids, vitamins, and minerals.
- In the early 18th century, it was the original source of iodine and used extensively to treat goitre, a swelling of the thyroid gland related to iodine deficiency.

- Some fucoids can hybridise, with cross-fertilisation occurring between eggs and sperm of different fucoid species. The result is that morphological features of these plants can vary somewhat from parental plants.

Himanthalia elongata

Common names: Sea spaghetti, Sea bean, Thongweed.
Irish names: Rúalach, Ríseach, Raif.

Phylum: Ochrophyta
Class: Phaeophyceae
Order: Fucales
Family: Himanthaliaceae
Genus: Himanthalia
Species: H. elongata

Fig 1. Individuals of *Himanthalia elongata*.

Morphology

- This brown alga is closely related to the wracks.
- The so-called "button" is its vegetative base, which annually produces a regularly forked and extremely long receptacle.
- Receptacles are 1-3 m long, 5-10 mm wide, flat, of yellow-brown colour and flexible.
- Older individuals are often overgrown by brown epiphytes forming fine, soft tufts especially near the tips.
- This species has a distinct morphology that is unlikely to be confused with any other species in Ireland.

Fig 2. Morphology.

Reproduction

- *Himanthalia elongata* has a direct life-cycle (see LC5*).
- Reproductive structures are found on the thong-like fronds known as receptacles and appear in little brown dimples (conceptacles).
  - ♀ ♂ Male and female structures occur on separate individuals.

*Note: Life-cycle 5 (LC5) inside front cover.

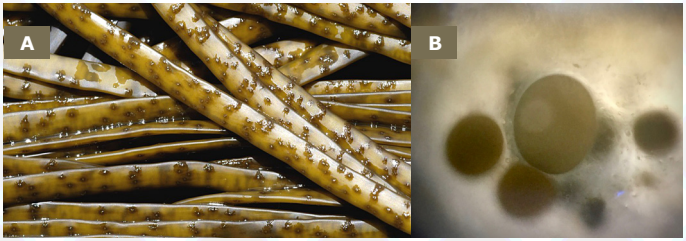
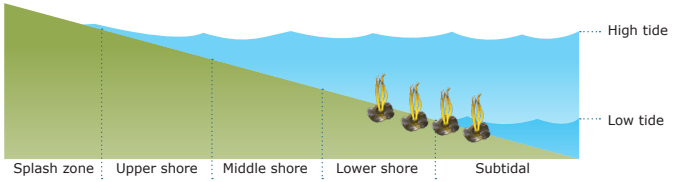


Fig 3. (A) Receptacles with brown, spot-like conceptacles. (B) Female eggs under a microscope.

Distribution and habitat

- *Himanthalia elongata* is found along the European Atlantic coasts (from the Faroe Islands to Portugal).
- It grows on rock and in rock-pools on moderately wave exposed shores.



Seasonality

Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

- Receptacles of *Himanthalia elongata* can be cooked or pickled before eating them as "haricots de mer" (sea beans). Fronds are best when collected young in spring.
- Extracts from this seaweed are used as additives with claimed functions as antioxidants, moisturising, antibacterial and anti-UV properties.

- First successfully cultivated in Ireland in 2019 by the Irish Seaweed Consultancy (INTEGRATE project).

Laminaria digitata

Common names: Oarweed, Tangle, Strapweed.
Irish names: Coirleach, Ribíní.

Phylum: Ochrophyta
Class: Phaeophyceae
Order: Laminariales
Family: Laminariaceae
Genus: Laminaria
Species: L. digitata

Fig 1. *Laminaria digitata* at low-tide.

Morphology

- Brown alga with a large holdfast, long stipe and a large, usually split (digitate or finger-like) blade.
- Very smooth, almost plastic-like to the touch.
- Exposed at low-tide; individuals collapse on top of one another.
- The stipe is long, flexible, smooth, oval in cross-section, without epiphytes.
- The blade is broad, commonly with 5-20 fingers.
- Generally 1-2 m, but may be larger.
- Frond is golden to deep brown in colour.
- Two *Laminaria* species commonly occur in Ireland: *L. digitata* and *L. hyperborea*. Mature individuals can be distinguished by the characteristics of the stipe. A third species, *Laminaria ochroleuca* has recently been reported in Ireland but is rare.

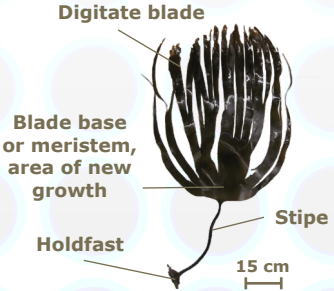


Fig 2. Morphology.

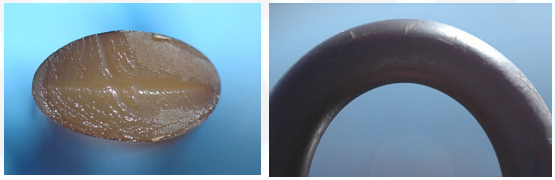


Fig 3. Close up of the stipe – oval in section (left), smooth, flexible (right).

Reproduction

- *Laminaria digitata* sporophytes are the macroscopic phase of a two-stage life-cycle (see LC4*).
- The reproductive tissue (sorus) appears as slightly raised and darkened areas on the fingers of the blades.

♀♂ Male and female gametes occur on separate microscopic individuals (gametophytes).

*Note: Life-cycle 4 (LC4) on page 4.

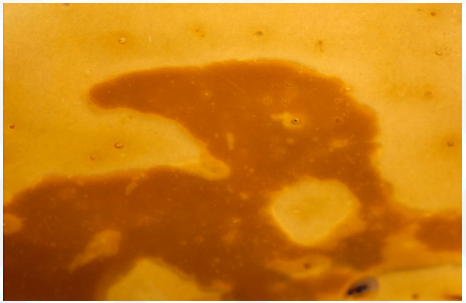
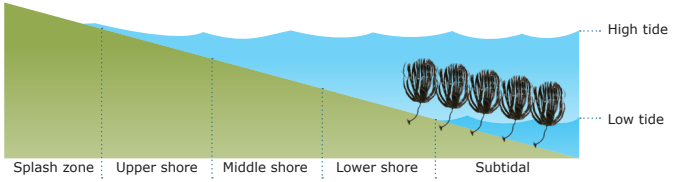


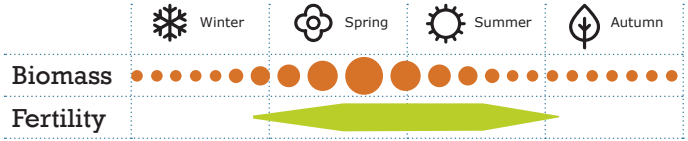
Fig 4. Detail of the sorus on the blade.

Distribution and habitat

- Present throughout E and WN Atlantic shores.
- It inhabits moderately sheltered rock-pools in wave exposed areas, to fully exposed coasts, always at full salinity sites and preferring rocky substrata.



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

• This alga is of agricultural interest for its growth-enhancing properties. It is also a source of bioactive compounds with hypotensive and antibacterial properties.

• All the kelps contain alginates which are used as for thickeners, stabilisers, and gelling agents for food: E400 – alginic acid, E401 – sodium alginate, E402 – Potassium alginate, E403 – Ammonium alginate, E404 – Calcium alginate, E405 – propylene glycol alginate (known in the food industry as as PGA).

• This species was first cultivated on longlines in Ireland in the late 2000's.

• Kelp beds reduce coastal erosion by dampening the intensity of wave forces before they hit the shoreline.

Laminaria hyperborea

Common names: Sea rods, Forest kelp, Cuvie.
Irish names: Leathnach, Feam, Scotach, Feamainn Bhealtaine.

Phylum: Ochrophyta
Class: Phaeophyceae
Order: Laminariales
Family: Laminariaceae
Genus: Laminaria
Species: L. hyperborea

Fig 1. *L. hyperborea* exposed at low-tide.

Morphology

- Brown alga with a large holdfast, long stipe and large, usually split (digitate or finger-like) blade.
- Very smooth, almost plastic-like, to the touch.
- Beds of this alga are only exposed at extreme low-tides, stipes remain erect, individuals do not collapse on top of one another. Commonly 1-3 m, but may be larger.
- The stipe is inflexible, rough and circular in cross-section, usually festooned with epiphytes.
- The blade is broad, commonly with 5-20 "fingers".
- Frond is light to dark brown in colour.
- Two Laminaria species commonly occur in Ireland: L. digitata and L. hyperborea. Mature individuals can be distinguished by the characteristics of the stipe. A third species, *Laminaria ochroleuca* has recently been reported in Ireland but is rare.

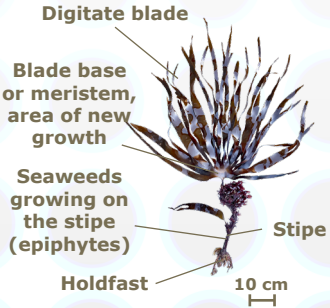


Fig 2. Morphology.

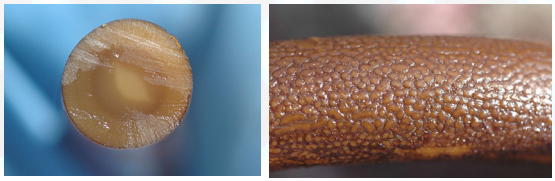


Fig 3. Close up of the stipe – circular in section (left), rough and inflexible (right).

Reproduction

- *Laminaria hyperborea* sporophytes are the macroscopic phase of a two-stage life-cycle (see LC4*).
- The reproductive tissue (= sorus) appears as slightly raised and darkened areas on the fingers of the blades.

♀♂ Male and female gametes occur on separate microscopic individuals (gametophytes).

*Note: Life-cycle 4 (LC4) on page 4.

