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The four European seagrass species

Seagrasses are flowering plants with terrestrial ancestors. Of about 60 species world wide, only four seagrass species are native of European waters. In spite of their terrestrial origin, seagrasses are well adapted to the marine environment and can in Europe be found from the intertidal zone at the shore to depths down to 50-60 m. The European species are easy to identify and their geographical distribution range is well known.

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There are four European species of seagrasses:

- *Zostera marina* (eelgrass)
- *Zostera noltii* (dwarf eelgrass)
- *Cymodocea nodosa*
- *Posidonia oceanica*

Seagrasses have evolved from different groups of freshwater plants, and some seagrass species are more closely related to freshwater plants than to other seagrasses. However the four European species are closely related. Other species of water plants occur in marine areas of low to moderate salinity but only the group defined as seagrasses can be found in oceanic waters with high salinity.

Seagrasses grow and reproduce sexually being continuously submerged under water. They do not require contact with air, and the reproductive cycle with flowering and pollination is completed under water. Seagrasses have a number of adaptations to the submerged life form. They rather efficiently take up inorganic carbon from the water, and the nutrients required for growth can be taken up by the roots, as for terrestrial plants, or from the water column through the leaves. Since the sediment comprising the sea floor is most often without oxygen, the underground parts are supplied with oxygen from the leaves through a system of air-filled channels within the tissue. The spreading of pollen to female flowers, which is typically mediated by wind or insects in terrestrial plants, occur by water currents.

Seagrasses may look quite different but the European species have several characteristics in

common. The above-ground, visible part of seagrasses consists of shoots or leaf bundles with 3 to 10 linear leaves. The shoots are attached to rhizomes (vertical and/or horizontal) creeping within or on top of the sediment from which roots penetrate into deeper layers of the sea floor. The rhizomes divide and form new leaf bundles, and each branched rhizome system can hold many genetically identical shoots, which are then interconnected as one individual like in other clonal plants.

Zostera marina

Zostera marina (eelgrass; Figure 1.1) is found from arctic waters along the northern Norwegian coast, where it can survive several months of ice cover, to the Mediterranean (Figure 1.2). The species is very abundant in the Baltic Sea, the North Sea and along the Atlantic coasts down to northern Spain. Further south, *Z. marina* becomes more rare and in the Mediterranean the species is mostly found as small isolated stands, but dense eelgrass beds do occur, especially, in lagoons. *Z. marina* is predominantly subtidal and may grow down to 10-15 meters depth depending on water clarity. *Z. marina* is most often perennial but annual stands are found intertidally in the Wadden Sea.

The shoots of *Zostera marina* have 3 to 7 leaves. Leaf width varies between 2 mm for young plants and up to 10 mm for large individuals. The leaves are usually 30 to 60 cm long but may be up to 1.5 m in beds on soft sediments at intermediate depths.

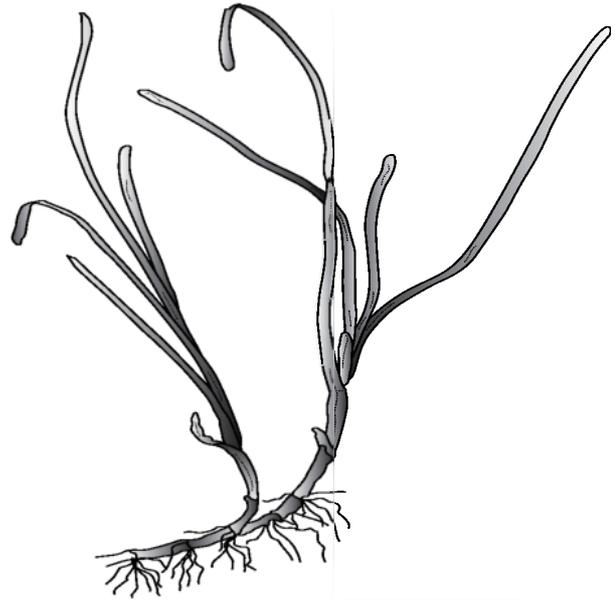


Figure 1.1. *Zostera marina* (eelgrass) forms dense stands from the intertidal zone to depths of 10-15 meters in areas with clear water. The species is easily identified by the terminal shoots on only horizontal rhizomes. Photo: P.B. Christensen; drawing: redrawn from Dawes 1981.

The leaf bundles are terminal shoots on horizontal rhizomes. The rhizome branches during the growth season forming new terminal shoots. For each new leaf produced a new rhizome segment

(internode) is formed and two bundles of roots develop from the nodes between the segments. The roots are thin (0.2-1 mm), covered by fine root hairs and may be up to 20 cm long. The

rhizome segments are 2-6 mm thick, the length of each segment varies from 5 to 40 mm and the colour changes from white-green in newly formed segments to dark brown in old segments.

