Encyclopedia of Earth

Seagrass meadows

Lead Author: **Carlos M. Duarte (other articles)**
Article Topics: **Oceans** ***and*** **Marine ecology**
This article has been **reviewed and approved** ***by the following Topic Editor:*** **Jean-Pierre Gattuso (other articles)**
Last Updated: September 21, 2008

Table of Contents

Introduction

Seagrasses are angiosperms that are restricted to life in the sea. Seagrasses colonized the sea, from terrestrial angiosperm ancestors, about 100 million years ago, which indicates a relatively early appearance of seagrasses in angiosperm evolution. With a rather low number of species (about 50-60), seagrass comprise < 0.02% of the angiosperm flora. Seagrasses are assigned to two families, Potamogetonaceae and Hydrocharitaceae, encompassing 12 genera of angiosperms containing about 50 species (Table 1). Three of the genera, *Halophila*, *Zostera* and *Posidonia*, which may have evolved from lineages that appeared relatively early in seagrass evolution, comprise most (55%) of the species, while *Enhalus*, the most recent seagrass genus, is represented by a single species (*Enhalus acoroides*, Table 1). Most seagrass meadows are monospecific, but may develop multispecies, with up to 12 species, meadows in subtropical and tropical waters.

Photo 1: *Posidonia oceanica* meadow in the NW Mediterranean. (Photograph by M. Sanfélix)

Adaptations to Colonize the Sea

The colonization of the sea required a number of key adaptations including (1) blade or subulate leaves with sheaths, fitted for high-energy environments; (2) hydrophilous pollination, allowing submarine pollination (except for the genus *Enhalus*) and subsequent propagule dispersal; and (3) extensive lacunar systems allowing the internal gas flow needed to maintain the oxygen supply required by their below-ground structures in anoxic sediments. Seagrass species are all clonal, rhizomatous plants, a necessary adaptation for angiosperm growth in the high-energy marine environment. The rhizome is responsible for the extension of the clone in space, as well as for connecting neighboring ramets, thereby maintaining integration within the clone. The growth rates of seagrass rhizomes vary from a few centimeters per year in the larger, slow growing species, to more than 5 m yr^{-1} in the smallest species. These horizontal extension rates result in estimated times to develop seagrass meadows ranging from less than 1 year, for fast-growing species (*Halophila*, *Syringodium* and *Cymodocea* species), to centuries for the slowest growing ones (e.g. *Posidonia oceanica*, Photo 1).

Table 1. List of seagrass species and their membership to the different seagrass floras. After Hemming and Duarte (2000).

Species	Biogeographic membership
Amphibolis antarctica	S. Australian flora
Amphibolis griffithii	S. Australian flora
Cymodocea angustata	Indo-Pacific flora
Cymodocea nodosa	Mediterranean flora
Cymodocea rotundata	Indo-Pacific flora