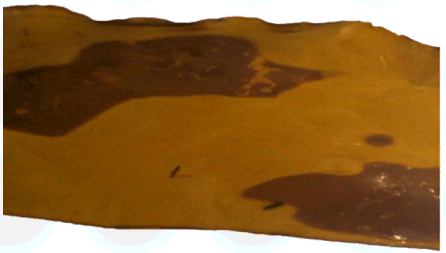
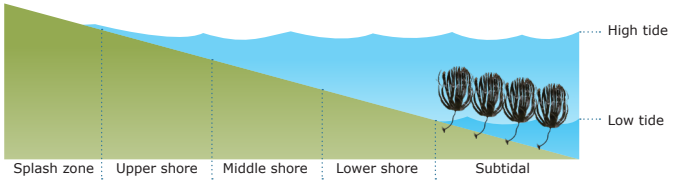


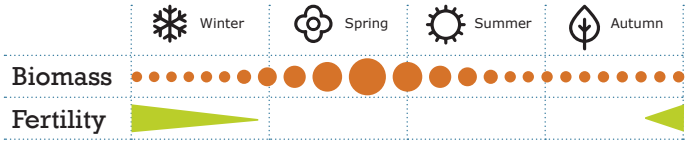
Fig 4. Detail of the sorus on the blade.

Distribution and habitat

- Present throughout E and WN Atlantic shores.
- It inhabits moderately sheltered rock-pools in wave exposed areas, to fully exposed coasts, always at full salinity sites and preferring rocky substrata.



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation



interesting facts

• *Laminaria hyperborea* individuals can live for a long time, which can be aged from annual growth rings in the stipe, like a tree. Specimens of over 20 years old have been found in the northern parts of their distribution, but in Ireland it generally lives for 3-4 years.

• It forms extensive subtidal forests which support a huge diversity of other flora and fauna, much like a mature forest would on land. They form a very important part of rocky-shore ecosystems in Ireland and energetically provide critical support for nearby ecosystems.

• In Norway and France it is harvested for alginate production, which is used as a food additive (see *Laminaria digitata*) and in the production of tailored alginate for biotechnology.

• This species has been cultivated on longlines in Ireland.

Pelvetia canaliculata

Common names: Cow tang, Channelled wrack.
Irish names: Dubhlamán, Múirín na muc, Caisíneach.

Phylum: Ochrophyta
Class: Phaeophyceae
Order: Fucales
Family: Fucaceae
Genus: Pelvetia
Species: P. canaliculata

Fig 1. *Pelvetia canaliculata* plants.

Morphology

- Brown alga with regularly forked fronds and in-rolled margins, forming a channel on one side.
- Individuals are 5-15 cm long and less than 5 mm wide.
- The fronds are tough, smooth and olive-green to brown when wet. On drying, the fronds become brittle and dark, almost black in colour, especially when out of water for long periods during neap tides.
- *P. canaliculata* is the only species of this genus in Ireland.
- It does not resemble any other wrack.

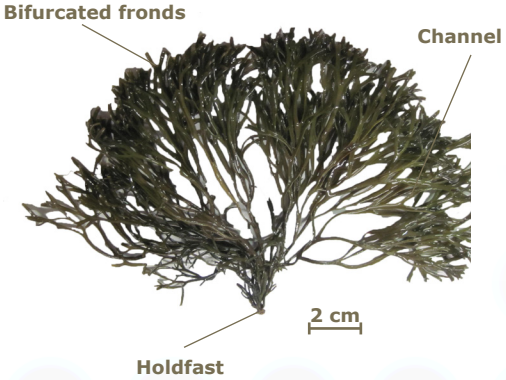


Fig 2. Morphology.

Reproduction

- *Pelvetia canaliculata* has a direct life-cycle (see LC5*)
- The reproductive structures or receptacles develop at the tips of the thallus and have a beaded, knobbly, forked appearance.

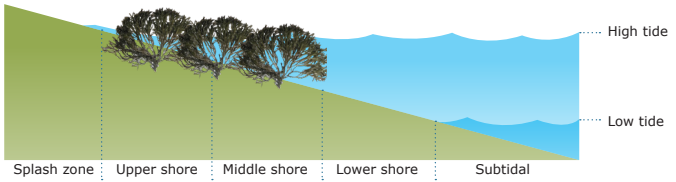
♀♂ Male and female structures occur on the same individual.

*Note: Life-cycle 5 (LC5) on page 4.

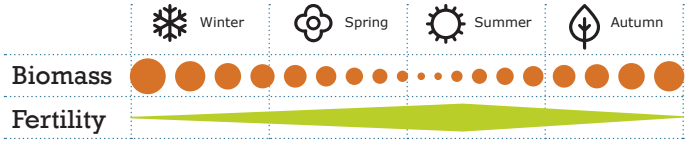
Fig 3. Detail of the reproductive receptacles.

Distribution and habitat

- This species is found in the NE Atlantic, from Iceland to Portugal.
- It grows on bedrock on shores ranging from sheltered to exposed shores.
- Free living forms (known to some as *P. canaliculata* var. *libera*) can be found in salt-marshes.



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

- *Pelvetia canaliculata* is very drought resistant and can endure high levels of tissue dehydration without affecting normal functionality. If it stays submerged for more than six hours a day it dies and decays.
- Purified chemicals called fucoidans from *Pelvetia* have been described as having anticoagulant properties.
- Natural production of chloroform by this species has been reported, and from many other red, brown and green seaweeds.
- The tissue of this alga is colonised by an endophytic fungus called *Mycosphaerella ascophylli* which may aid in resisting desiccation. *M. ascophylli* was first described in *Ascophyllum nodosum.*

Saccharina latissima

Common names: Sugar kelp, Sweet kombu.
Irish names: Lásaí, Rufa, Rufaí, Fruill, Ribíní, Láin, Cupóg.

Phylum: Ochrophyta
Class: Phaeophyceae
Order: Laminariales
Family: Laminariaceae
Genus: Saccharina
Species: S. latissima

Fig 1. *Saccharina latissima* exposed at low-tide.

Morphology

- A large brown kelp with a relatively short stipe (< 60 cm), and a single, elongated frilly-edged, crinkled frond, which extends tongue-like up to 5 m long.
- The yellow-brown frond is undivided, and in older specimens the surfaces are heavily pitted, often torn and heavily indented.
- The stipe is flexible, smooth, and round in cross-section.
- The holdfast is similar to all other kelps, i.e. a cluster of strong, flat, spreading, branching, root-like growths known as haptera.
- Length,width and overall fragility of the frond can vary widely for this species depending on how sheltered or deep it grows.

Fig 2. Morphology.

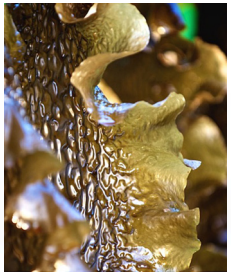


Fig 3. Close up of the blade's edges.

Reproduction

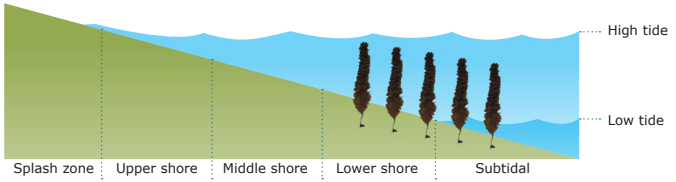
- *Saccharina latissima* sporophytes are the macroscopic phase of a two-stage life-cycle (see LC4*).
- The reproductive tissue, known as sorus, forms a long dark streak in the middle of the blade and appears as darkened raised patch.
  - ♀ Male and female gametes occur on separate microscopic individuals
  - ♂ (gametophytes).

*Note: Life-cycle 4 (LC4) on page 4.

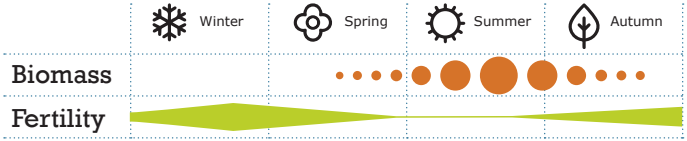
Fig 4. Detail of sorus on the blade.

Distribution and habitat

- *Saccharina latissima* occurs in both the N Pacific and N Atlantic.
- It grows in sheltered waters on rocks.



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

- All kelps contain alginates which are used as for thickeners, stabilizers, and gelling agents for food: E400 – alginic acid, E401 – sodium alginate, E402 – Potassium alginate, E403 – Ammonium alginate, E404 – Calcium alginate, E405 – propylene glycol alginate (PGA).
- Adding a piece of dried sugar kelp to both the soaking water and then the cooking water of legumes (i.e. the same piece of kelp) will aid good digestion.

- Today, this kelp is the most widely cultivated in the N Atlantic and grows well on longlines.
- 1.2 billion tonnes (wet weight) of a sister species, *Saccharina japonica*, is currently grown annually in China, Korea and Japan, the largest marine aquaculture crop by weight.

Saccorhiza polyschides

Common name: Furbelows.
Irish names: Claíomh, Madra, Clabhthaí.

Phylum: Ochrophyta
Class: Phaeophyceae
Order: Tilopteridales
Family: Phyllariaceae
Genus: Saccorhiza
Species: S. polyschides

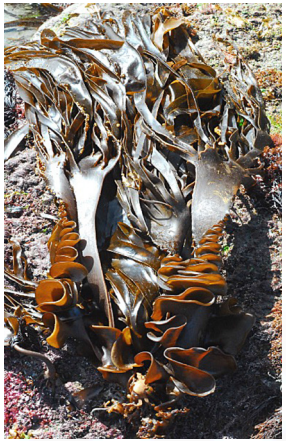


Fig 1. *Saccorhiza polyschides* exposed at low-tide.

Morphology

- An annual brown kelp with a light to dark brown colour, with a digitate "finger-like" blade, a wide stipe and a large hedgehog-like holdfast.
- The stipe is large and flat, with characteristic marginal undulated wings near the base.
- The holdfast of mature individuals is a hollow bulbbous structure up to 50 cm wide of a yellow-brown colour covered in smooth short spikes.
- Usually individuals are 3 to 4 m long, but occasionally they can grow up to 10 m length.
- A single individual can weigh up to 22 kg.

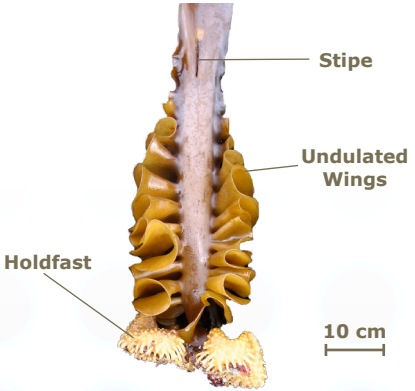


Fig 2. Morphology.