The male and female flowers of *Zostera marina* are small, greenish and partly hidden in pockets within the leaf sheaths. Male and female flowers are found on the same individual. *Zostera marina* flowers frequently and may produce several thousand seeds per square meter. Flowering can be observed from early spring to fall. During flowering the shoots change morphology to produce more leaf bundles separated by long, thin stem segments. The seeds are 2-4 mm long and, when fully developed, the flowering shoots detach and float away from the bed. The seeds either drop to the sediment within the bed or are dispersed along with the floating shoots (rafting). Seeds are probably also spread by ducks and geese feeding on eelgrass stands.

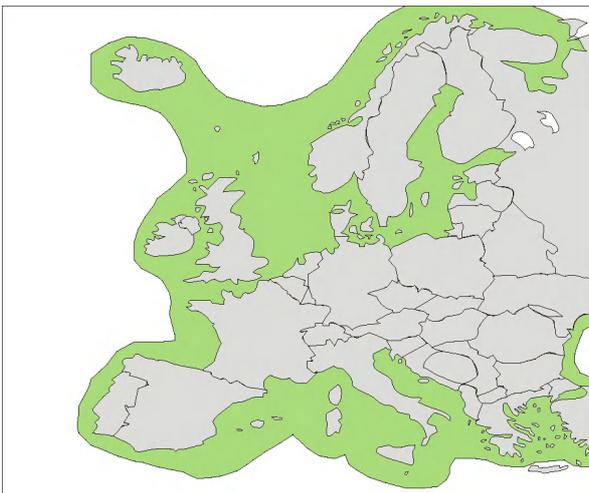


Figure 1.2. Geographical distribution of *Zostera marina* (eelgrass) in European coastal waters. Eelgrass is found from arctic waters along the northern Norwegian coasts to the Mediterranean, where it is more sparse and only forms dense and extensive beds in some lagoons. Eelgrass is the only seagrass species growing around Iceland.

Zostera noltii

Zostera noltii (dwarf eelgrass; Figure 1.3) is distributed from the southern coasts of Norway to the Mediterranean Sea, the Black Sea, the Canary Islands and has been recorded as far south as on the Mauretanean coast (Figure 1.4). *Z. noltii* forms dense beds in the muddy sand of intertidal areas, where *Zostera marina* is sparse due to its lower tolerance to desiccation. The

narrow, flexible leaves of *Z. noltii* often become fully exposed to the air but are kept moist by the thin film of water on muddy sediments. *Z. noltii* also occurs subtidal but often seems to be outcompeted by other seagrasses where the water cover is permanent.

Zostera noltii has small leaf bundles with 2 to 5 narrow leaves attached to a horizontal rhizome. Each rhizome holds many shoots on short branches separated by rhizome segments. The leaves are 0.5-2 mm wide and 5 to 25 cm long.

The rhizomes are 0.5 to 2 mm thick and the rhizome segments are from 5 to 35 mm long. The most recently formed internodes are light green while older segments turn yellow or brown. *Z. noltii* have 1-4 thin (< 1 mm) roots attached to each node between the rhizome segments.

The male and female flowers of *Z. noltii* are small and found on the same individual. The seeds are 1½-2 mm long. The seeds are probably spread by ducks and geese feeding on the intertidal beds.

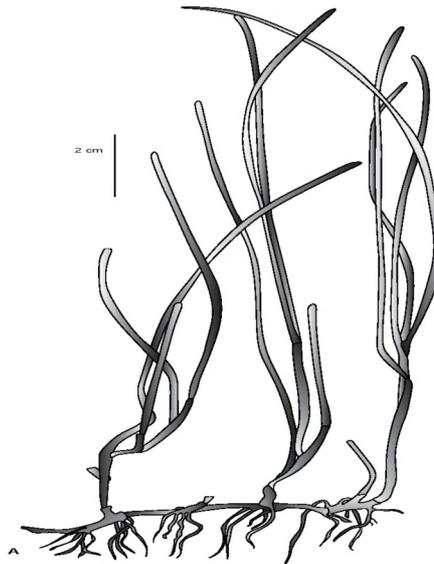


Figure 1.3. *Zostera noltii* (dwarf eelgrass) forms dense stands within the intertidal zone, where other seagrass species are excluded. The species is best identified by the many small shoots with narrow leaves attached by short branches to the horizontal rhizome. Photo: J. Borum; drawing: redrawn from NN.