Cymodocea serrulata	Indo-Pacific flora
Enhalus acoroides	Indo-Pacific flora
Halodule pinifolia	Indo-Pacific flora
Halodule uninervis	Indo-Pacific flora
Halodule wrightii	Caribbean flora
Halophila baillonis	Caribbean flora
Halophila beccarii	Indo-Pacific flora
Halophila capricornii	Indo-Pacific flora
Halophila decipiens	Caribbean and Indo-Pacific floras
Halophila engelmannii	Caribbean flora
Halophila ovata	Indo-Pacific flora
Halophila ovalis	Indo-Pacific flora
Halophila spinulosa	Indo-Pacific flora
Halophila stipulacea	Indo-Pacific flora
Heterozostera tasmanica	S. Australian flora
Phyllospadix iwatensis	Temperate W. Pacific flora
Phyllospadix japonicus	Temperate W. Pacific flora
Phyllospadix scouleri	Temperate E. Pacific flora
Phyllospadix serrulatus	Temperate E. Pacific flora
Phyllospadix torreyi	Temperate E. Pacific flora
Posidonia australis	S. Australian flora
Posidonia oceanica	Mediterranean flora
Posidonia ostenfeldii	S. Australian flora
Posidonia sinuosa	S. Australian flora
Posidonia angustifolia	S. Australian flora
Posidonia coriacea	S. Australian flora
Posidonia denhartogii	S. Australian flora
Posidonia kirkmanii	S. Australian flora
Posidonia robertsoniae	S. Australian flora
Syringodium filiforme	Caribbean flora
Syringodium isoetifolium	Indo-Pacific flora
Thalassia hemprichii	Indo-Pacific flora
Thalassia testudinum	Caribbean flora
Thalassodendron ciliatum	Indo-Pacific flora
Thalassodendron pachyrhizum	S. Australian flora
Zostera asiatica	Temperate W. Pacific flora
Zostera capensis	S. Atlantic flora
Zostera capricorni	S. Australian flora
Zostera caulescens	Temperate W. Pacific flora
Zostera japonica	Temperate W. Pacific flora
Zostera marina	N. Atlantic, Mediterranean, W. and E. Pacific floras
Zostera mucronata	S. Australian flora
Zostera mulleri	S. Australian flora
Zostera noltii	N. Atlantic and Mediterranean floras
Zostera novazelandica	New Zealand flora

Seagrass Distribution and Habitat

Seagrasses occur in all coastal areas of the world, except along Antarctic shores. The four most obvious habitat requirements of seagrasses are a marine environment, adequate rooting substrate, sufficient immersion in seawater and illumination to maintain growth. Seagrasses are found in waters with salinity greater than 10‰ in estuaries to salinities of about 45‰, in hypersaline coastal environments. Seagrass grow from the intertidal, where they are exposed to full sunlight during the emersion periods to depths receiving, on average, 11% of the irradiance incident just below the water surface, allowing seagrasses to grow deeper than 40 m in the clearest ocean waters. Most seagrass species are confined to sandy to muddy sediments, although some species can grow over rock. High sediment mobility by currents and waves, causing successive burial and erosion, may cause seagrass mortality. Consequently, highly mobile, but otherwise suitable, sandy sediments, may be bare of seagrass cover. High inputs of organic matter, which stimulate bacterial activity, are conducive to seagrass mortality due to the accumulation of phytotoxic compounds, such as sulphide. The organic matter concentrations of sediments supporting seagrass growth is generally less than 6% of the dry weight, with redox potentials spanning from highly oxidized to moderately reduced (> - 100 mV). Seagrass encounter suitable conditions along a global area estimated at about 0.6106 km^2, equivalent to 10% of the coastal ocean, an estimate of seagrass cover that involves considerable uncertainty.

Seagrass Functions

Seagrass form extensive meadows (Photos 1 and 2), which are highly productive and often support high biomass, with a global average biomass of about 180 g C m^{-2} an average net production of about 400 g C m^{-2} yr^{-1}, ranking amongst the most productive ecosystems in the biosphere. These estimates represent, when scaled to the estimated global cover of seagrasses, a contribution to marine primary production of 0.61015 g C yr^{-1}, or about 1.13% of the total marine primary production. Because herbivory rates are low in most seagrass meadows, most of their primary production is either stored in the sediments or exported to neighboring ecosystems. Seagrass bury about 27 Tg C $year^{-1}$, or about 12% of the total carbon storage in marine ecosystems. Hence, seagrasses are important components of the marine carbon cycle, being responsible for a significant fraction of the net CO_2 uptake by marine biota.

Seagrass meadows enhance the biodiversity of coastal waters. They harbor, virtually without exception, more animals and more species than nearby unvegetated areas. The fish fauna of seagrass meadows can be of considerable diversity, typically reaching more than 100 species in any one region, often dominated by juvenile specimens, as seagrass meadows often play a nursery role. The largest animals that are associated with the seagrass habitat are the green turtle, *Chelonia mydas*, and species of the order Sirenia (sea cows), notably the dugong *Dugong dugon*, and the West Indian manatee *Trichechus manatus*. These animals are the largest marine herbivores, and forage over seagrass meadows. A second manatee species, *T. senegalensis* (the West African manatee) may also consume seagrass, but data on this animal are scanty.