Reproduction

- *Saccorhiza polyschides* sporophytes are the macroscopic phase of a two-stage life-cycle (see LC4*).
- The reproductive tissue (sorus) appears as slightly raised and darkened areas on the undulated part of the stipe.
  - ♀ Male and female gametes occur on separate microscopic individuals
  - ♂ (gametophytes).

*Note: Life-cycle 4 (LC4) on page 4.

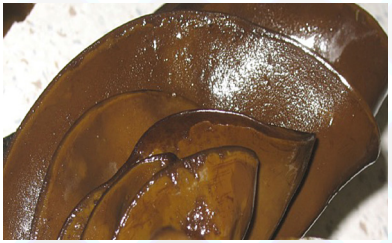
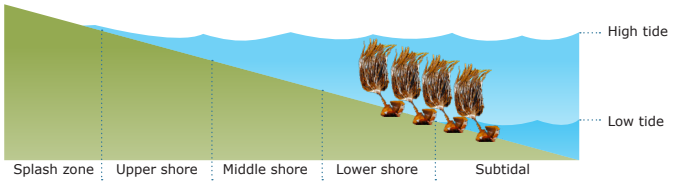


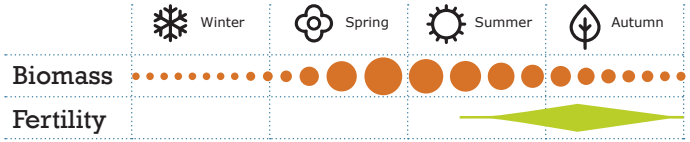
Fig 3. Detail of the sorus on the stipe.

Distribution and habitat

- Limited to the N Atlantic Ocean, found from Norway to Morocco.
- Sublittoral species present in exposed to sheltered shores.



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

• This is the largest brown alga in Europe. As an annual species it grows very rapidly and was therefore cultivated at an experimental scale for its biomass.

• Its shape is highly dependent on hydrodynamic constraints.

• As an opportunistic species, *S.polyschides* fills spaces made in kelp beds after intense harvesting of *L. digitata*, or when *L. hyperborea* individuals are torn off by storms.

• This species has been cultivated experimentally on long-lines in Ireland.

Sargassum muticum

Common name: Wireweed.
Irish name: Feamainn sreangach.

Phylum: Ochrophyta
Class: Phaeophyceae
Order: Fucales
Family: Sargassaceae
Genus: Sargassum
Species: S. muticum

Fig 1. *Sargassum muticum* under the water.

Morphology

- Brown alga with bush-like shape and attached to the substratum by a disc-shaped holdfast.
- The fronds are principally a branched stipe with three characteristic structures: leaf-like proliferations, spherical bladders, and in the reproductive stage, receptacles are small tubular branches.
- In summer, in Ireland it can reach up to 10 m in length while in winter only the holdfast and a primary shoot remains as a perennial phase (few centimetres).
- The colour varies throughout the year from brown to yellow.
- This species can be confused with *Halidrys siliquosa*, but the latter has compressed fronds and compartmentalise bladders like seed-pods. This is the only species of *Sargassum* in Ireland.

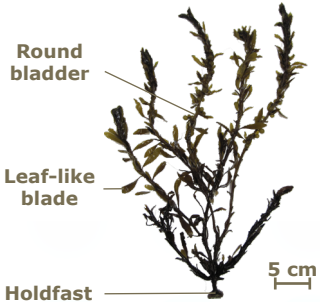


Fig 2. Morphology.

Fig 3. Close-up of bladders.

Reproduction

- *Sargassum muticum* has a direct life-cycle (see LC5*).
- The gametes occur in structures called receptacles. The receptacles are tubular structures found at the bases of the leaf-like structures.
  - ♀ Each receptacle releases both types of gametes, female eggs and male ♂ sperm.

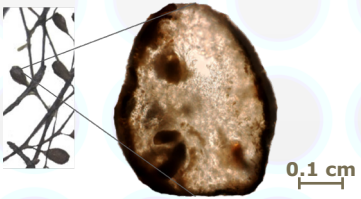
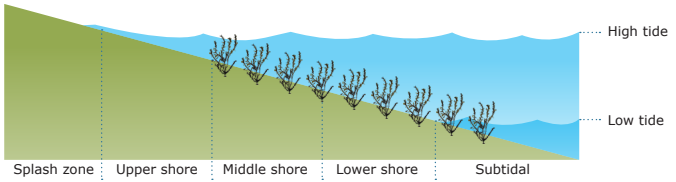


Fig 4. Receptacle with female eggs.

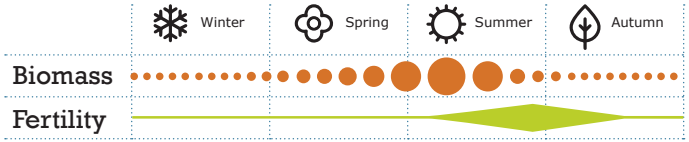
*Note: Life-cycle 5 (LC5) on page 4.

Distribution and habitat

- Seemingly originally introduced from Japan, it has spread to W coast of U.S.A. and W coast of Europe and the W Mediterranean
- Occurs in sheltered to moderately exposed shores and associated with tide/rock pools, it can be found in sandy beaches growing on stones or shells. It tolerates moderate freshwater and high nutrients input. It does not tolerate drying.



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

• *Sargassum muticum* is an non-native species which arrived in Britain in 1973 and spread to Ireland in the 1990's. This seaweed is native to the NW Pacific (Japan, Russia, Korea and China).

• In its native environment, it is relatively small (up to 2 m length), compared to sites in which it is invasive where it can reach lengths of 16 m (e.g. Normandy, France).

• *Sargassum*, like most Fucales, contains a high percentage of phenolic compounds. These are secondary metabolites, known to act as a chemical defence against grazers.

• Antiviral, anti-inflammatory, antibacterial and antitumor bioactivities have been described.

Asparagopsis armata

Common name: Harpoon weed.
Irish name: Feamainn mhuirgha.

Phylum: Rhodophyta
Class: Florideophyceae
Order: Bonnemaisoniales
Family: Bonnemaisoniaceae
Genus: Asparagopsis
Species: A. armata

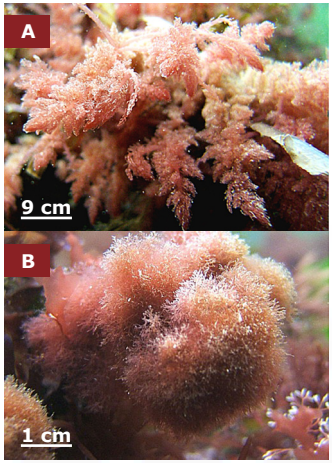


Fig 1. Gametophyte (A) and tetrasporophyte (B).

Morphology

- Red alga with two red to rosy pink macroscopic life phases. The gametophyte is easily identified by some branches developing into harpoon-like anchor structures. The tetrasporophyte looks like a cotton-wool ball and its thallus is highly reduced and profusely branched.
- The gametophyte can reach 25 cm in length but the tetrasporophyte is generally less than 3 cm in diameter.
- The tetrasporophyte is often confused with other red tufted seaweeds, particularly with *Bonnemaisonia hamifera* commonly known as Bonnemaison's Hook Weed. Identification requires the use of a microscope.
- No other species of this genus are known in Ireland.

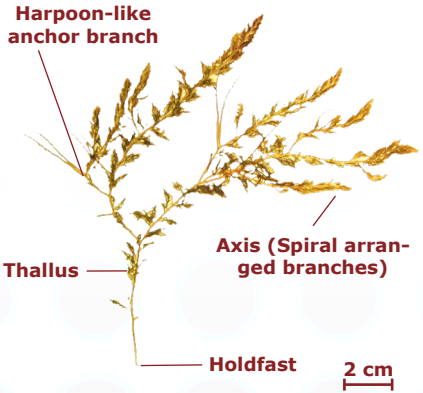


Fig 2. Morphology.

Reproduction

- *Asparagopsis armata* has two morphologically different macroscopic phases in the life-cycle (see LC1*). Male and female structures occur on different individuals.

♀ Fertile female: The female structures are flask-shaped.
♂ Fertile male: The male branches are club-shaped.
Both, female and male structures are not visible to the unaided eye.

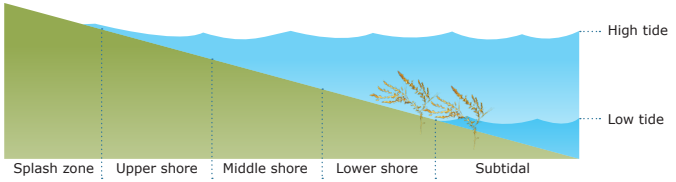
⊕ The tetrasporophyte (Fig 1B) is also known as the *Falkenbergia* phase.

*Note: Life-cycle 1 (LC1) on page 3.

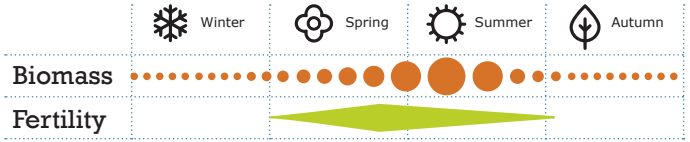
Asparagopsis armata

Distribution and habitat

- Found in New Zealand, Australia, W Mediterranean and NE Atlantic.
- **Gametophyte**- Attaching to other algae by its hooks, mainly in sandy pools.
- **Tetrasporophyte**- Free floating or associated with other seaweeds, in particular *Ulva* spp. and *Corallina officinalis*. Both are found in sheltered to slight wave-exposed locations.



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

• This species is known to have several interesting bioactive molecules, mainly sulphated polysaccharides and bromophenols. These compounds have been found to have anti-cancer, anti-fungal and anti-microbial properties. Extracts are used as natural preservatives in cosmetics, in anti-dandruff and scalp cleansers and in anti-acne treatments.

• It is an introduced species from the southern hemisphere. It arrived in the Atlantic and Mediterranean in the 1920's. In Ireland it was first recorded in Galway harbour in 1939, as the "Falkenbergia" stage.

• This species has been cultivated on longlines and tank culture in Ireland since the early 1990's to extract natural preservatives for cosmetics. It is now being investigated as a feed addition for cattle to reduce their methane emissions.