Figure 1.4. Geographical distribution of *Zostera noltii* (dwarf eelgrass) in European coastal waters. Dwarf eelgrass is found from the southern coast of Norway to the Mediterranean and even as far south as the Mauretanian coast.



Figure 1.5. *Cymodocea nodosa* (seahorse grass) occurs from the intertidal zone to large depths of even 50-60 m in areas with clear water. The species is best identified by its vertical rhizomes and the long, white or pink segments of the horizontal rhizomes. Photo: O. Pedersen; drawing: redrawn from Luque and Templado 2004.

Cymodocea nodosa

Cymodocea nodosa (Figure 1.5) has no vernacular English name, but we propose to use 'seahorse grass' as an appropriate name because beds of *Cymodocea nodosa* are characteristic habitats for seahorses. *C. nodosa* is a warm water species and is widely distributed throughout the Mediterranean, around the Canary Islands and down the North African coast (Figure 1.6). The species does not extend further north than the southern coasts of Portugal. *C. nodosa* can be found from shallow subtidal areas to very deep waters (50-60 m).

Cymodocea nodosa has leaf bundles consisting of 2 to 5 leaves. The leaves are 2 to 4 mm wide and from 10 to 45 cm long. The leaves resemble those of medium sized *Zostera marina*. However, the shoots are attached to vertical rhizomes with short rhizome segments which again are attached to a horizontal rhizome with 1-6 cm long segments. The apex forms vertical rhizomes and branches to new horizontal rhizomes. The rhizome may grow several meters per year, and *C. nodosa* is considered a pioneer species which can quickly colonize bare areas of the sea floor. *C. nodosa* can easily be identified by its vertical rhizomes and the long white to pink horizontal rhizome segments. The roots are dispersed along the vertical and horizontal rhizomes. Each rhizome

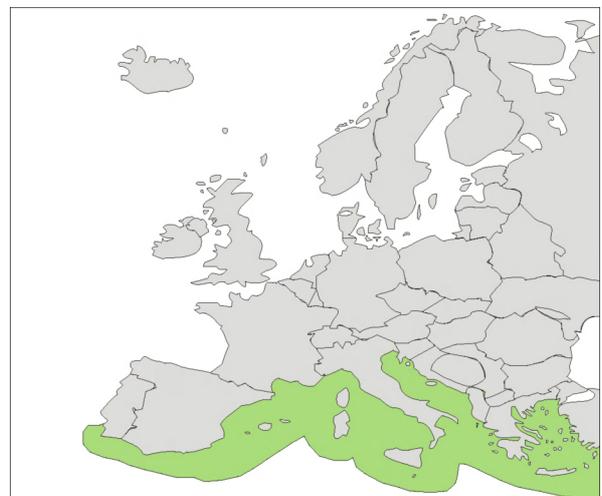


Figure 1.6. Geographical distribution of *Cymodocea nodosa* (seahorse grass) in European coastal waters. Seahorse grass is a South European species found in the Mediterranean and along the Atlantic coasts from southern Portugal to Mauretania.

segment only has one root which is often strongly branched and may be up to 3 mm thick and up to 35 cm long.

The individuals are either male or female plants. The female flowers have two ovaries and the two lentil-shaped seeds produced from each flower are around 8 mm long and, hence, considerably larger than the seeds of the *Zostera* species.

Flowering is observed between May and August but is in general rare.

Posidonia oceanica

Posidonia oceanica (Figure 1.7) is restricted to the Mediterranean Sea and its distribution stops at the boarder line where Mediterranean and Atlantic waters mix in the western part of the Mediterranean Sea (Figure 1.8). *P. oceanica* grows from shallow subtidal waters to 50-60 m depth in areas with very clear waters. In contrast expand by terminal apices. The rhizome internodes are short (0.5 to 2 mm) reflecting the slow horizontal growth of the plant, and the thickness of the rhizomes vary between 5 and 10 mm. The roots are 3-4 mm thick, up to 40 cm long and richly branched. The rhizomes of *P. oceanica* can easily be distinguished from those of the other three species, among other things by the dense, hairy remains of old, degrading leaf sheaths around the rhizomes. The hairy remains are also found as conspicuous balls of fibers washed ashore on the beaches.