Photo 2: Seagrass landscape in the shallow waters of Shark Bay (W. Australia). (Photograph by C.M. Duarte)

Seagrass meadows have other important ecological functions. They improve water quality by reducing the particle loads in the water and absorbing dissolved nutrients. Seagrass stabilize sediments, diminishing sediment resuspension while promoting sedimentation. Seagrass meadows dissipate wave energy and protect coastlines. In addition, a significant fraction of seagrass production accumulated in the beach, as beach-cast detritus, where they deliver carbonate materials that nourish the beach and contribute to dune formation.

Conservation Issues

Seagrass meadows are believed to be experiencing a world-wide decline, with global loss rates estimated at 2-5% $year^{-1}$, compared to 0.5% $year^{-1}$ for tropical forests. The causes for seagrass loss are multiple and include disease, extreme events, such as hurricanes and typhoons, burial by shifting sand, excess nutrient inputs to coastal waters and a reduction of water and sediment quality associated to eutrophication, and overgrowth by opportunistic algae, leading to seagrass loss, excess organic supply from aquaculture and effluents, water quality deterioration by excess sediment inputs, mechanical damage from fishing activities, coastal engineering and boat activities; climatic extremes, such as heat waves and associated hypoxic events; displacement by invasive species, and excessive herbivory. Whereas actions are being taken to curb these trends, including legislation to protect seagrass meadows, transplanting efforts, and monitoring efforts to detect change, there is, as yet, no evidence that the associated recoveries compensate for the losses.

Further Reading

- den Hartog, C., 1970. The seagrasses of the world. North Holland, Amsterdam.
- Duarte, C.M., 1991. Seagrass depth limits. Aquatic Botany, 40, 363-377.
- Duarte, C.M., 1995. Submerged aquatic vegetation in relation to different nutrient regimes. Ophelia, 41: 87-112.
- Duarte, C.M., Chiscano, C.L., 1999. Seagrass biomass and production: A reassessment. Aquatic Botany, 65: 159-174.
- Duarte, C.M., 2001. Seagrass Ecosystems. In: S.L. Levin (ed.). Encyclopedia of biodiversity, Vol. 5. , Pp. 254-268. Academic Press, San Diego.
- Duarte, C.M., Middelburg, J., Caraco, N. 2005. Major role of marine vegetation on the oceanic carbon cycle. Biogeosciences, 2: 1–8.
- Hemminga, M.A., Duarte, C.M., 2000. Seagrass Ecology. Cambridge Univ. Press, Cambridge.
- Larkum, A.W.D., Orth, R.J., Duarte. C.M. (Editors), 2006. Seagrasses: Biology, Ecology and Conservation. Springer.
- Orth, R.J., Carruthers, T.J.B., Dennison, W.C., Duarte, C.M., Fourqurean, J.W., Heck, K.L. Jr., Hughes, A. R., Kendrick, G.A., Kenworthy, W. J., Olyarnik, S., Short, F. T., Waycott, M., Williams, S.L., 2006. A Global Crisis for Seagrass. Ecosystems. Bioscience, 56: 987-996.

Citation

Duarte, Carlos (Lead Author); Jean-Pierre Gattuso (Topic Editor). 2008. "Seagrass meadows." In: Encyclopedia of Earth. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment). [First published in the Encyclopedia of Earth December 11, 2006; Last revised September 21, 2008; Retrieved February 10, 2009]. <http://www.eoearth.org/article/Seagrass_meadows>

Editing this Article

EoE Authors can click here to access this article within the editor wiki

If you are an expert, but not yet an Author, click here