Chondrus crispus

Common names: Carrageen moss, Carrageen, Irish moss, Jelly moss.
Irish name: Carraigín.

Phylum: Rhodophyta
Class: Florideophyceae
Order: Gigartinales
Family: Gigartinaceae
Genus: Chondrus
Species: C. crispus

Fig 1. Fronds of *Chondrus crispus*.

Morphology

- Red alga with cartilaginous, smooth regular flat and dichotomously branching fronds. It has a roughly fan-like shape. Some variants can exhibit thick narrow fronds.
- The colour varies from deep purple, red, yellow and green tones. When underwater the branched tips of the female gametophytes show a blue-violet iridescence.
- Low-lying bushy plant, < 15 cm high often with a blue iridescence.
- Often confused with *Mastocarpus stellatus*. This latter species has a channelled thallus with thickened edges, and reproductive structures formed in surface papillae.

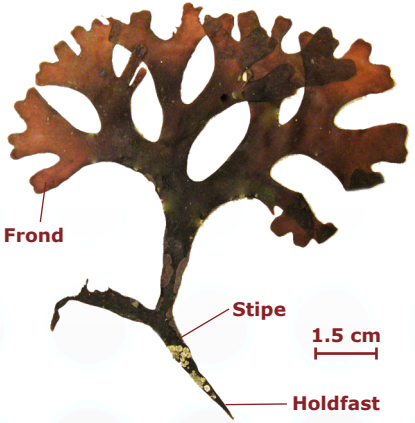


Fig 2. Morphology.

Reproduction

- *Chondrus crispus* has two morphologically similar macroscopic phases in their life-cycle (see LC1*).

♀ Fertile female: swollen oval sori, often found in pairs at the tip of the frond (Fig 3B).
♂ Fertile male: Not visible to the unaided eye, and difficult to identify.
⊕ Tetrasporophytes: tetrasporangial sori protrude only slightly from the thallus, with an oval or linear shape. Found on the upper part of the frond and abundantly in young individuals (Fig 3A).

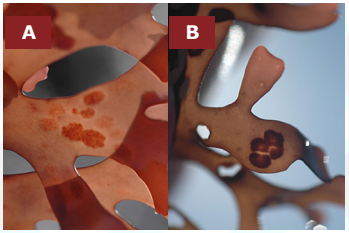


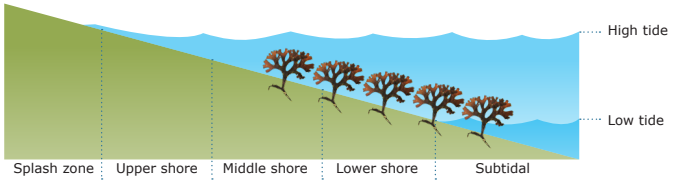
Fig 3.(A) Individuals showing tetrasporangial sori and (B) sunken cystocarps.

*Note: Life-cycle 1 (LC1) on page 3.

Chondrus crispus

Distribution and habitat

- This species is found on both sides of the N Atlantic.
- It is typically attached to rocks or stones in the mid to lower intertidal in sheltered areas but also confined to low intertidal in exposed areas.



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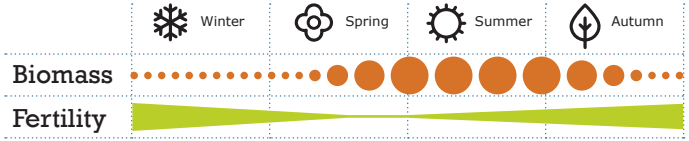
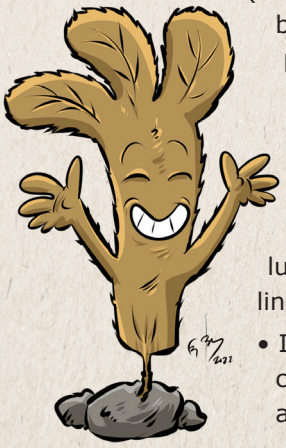


Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

- *Chondrus crispus* produces large amounts of sulphated polysaccharides with gelling properties, known as carrageenans.
- The name carrageenan is probably derived from a place name in Co. Donegal, Ireland, *viz* Carrigan Head.
- Known usages include: food purposes (desserts, jellies, blancmanges, aspics and puddings, food thickener, beer production), folk remedy (cough, colds, bronchitis and asthma), leather-curing, soap-making, shampoos, lubricants and paper and linen production.



- In the food industry, carrageenan is classified as a food additive, E407.

Dilsea carnosa

Common names: Red rags, False dulse, Poor man's weather glass, Sea belt.
Irish name: Ceirteacha dearga.

Phylum: Rhodophyta
Class: Florideophyceae
Order: Gigartinales
Family: Dumontiaceae
Genus: Dilsea
Species: D. carnosa

Fig 1. Plants of *Dilsea carnosa* at low tide.

Morphology

- Red alga with a firm, leathery, flattened leaf-like fronds. Multiple fronds are oval in shape and arise from one common holdfast. It has a short cylindrical stype of 1 cm long (approx.).
- The fronds can be up to 50 cm long and 25 cm wide.
- Thallus deep blood red in colour. Often becomes brick red to yellow-green at apical ends, in particular when reproducing.

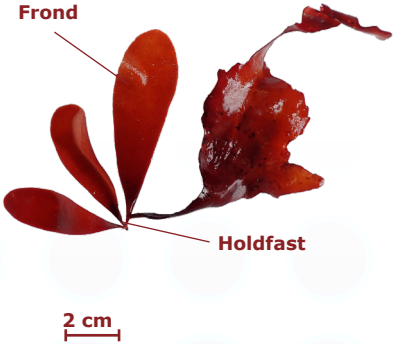


Fig 2. Morphology.

Reproduction

- *Dilsea carnosa* has two macroscopic phases in their life-cycle (see LC1*). Male and female structures occur on different plants.
  - ♀ Fertile female: cystocarps are small and are also found near the margins of young plants.
  - ♂ Fertile male: pale reproductive patches near young frond margins.
  - ⊕ Tetrasporophytes: tetraspores occur in indistinct sori near the margins of young parts of the plant.

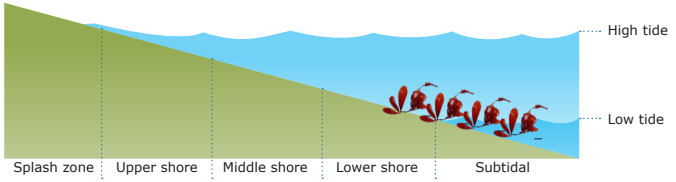
*Note: Life-cycle 1 (LC1) on page 3.

Fig 3. Reproductive edges of *Dilsea carnosa*.

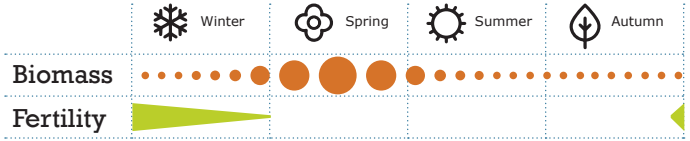
Dilsea carnosa

Distribution and habitat

- Around Ireland and the British Isles including the Shetlands and the Channel Islands. Portugal, Spain, France, the Baltic Sea (in salinities greater than 20‰), Norway and Iceland.
- Grows sporadically on rocks in shaded rock pools in the lower intertidal. More commonly in the subtidal zone, specially on rock in subtidal kelp forests as low as 24 m.



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

- Known as False Dulse as it is often confused with *Palmaria palmata*.
- There are no records of it being used in Ireland, however it is a recognisable seaweed in beach-cast material after storms.
- The Danish name, Kødblad, translates as 'meat leaf' which aptly describes the frond which is fleshy in texture and red in colour.

Gracilaria gracilis

Common name: Slender wart weed.
Irish name: Feamainn gharta chaol.

Phylum: Rhodophyta
Class: Florideophyceae
Order: Gigartinales
Family: Gracilariaceae
Genus: Gracilaria
Species: G. gracilis

Fig 1. Individuals growing on sand-covered rocks.

Morphology

- Red alga with dark brown to purple-red colour, elongated with branched fronds, round and with tapered apices, attached by a disc-shaped holdfast. In summer the colour of the thalli may become yellow-translucent .
- This species has different growth forms, from branched and bushy to long and irregularly branched.
- The texture is cartilaginous with young plants being softer than older ones.
- The thalli can reach 60 cm in height and fronds 3 mm width in cross section.
- Identification of this species requires taxonomic expertise.
- Another very similar species in Ireland is *Agarophyton vermiculophyllum*. Only identified as present in recent years, it is a non-native species originally from the NW Pacific.

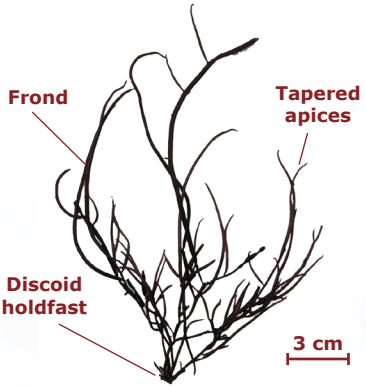


Fig 2. Morphology.

Reproduction

- *Gracilaria gracilis* has two macroscopic phases in their life-cycle (see LC1*). Male and female structures occur on different plants.

♀ Fertile female: bears wart-like structure of 0.5 to 1 mm in diameter.
♂ Fertile male: Structures not visible to the unaided eye.
⊕ Tetrasporophyte: tetrasporangia not visible to the unaided eye.

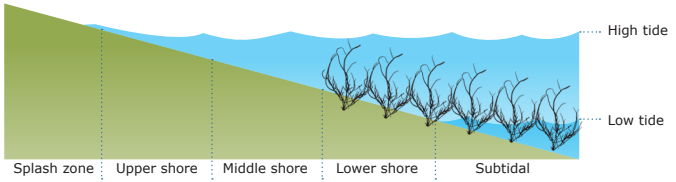
*Note: Life-cycle 1 (LC1) on page 3.

Fig 3. Fertile female thalli.

Gracilaria gracilis

Distribution and habitat

- This species occurs in NE and E Atlantic (Ireland to Canary Is. and W Africa); Records outside this area are dubious.
- It grows on rocky shores in sheltered locations, often in sandy areas, and can be found in up to 20 m depth.