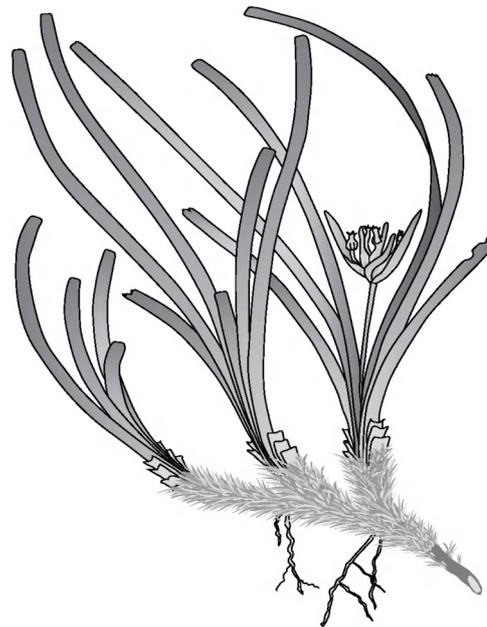


Figure 1.7. *Posidonia oceanica* forms very dense stands from the subtidal to depths down to 50-60 m in areas with clear water. The species is easily identified by the dense, broad leaves and the hairy remains around the rhizomes and lower parts of the shoots. Photo: P.B. Christensen; drawing: redrawn from Luque and Templado 2004.

to the other European seagrasses, *P. oceanica* can form reefs of slowly accumulating, compacted sediments. In spite of its very slow growth, *P. oceanica* is the most wide-spread higher plant in the Mediterranean, and beach cast up of *Posidonia* leaves can be found in large amounts.

Posidonia oceanica has leaf bundles consisting of 5 to 10 leaves attached to vertical rhizomes. The leaves are broad (5 to 12 mm) and the length usually varies from 20 to 40 cm but may be up to 1 m. The vertical rhizomes are, as for *C. nodosa*, attached to horizontal rhizomes which branch and *Posidonia oceanica* rarely flowers. Usually, less than 1 flower is produced per 10 square meters per year, but flowering may be more frequent during warm years. The flowers are large and produce a large fruit (10 mm). Young individuals originating from seeds (seedlings) are rarely found and spreading of *P. oceanica* primarily occurs vegetatively by branching of the rhizomes.



Figure 1.8. Geographical distribution of *Posidonia oceanica* in European coastal waters. *Posidonia oceanica* is strictly Mediterranean and its distribution stops in the western part of the Mediterranean where the warm Mediterranean water mixes with cold Atlantic water.

Confusion of species

The four seagrass species are easily distinguished but confusion may occur under some circumstances. Young specimens of *Zostera marina* may be confused with *Z. noltii* in the transition zone between the intertidal and the subtidal area. However, the leaves of *Z. noltii* are

more narrow than those of *Z. marina*. Where *Z. marina* and *Cymodocea nodosa* occur in mixed stands, their leaves may be difficult to distinguish, but *C. nodosa* is easily identified by the long white to pink horizontal rhizome segments and the vertical rhizomes with compressed segments.

Zostera noltii may grow in the same intertidal habitats as species of the genus *Ruppia*. Although *Ruppia* species also have narrow leaves, they can be identified by their long white rhizome segments. Each node forms a leaf bundle and one long root. Finally, *Z. marina* may be confused with young specimens of the freshwater plant, *Potamogeton pectinatus* that grows in brackish water. However, the rhizome of *P. pectinatus* has two segments between each shoot and root bundle.

Invading seagrasses

Other species of seagrasses may successfully invade European waters if seeds or fragments are accidentally introduced. Currently, the warm water seagrass species *Halophila stipulacea* is invading the eastern Mediterranean and has reached the southern coasts of Italy. The species was introduced through the Suez Channel. *Halophila stipulacea* is a small species with 3-6 cm oblong leaves looking very different from the linear leaves of the native European seagrass species.

Box 1.1 There are four European species of seagrasses:

- *Zostera marina* (eelgrass) grows from the Arctic to the Mediterranean Sea and is the only seagrass species found along the coast of Iceland.
- *Zostera noltii* (dwarf eelgrass) is widely distributed along the Mediterranean and Atlantic coasts but does not extend further north than to the southern coasts of Norway.
- *Cymodocea nodosa* (seahorse grass) is found in the Mediterranean Sea and in the warmer regions of the Atlantic Sea from southern Portugal to the northwestern African coast.
- *Posidonia oceanica* is a strictly Mediterranean species.
- Sometimes *Zostera marina* is separated in two species, *Z. marina* and *Z. angustifolia*, but the species characteristics are not clear.
- In older literature *Zostera noltii* is referred to as *Zostera nana*.
- Some consider the genus *Ruppia* to belong to the group of seagrasses, but according to den Hartog (1970) the species within this genus are not true seagrasses because they do not occur in oceanic water with consistently high salinity.

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