Seasonality

Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

• Other species of *Gracilaria* are consumed as food in many Asian countries, and all species are known for their agar content.

• Agar is a gelatinous substance with a wide range of industrial applications. It is used as a thickener for soups, fruit-preserves, ice-cream, as a clarifying agent in brewing and for sizing paper and fabrics. In the food industry it is classified as food additive (E406).

• Agar is a solid substratum also used as culture medium in microbiological work. However the agar extracted from *Gelidium* species is the one used for this application.

• Annual global production is approximately 30,000 tons (dry weight), most of which comes from natural populations in Chile, Argentina, and Brazil.

• The genus *Gracilaria* contains more than 200 species. Some species are now cultivated on large scale in Chile, Taiwan, Vietnam, and parts of Thailand.

Lomentaria articulata

Common names: Bunny ears, Bunny-eared bead-weed.
Irish name: Cluasa coinín.

Phylum: Rhodophyta
Class: Florideophyceae
Order: Rhodymeniales
Family: Lomentariaceae
Genus: Lomentaria
Species: L. articulata

Fig 1. *Lomentaria articulata* attached to a rocky substrate.

Morphology

- A red alga which has oval or cylindrical bright red to brown fronds compressed into regular segments that look like a string of beads. The hollow segments are soft and the surface shiny.
- Plants grow up to 10 cm long, the bead-like segments are 4-10 mm long and 1-5 mm in diameter.
- Holdfast forms a small disc, the algal forms branches but the pattern is variable; branches may be dichotomous (forked) and can often be whorled. A pair of apical tips are shaped like "Bunny ears".

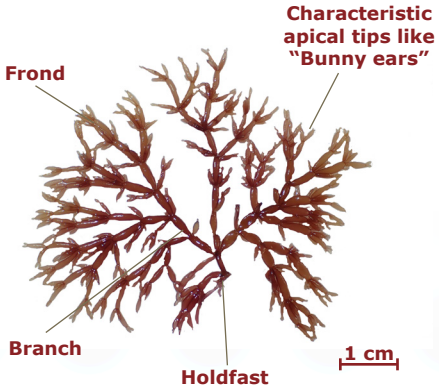


Fig 2. Morphology.

Reproduction

- *Lomentaria articulata* has two macroscopic phases in their life-cycle (see LC1*). Male and female reproductive structures occur on separate plants.

♀ Fertile female: cystocarps are external with a prominent pore.
♂ Fertile male: male reproductive structures can be found in pale patches of sori covering the younger segments.
⊕ Tetrasporophyte: Sori containing tetraspores are found in depressions of the surface of the younger segments too.

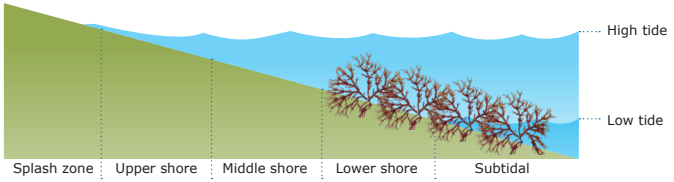
*Note: Life-cycle 1 (LC1) on page 3.

Fig 3. Close up of *Lomentaria articulata*.

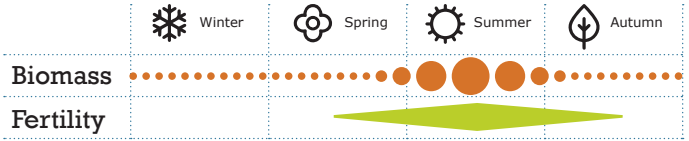
Lomentaria articulata

Distribution and habitat

- All around Ireland and Britain. Found from Norway south to Cameroon and the Mediterranean; records elsewhere require further study.
- Widely found in rockpools, and on boulders in the lower intertidal. Also found subtidally up to 18 m on stipes of *L. digitata*.



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

- This seaweed has bead-like segments that also have apical tips that are shaped like little "Bunny Ears" hence the common name.
- It is very common in the intertidal and can be seen on rocks or as epiphyte to other seaweeds.
- Despite being a common seaweed in Europe, it is not a well studied alga. However, some research suggests this species may be an important food source for small snails, which can be typically found in abundance on the fronds.

Maërl / Rhodoliths

Common names: Maërl, Rhodolith beds.
Irish names: Gruán, Gruánach, Feamainn choirleach.

Phylum: Rhodophyta
Class: Florideophyceae
Order: Corallinales
Family: Hapalidiaceae
Genus: Lithothamnion and Phymatolithon

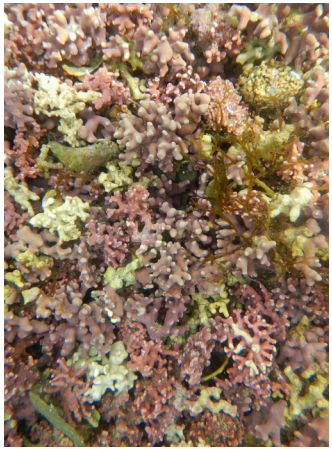


Fig 1. Individuals growing on sand-covered rocks.

Morphology

- Red algae bright to pale pink in colour, nodular calcareous branches, variously compressed.
- The morphology is related to environmental conditions, so the same species can look different depending on where it is growing.
- Most growths are between 1 and 10 cm in diameter.
- They grow only a few millimeters per year.
- The most common species are *Phymatolithon calcareum* and *Lithothamnion corallioides*.

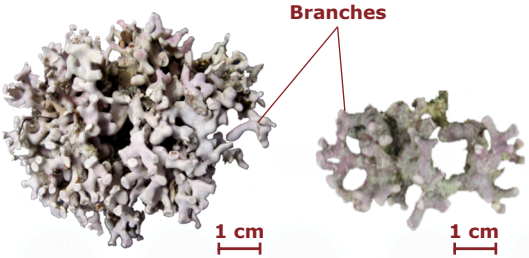


Fig 2. Morphology (two examples).

Reproduction

- Maërl species have two macroscopic phases in the life-cycle (see LC1*). Male and female structures can occur on the same individual or on different ones (species dependant). Additionally, they also reproduce asexually by fragmentation.

  ♀ ♂ Fertile female and male individuals: both structures are not visible to the naked eye.

  ⊕ Tetrasporophyte: multiporated chambers on the plant (Fig 3.).

*Note: Life-cycle 1 (LC1) on page 3.

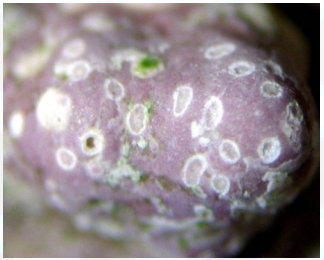
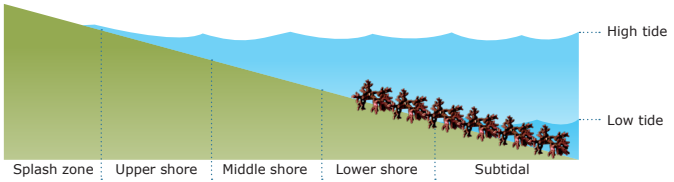


Fig 3. *Phymatolithon purpureum* tetrasporophyte

Distribution and habitat

- Maërl occurs in the NW Atlantic (Scotland, W Ireland, W France and W Spain). There are other mäerl beds around the world but they may not be formed by species that occur in Europe.
- Found in tidal channels and moderately exposed shores from 0 to 32 meters depth.



Seasonality

Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

• As plants die, the calcareous remains accumulate into deep beds. Subfossil beds are bing dredged in Ireland, Iceland and France.

• The deposits are used as a calcium supplement for human health, in the agriculture industry, and for water filtration.

• Rarely maërl is washed up in large amounts and forms the so called "coral strands" such as those at Carraroe and Mannin Bay (Co. Galway, Ireland).

•The management of maërl beds is protected under the EU Habitats Directive, 92/43/EEC as they support a high diversity of marine organisms.

Osmundea pinnatifida

Common name: Pepper dulse.
Irish names: Máthair an duillise, Derida, Griabhán.

Phylum: Rhodophyta
Class: Florideophyceae
Order: Ceramiales
Family: Rhodomelaceae
Genus: Osmundea
Species: O. pinnatifida

Fig 1. *Osmundea pinnatifida* plants.

Morphology

- Red alga with dark purple to brownish-red tufted thallus, with flattened fronds and robust main axes. The holdfast is tangled and creeping.
- Branching is irregular with an overall shape that is approximately triangular/pyramidal.
- The texture is softly cartilaginous and thick.
- The plant can reach up to 10 cm length, with fronds being 2-8 mm wide.
- The two most similar species, *O. osmunda* and the rare *O. oederi* have discoid holdfasts and are found on the lower shore or in pools and in the shallow subtidal. *O. osmunda* is a larger species (up to 20 cm long) and *O. oederi* is attached to other algae. Also present in Ireland are *O.hybrida, O.truncata* and *O.ramosissima*.

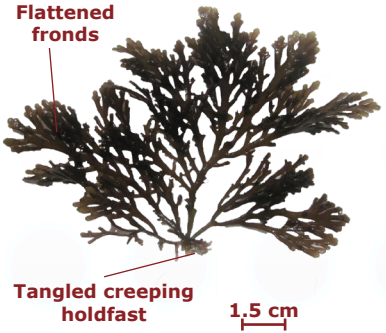


Fig 2. Morphology.

Reproduction

- *Osmundea pinnatifida* has two macroscopic phases in the life-cycle (see LC1*). Male and female structures occur on different individuals. The reproductive structures occur laterally on the last branchlets.

♀ Fertile female: Oval structures (~ 1 mm in diameter).
♂ Fertile male: Urn-shaped structures (~ 1 mm).
⊕ Tetrasporophyte: Tetrasporangia appear as dark dots at or near the apices of the fronds.

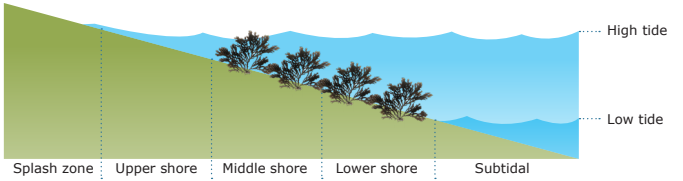
*Note: Life-cycle 1 (LC1) on page 3.

Fig 3. Fertile female fronds.

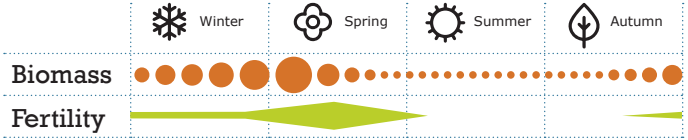
Osmundea pinnatifida

Distribution and habitat

- This species has been reported in the NE Atlantic, NW Africa and W Indian Ocean (India and Pakistan).
- It grows on open rock surfaces, often covering damp slopes.



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

• It has a peppery flavour and can be used as a condiment. This flavour comes from molecules called halogenated terpenes (a large and diverse class of aromatic organic compounds). However, *Osmundea* should be consumed in moderation, as its terpenes and phenols may be associated with health risks.

• In the wild, the alga produces terpenes and phenols often as a protective function to deter grazing by molluscs and fish.

• Terpenes have a strong smell. If you get familiar with the smell of *Osmundea,* you can tell where it is on the shore by its strong scent.

Palmaria palmata

Common name: Dulse.
Irish names: Dillisk, Duilleasc, Creathnach.

Phylum: Rhodophyta
Class: Florideophyceae
Order: Palmariales
Family: Palmariaceae
Genus: Palmaria
Species: P. palmata

Fig 1. *Palmaria palmata* plants.

Morphology

- Red alga with smooth, leathery fronds that are palmate (hand-like). Fronds can change over the year from deep red/purple in autumn and winter, to greenish-yellow in the summer when sun-bleached.
- The holdfast is small and disc-like. The stipe is short, approximately 1-2 cm in length.
- Older or damaged individuals produce small blades from the edge of the main frond.
- The size of the seaweed depends on the growing conditions, but generally, individuals reach a maximum length of 30-40 cm. The larger plants are found in semi-wave-exposed areas.
- *P. palmata* is the only species of this genus in Ireland.

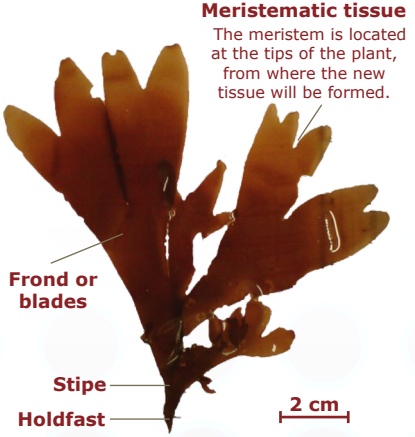


Fig 2. Morphology.

Reproduction

- *Palmaria palmata* plants seen on the shore are either male or tetrasporophytes (see LC1*).
  - ♀ Female individuals form microscopic crusts and have yet to be found in the wild.
  - ⊕ Tetrasporophyte: when fertile spores are held in dark patches. The tetrasporophyte thallus overgrows the fertilised female.
  - ♂ Male fertile: thallus with spermatia held in the smooth lighter areas on the frond.

*Note: Life-cycle 1 (LC1) on page 3.

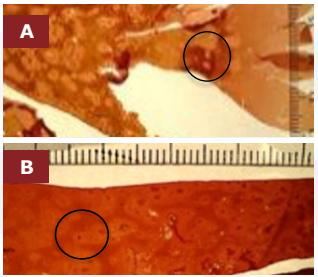
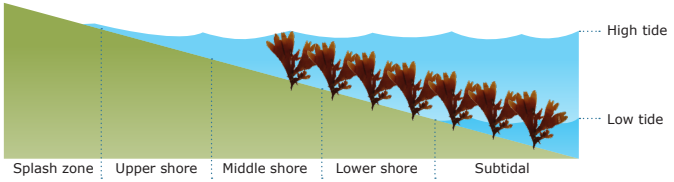


Fig. 3(A) Fertile tetrasporophyte; (B) Fertile male thallus.

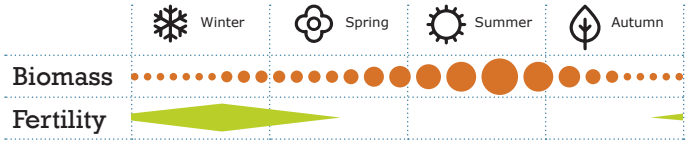
Palmaria palmata

Distribution and habitat

- It grows in the NE Atlantic (from Norway to Atlantic Spain and Portugal, and Azores), and in the NW Atlantic.
- Found mainly in moderately exposed to exposed shores and in areas subjected to tidal currents rather than waves. Plants can be found growing directly on rocks/boulders or on other seaweeds such as wrack (*Fucus* species) and kelps (*Laminaria hyperborea*).



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

- The earliest written record of this species is of monks harvesting it in the 12th century.
- Commonly used in Ireland, Scotland, Iceland, Norway, France, Atlantic Canada, and New England (US).
- Most commonly eaten as a dried snack, but can also be eaten, pan-fried quickly into chips, baked in the oven, or simply incorporated in dough.
- It is rich in vitamins, minerals, and has a high protein content. It also contains a significant amount of iodine.

- It has been successfully cultivated on long-lines and tanks in Europe.

Porphyra dioica

Common names: Nori, Laver, Sloke.
Irish names: Sleabhcán, Sleabhan, Sleabhac.

Phylum: Rhodophyta
Class: Bangiophyceae
Order: Bangiales
Family: Bangiaceae
Genus: Porphyra
Species: P. dioica

Fig 1. Adult fronds of *Porphyra dioica*.

Morphology

- Red alga with very thin and membranous fronds with a slippery texture. The blades can look like long and shiny ribbons, and can be olive-green to purple-brown or even blackish in appearance.
- The fronds fold in two when held vertically.
- Up to 20 cm long and 3 cm wide.
- Currently, five species of *Porphyra*-like algae (including *Pyropia* and *Wildemania*) are found in Ireland, which are difficult to tell apart .
- Other species are *W. amplissima, Pyropia leucostica, Porphyra linearis, Porphyra purpurea* and *Porphyra umbilicalis*. Identification may require molecular data.

Fig 2. Morphology.

Reproduction

- *Porphyra dioica* has a macroscopic phase in the life-cycle (see LC2*). Depending on the species, male and female structures usually occur on different individuals, and only occasionally on the same one.

♀♂ A microscope is needed to identify male and female structures.

⊕ The sporophyte is microscopic and grows inside shells and is known as the *Conchocelis* phase.

*Note: Life-cycle 2 (LC2) on page 3.

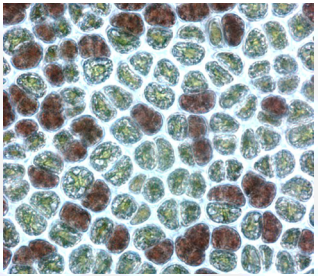
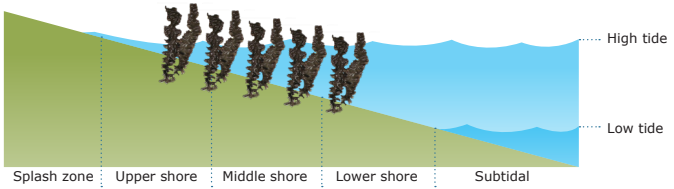


Fig 3. Female individual under the microscope.

Porphyra dioica

Distribution and habitat

- *Porphyra dioica* is found along the European Atlantic coasts from the Faroes south to the Canary Islands.
- It usually grows on hard surfaces such as stones, rocks and piers and can survive being buried by sand for extended periods.



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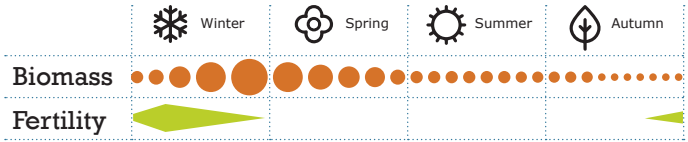


Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

- Recent research has reclassified many species of the old genus *Porphyra*. For example, previously known commercial species *Porphyra yezoensis* and *Porphyra tenera* are now referred to the genus *Neopyropia*.
- *Neopyropia yezoensis* and *N. tenera* are cultivated in Asia from which the traditional nori sheets to make sushi are made.
- In Japan, Korea and China, 3 million tonnes wet weight were produced in 2019 with a value of US$2.7 billion.

- Its nutritional value mainly lies in the high protein content although it is also rich in vitamins and minerals.
- Its economic value is based on its widespread use in Asian cuisine.

Vertebrata lanosa

Common names: Wrack siphon weed, Truffle of the sea.
Irish name: Olann dhearg.

Phylum: Rhodophyta
Class: Florideophyceae
Order: Ceramiales
Family: Rhodomelaceae
Genus: Vertebrata
Species: V. lanosa

Fig 1. Plants of *Vertebrata lanosa*.

Morphology

- Red alga, up to 75 mm in length and tufty in appearance due to large numbers of fine branches that fork many times.
- Whole plant is dark purplish-red in colour, almost black when dried out.
- The main branches have a striped appearance while the branch tips are widely forked.
- It is attached to the host *Ascophyllum nodosum* and, more rarely, *Fucus vesiculosus*, by creeping rhizoids that penetrate the frond, mainly at points of damage.

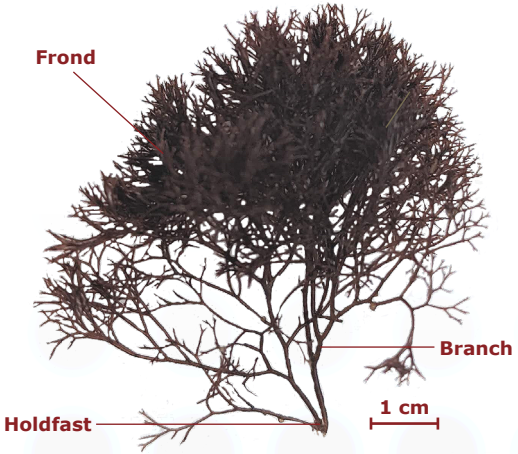


Fig 2. Morphology.

Reproduction

- *Vertebrata lanosa* has two macroscopic phases in the life-cycle (see LC1*). Male and female structures occur in different plants.

♀♂ Fertile female and male reproductive structures occur at the tips of the branches.

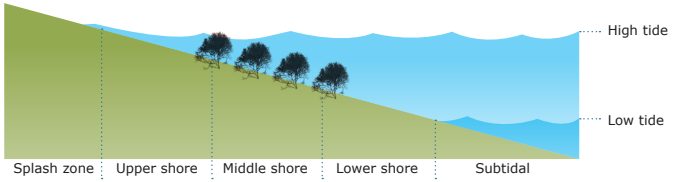
⊕ Tetrasporophyte: This phase is morphologically the same as the male and females.

*Note: Life-cycle 1 (LC1) on page 3.

Fig 3. *Vertebra lanosa* attached to *Ascophyllum nodosum*.

Distribution and habitat

- It is found in the NE Atlantic (from the Arctic shores to Portugal and the N Sea) and NW Atlantic (from Arctic to New Jersey).
- It occurs almost exclusively as a hemiparasite within the thallus tissue of the large brown alga *Ascophyllum nodosum* which grows most abundantly in the mid-littoral zone in wave-sheltered rocky shores.



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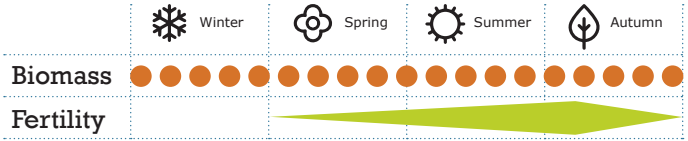


Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

• The harvesting of this seaweed is growing in popularity, particularly in Norway, because of its distinctive smell and taste, which in turn gives it one of its common names of 'Truffle of the Sea'.

• As a hemiparasite, *V. lanosa* is anchored into the frond of *A. nodosum*, gains some nutrition from its host, however it can still create its own food via photosynthesis.

• Although almost always found growing on *A. nodosum*, it can also occasionally be found on *Fucus vesiculosus*.

• It often has a parasite living within itself – another red alga called *Choreocolax polysiphoniae*.

Cladophora rupestris

Common name: Common green branched weed.
Irish name: Slobán.

Phylum: Chlorophyta
Class: Ulvophyceae
Order: Cladophorales
Family: Cladophoraceae
Genus: Cladophora
Species: C. rupestris

Fig 1. Plants of *Cladophora rupestris*.

Morphology

- Green alga, usually found in dense clumps, formed of fine branches of rough and straight threads.
- Thallus is dark green, sometimes with brown tips and can reach up to 20 cm in length
- The texture is coarse and rigid.

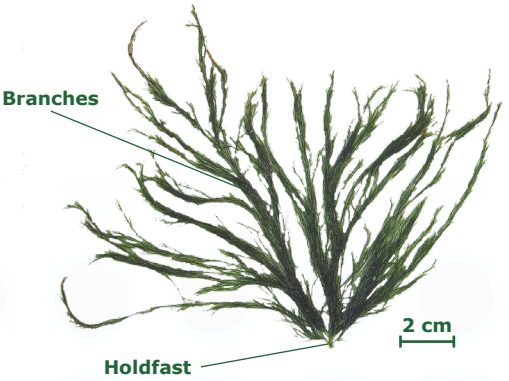


Fig 2. Morphology.

Reproduction

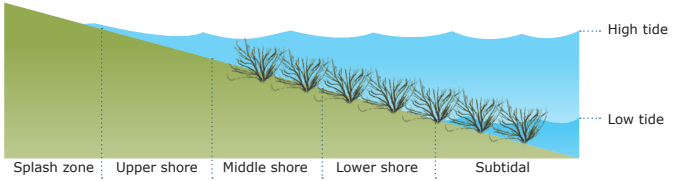
- *Cladophora rupestris* has two isomorphic macroscopic phases in the life-cycle (see LC3*). Male and female reproductive structures occur in different plants.
  - ♀ ♂ Fertile female and male gametes are found in the terminal cells at the tips of the branches.
  - ⊕ Sporophyte: This phase is morphologically the same as the male and females and the zoospores are also found in the terminal cells at the tips of the branches.

*Note: Life-cycle 3 (LC3) on page 3.

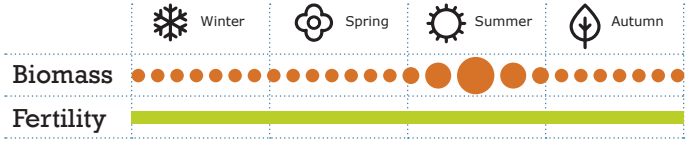
Fig 3. *Cladophora rupestris* on bedrock.

Distribution and habitat

- It is found in the NE Atlantic (from the Arctic shores to Portugal and the North Sea) and NW Atlantic (from the Arctic to New Jersey). Also found in Morocco, Brazil, Japan, Lord Howe Island (Australia) and in the Antarctic.
- Attaches to rock under cover of larger *Fucus* species and grows most abundantly in the mid-littoral zone in wave exposed rocky shores.



Seasonality



Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

• Species of the genus *Cladophora* are colonised by a wide variety of epiphytes and motile animals because they can offer protection from predation and provide food (either in the form of epiphytes, or itself).

• *Cladophora rupestris* appears to be widely distributed worldwide, can tolerate a wide range of salinities and occurs at all levels on the shore, making it a cosmopolitan species.

• *Cladophora rupestris* is perhaps the most easily identifiable member of the *Cladophora* genus. Approximately 19 species have been identified around Ireland and Britain, with some even living in freshwater environments.

Codium fragile

Common names: Dead man's fingers, Green sponge fingers, Velvet horn, Sponge tang.
Irish names: Spúinse, Beanna veilbhite.

Phylum: Chlorophyta
Class: Ulvophyceae
Order: Bryopsidales
Family: Codiaceae
Genus: Codium
Species: C. fragile

Fig 1. Underwater plants of *Codium fragile*.

Morphology

- Green alga, with a frond dark-green to black-green 15 to 40 cm long.
- Several main branches of ~5 mm diameter arising from a small basal disc. Generally dichotomously branched. Older branches support epiphytes.
- Characteristic spongy texture, branches round in cross-section.
- *Codium fragile subsp. fragile* is the most common *Codium* in Ireland. It is a non-native species. *Codium fragile subsp. atlanticum* likely to be the native species of Ireland. *Codium tomentosum* and *Codium bursa* are also found in Ireland.

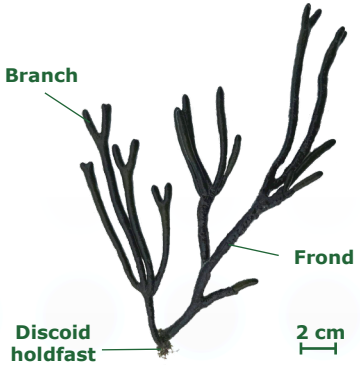


Fig 2. Morphology.

Reproduction

- *Codium fragile* is the macroscopic phase of a two-stage-life-cycle. Reproductive structures are located on the tips of the sporophytes.
  - ♀♂ *Codium subsp. atlanticum* plants, male and female structures occur in separate individuals.
  - ♀ *Codium fragile subsp. fragile*, reproduction is parthenogenetic, female gamete germinates without fertilisation.

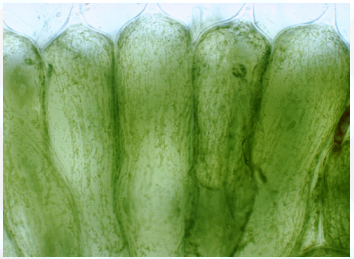
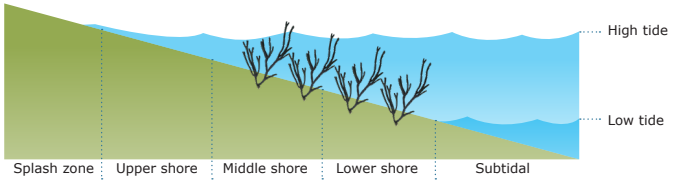


Fig 3. Detail of utricles (tips) of *C. fragile* under the microscope.

Codium fragile

Distribution and habitat

- Worldwide distribution in marine environments.
- On rock and encrusting coralline algae in rock-pools in the mid intertidal and on open rock surfaces from mid to lower littoral, down to 1-2 m.



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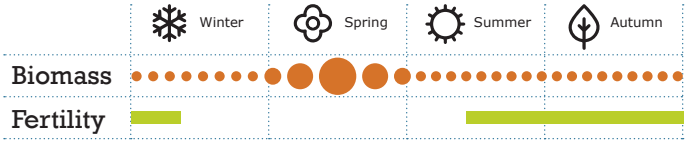


Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

- *Elysia viridis* is a small green sea slug with iridescent spots that feeds on *Codium fragile* sp. and retains the seaweed's chloroplasts (site of photosynthesis within algal cells). Once eaten, the chloroplasts continue to function and are a source of energy to the sea slug.
- In Ireland, the type locality of *Codium fragile subsp. atlanticum* is Clare Island and *fragile subsp. fragile* was first reported in the 1930s.
- *Codium* spp. are cultivated worldwide. When in tank culture, branched specimens of *Codium tomentosum* develop into spiky ball-like structures due to the water movement.
- The flavour of *Codium* has been reported to be similar to goose barnacles.

Ulva spp.

Common name: Sea lettuce.
Irish names: Glasán, Sleaidí.

Phylum: Chlorophyta
Class: Ulvophyceae
Order: Ulvales
Family: Ulvaceae
Genus: Ulva
Species: U. spp.

Fig 1. *Ulva rigida* thalli.

Morphology

- The genus comprises a number of very similar leafy and tubular species. They can only be distinguished reliably by genetic markers.
- The fronds of leafy species consist of thin, grass-green, irregularly shaped lobed sheets that are two cell layers in thickness.
- Individuals can grow up to 45 cm or more in length.
- Common lobed species in Ireland are *Ulva fenestrata* (formerly incorrectly *U. lactuca*), *U. rigida*, and *U. scandinavica*.
- *Ulva* spp. can be confused with the related *Umbraulva olivascens*, which has an olive-green colour, a plastic feel and is much rarer.

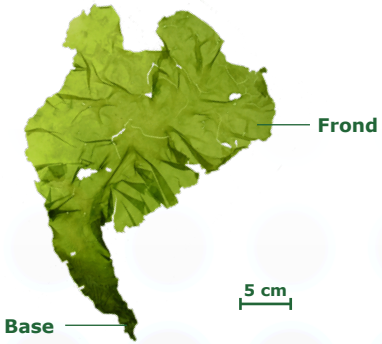


Fig 2. Morphology.

Reproduction

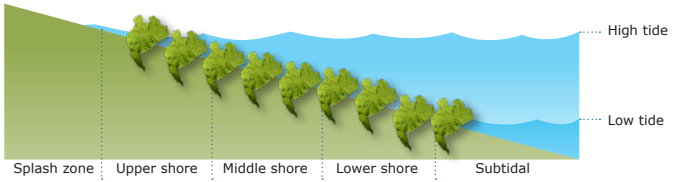
- *Ulva* have two macroscopic phases in their life-cycle (see LC3*).
  - ♀ Female plants have olive green coloured edges before the gametes are released.
  - ♂ Male plants have yellowish coloured edges before the gametes are released.
  - Sporophytes have dark green coloured edges before the spores are released.

*Note: Life-cycle 3 (LC3) on page 3.

Fig 3. *Ulva rigida* thalli.

Distribution and habitat

- About 100 *Ulva* species are found worldwide.
- It is found in both brackish and marine environments, particularly in estuaries, where the water is warm, and nutrient rich. Some tubular species occur in freshwater.



Seasonality

Note: These seasonal characteristics may vary slightly from year to year.

Wild resource and cultivation

interesting facts

- All species of *Ulva* are edible.
- *Ulva* can grow very rapidly. In summer large amounts, called green tides, can accumulate on beaches, mud-flats and salt marshes. They become a nuisance, when the seaweed decomposes and hydrogen sulphide is generated.
- Using genetic markers, green tubular species formerly assigned to the genus *Enteromorpha* have been shown to belong to the genus *Ulva*.

- Some *Ulva* spp. are known to have antibacterial, hypocholesteroelemic and antihelminthic properties.

Ulva spp. can be used as a protein source for fish, shellfish, poultry and cattle and are used in remediation of effluents. in some countries.

Harvesting

Ecological surveys and continuous monitoring are necessary to define best harvesting practices. To date, there is a real lack of scientific data to recommend sustainable harvesting levels in Ireland. The following harvesting advice is aimed at individual foragers only, where quantities harvested are small. Where seaweeds are harvested in quantity or for commercial use, a foreshore licence is required (Foreshore Acts 1933-2011). Further information on how to apply for a licence can be found through the Department of Housing, Local Government and Heritage website.

General harvesting advice

- Always harvest seaweeds where you know water quality is very good. In particular, avoid collecting *Ulva* spp. from blooms of the alga that develop near sewage outlets, harbours or industrial areas as it may be contaminated with faecal coliform bacteria, heavy metals etc.
- Avoid over-harvesting by collecting too many plants in a small area. Only harvest seaweeds that are plentiful, taking small amounts of material across as large an area as practicable.
- Harvest seaweeds by cutting sections avoiding removing the whole seaweed from the shore and allowing the remaining attached seaweed to regenerate. The best cutting method can be specific to one or a group of species and is noted below in specific harvesting advice, where available.
- Avoid harvesting fertile individuals as much as possible.
- Use scissors, or a sharp, clean blade that minimises damage to the frond when cutting.
- For most of the branched or single blade seaweeds described in this factsheet, it is preferable to remove some of the branches or blade of the selected frond, leaving the holdfast and at least 50% of the branches behind.

Specific harvesting advice

- *Ascophyllum nodosum:*
    - This species forms large clumps on the shore, with new growth occurring near the holdfast. Allow regrowth and recruitment of young plants by cutting fronds no lower than 20-30 cm from the base.
    - Current practices allow 3 to 5 years for regeneration after harvesting but the exact period depends on the area and the time of harvesting.
- *Chondrus crispus:*
    - It is recommended to harvest every two years at exposed sites and every four years in sheltered sites, leaving mature plants to grow every two metres. (see references, Carrasea project).
- Kelps:
    - Include five species from this booklet (*A. esculenta, L. digitata, L. hyperborea*, *S. latissima* and *S. polyschides*).
    - When cutting these species, leave 20 cm of blade above the stipe. This will leave the growing area (the meristem) untouched, allowing new growth.
- *Maërl*:
    - Due to the slow growth rate of this species, "large" extractions could have damaging effects on the *Maërl* beds and the habitats they form. Avoid collecting this species where possible.
- *Sargassum muticum* and *Colpomenia peregrina*:
    - If an individual *S. muticum* breaks, the new frond can easily develop from a remaining primary axis, even after being buried when under sand. Since it is a rapidly invasive species, the removal of the entire plant is recommended.
    - Due to the morphology of *C. peregrina*, it is not possible to collect only a portion of the individual. Therefore, collect whole individuals only from areas where the alga is very abundant.

Glossary

NOTE: Unlike green and red algae, brown algae are not plants in a taxonomic sense. However, to allow for simplicity in this book we use the term "plant" to refer to algal thalli, specimens or individuals.

Anthelmintic: Substance (e.g. a medicine) used to destroy parasitic worms.

Anticoagulant: A substance that has the effect of retarding or inhibiting the coagulation of the blood.

Antithrombotic: An antithrombotic agent is a drug that reduces the formation of blood clots.

Brackish: A term that has several definitions. To some, it applies to diluted seawater with a salt content somewhere between oceanic and true freshwater (approx. 2-20 salinity units); to others, it means that the salt content is <10 salinity units or simply if it is a stable low salinity water, such as in the Baltic Sea.

Calcareous: Hard coverings of calcium compounds that are formed by some marine algal species, which frequently develop reefs in tropical areas (cf. calcareous seaweeds).

Cartilaginous: Firm, tough, and elastic texture when living; also gristly or having a tough (hard) texture, rather like cartilage.

Chloroplast(s): Location of photosynthesis within algal/plant cells. Can often be seen within the cells as distinct spots of green/greenish yellow under low magnifcation using a microscope.

Cystocarp: Location of fertilisation on red seaweed gametophytes of species with complicated life cycles, resulting in a tiny structure called a carposporophyte. This in turn produces diploid carpospores which develop into the diploid sporophyte life phase. Cystocarp is based upon the Greek, kustis (cavity) or kystis (bladder) & karpos (fruit).

Diploid: Cells or life cycle generations with two sets of chromosomes.

Discoidal: Having a flat circular shape. With reference to algal holdfasts, it is a disc-like pad of tissue that serves as an attachment structure in some algae.

Epiphyte(s): A non-parasitic seaweed that grows on another seaweed.

Estuary (plural estuaries): An estuary is a partially enclosed, coastal water body where freshwater from rivers and streams mix with salt water from the ocean. A salinity gradient forms in these transitional waters from freshwater to fully saline water, with estuary water often described as low salinity or 'brackish' (see separate definition).

Fertilisation: Fusion of two haploid gametes (reproductive/sex cells such as an egg and sperm) which forms a diploid cell.

Frond(s): The main body or thallus of a seaweed may be divided into fronds or blades, which provide a large surface for the absorption of sunlight.

Gamete(s): Gametes are reproductive or sex cells that are formed by mitosis or meiosis in the gametophyte phase and are generally haploid. Two gametes must fuse during fertilisation to form a zygote (a diploid cell with two sets of chromosomes) to develop into a full organism.

Gametophyte: The haploid generation of an algal/plant life-cycle that produces sexual organs and gametes.

Haploid: Cells or life cycle generations with one set (i.e. half the number) of chromosomes.

Hemiparasite: Partially or incompletely parasitic; typically such seaweeds are capable of initial germination but thereafter require a host (e.g. *Vertebrata lanosa*).

Holdfast: The attachment organ of a seaweed i.e. a root-like, single cell or group of cells that anchors an alga to the substratum (cf. attachment-disc, haptera & tenaculum).

Hypocholesterolemic: Abnormally low levels of cholesterol in the blood.

IMTA: Integrated Multi-Trophic Aquaculture. Enhanced production of aquatic organisms (with or without terrestrial organisms) of two or more functional groups, that are trophically connected by demonstrated nutrient flows and whose biomass is fully or partially removed by harvesting to facilitate ecological balance. (INTEGRATE, 2017-2020; http://integrate-imta.eu/).

Iridescence: Showing rainbow-like colours; also reflecting metallic, the changeable colours of a rainbow, glowing, or shining (based upon the Greek, Iris (goddess or rainbow); cf. iridescent).

Midrib: The thickened longitudinal axis of a flattened branch or blade; also a vein- or rib-like structure running up the middle of a blade.

Morphology: The study of form, reproduction and development (based upon the Greek, morphe (form) & logos (discourse) or the Greek, morph (form) & -ology (study of)).

Phylum: A level of classification or taxonomic rank below Kingdom and above Class.

Receptacle(s): The receptacles are the swollen tips of the frond and each contains many reproductive structures called conceptacles.

Sorus (plural sori): Raised patches of reproductive tissue on the thallus of sporophytes that contain and release spores, e.g. zoospores of kelps.

Sporophyte: The diploid generation of an algal/plant life-cycle that produces haploid spores.

Stipe: Any stem-like portion of a thallus inbetween the holdfast and the frond(s) that is either cylindrical or flattened (based upon the Latin, stipes (a trunk or branch).

Substratum (also "substrate"), plural substrata: The underlying layer; i.e. a surface on which an organism such as a seaweed can grow or is attached. In other usage, it is the material or substance on which an enzyme acts.

Tetrasporophyte: The diploid generation responsible for producing tetraspores (based upon the Greek, tetras (four), sporos (seed) & phyton (a plant); cf. tetrasporophytic).

Thallus (plural thalli): The vegetative plant-body that has relatively simple internal differentiation of tissues. Within the seaweeds, the thallus is the algal-body with no differentiation into true roots, stems or leaves (based upon the Greek, thallos (young shoot or sprout) or thallein (to sprout or bloom).

Utricle: The dilated or swollen, terminal portion of a filament or tube, as in *Codium*.

Vegetative: A stage in the life history of a plant when reproduction proceeds asexually by detachment of some part of the plant body and its subsequent development into a complete plant; the term also means simply, a non-reproductive state (cf. vegetative propagation).

Zoospore: A haploid single cell released from sori of diploid sporophytes capable of swimming in the water column.

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NOTES

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