CRJ2: Photista

In Seok Suh

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Oceanic Divisions

Zones

The word pelagic comes from the Greek word pelagos meaning sea. The pelagic zone encompasses the entirety of the ocean except for the coastal areas.

The pelagic zone is divided into four main layers or zones. They are the epipelagic, mesopelagic, bathypelagic, abyssopelagic, and a special zone that only exists in certain places around the world is named the hadopelagic zone. Organisms that live on the ocean floor (regardless of depth) are part of the benthos or the benthic zone. Benthic ecosystems include coral reefs, seagrass beds, and other systems in shallow coastal areas and deep hydrothermal vents, the abyssal plain, and other systems in the deep sea.

Epipelagic

The epipelagic, also known as the sunlight zone, is the upper open ocean which receives the most sunlight. There is enough sunlight for plants and protists to utilize photosynthesis (the process by which organisms use sunlight to convert carbon dioxide into nutrients and oxygen). This zone generally reaches from the sea surface down to approximately 200 m (650 ft). The primary producers that exist in this zone are responsible for much of the original food production of the entire ocean and create at least 50% of the oxygen in the earth’s atmosphere.

Mesopelagic

The mesopelagic, also known as the twilight zone, is the middle open ocean which stretches from the bottom of the epipelagic down to the point where sunlight cannot reach. This zone is approximately 1000 m (3300 ft) and is much larger than the epipelagic zone. Many of the species of fishes and invertebrates that live here migrate up into shallower, epipelagic depths to feed, but only under the cover of night.

Bathypelagic Zone

The bathypelagic, also known as the bathyal zone, is the lower open ocean which stretches from the bottom of the mesopelagic and the upper bound of this zone is defined by a complete lack of sunlight. This zone is approximately 4000 m (13000 ft) and is 15 times the size of the epipelagic zone. This zone is the largest ecosystem on earth and organisms in the bathypelagic live in complete darkness from the sun. However, some organisms use bioluminescent light to attract prey or find a mate.

Abyssopelagic and Hadopelagic Zone

The abyssopelagic, also known as the abyssal zone, stretches from the bottom of the bathypelagic to the ocean floor. This zone stretches approximately 6000 m (19,700 ft) and makes up over 83% of the ocean and covers 60% of the earth.

A special zone that only exists in certain places around the world is named the hadopelagic zone or the hadal zone. This is the deepest region of the ocean and lies within the oceanic trenches that occur in the otherwise flat seafloor. By this definition, all of the deepest parts of the ocean conclude in the hadopelagic. The southern end of the Mariana Trench is named Challenger Deep and it is the deepest known ocean depth which stretches nearly 11,000 m (36,000 ft or almost 7 miles).

+ Sources:

"Open Ocean." Oceana. 2020. https://oceana.org/marine-life/marine-science-and-ecosystems/open-ocean.

Kennedy, Jennifer. "The Open Ocean." ThoughtCo, Jan. 2, 2018. https://www.thoughtco.com/open-ocean-pelagic-zone-2291774.

NOAA. How deep is the ocean? National Ocean Service, 5 Oct. 2017. https://oceanservice.noaa.gov/facts/oceandepth.html.

Marine Algae

Algae

Plant-like protists are named algae. They include single-celled diatoms and multicellular seaweed. Algae are plant-like because they contain chloroplasts and produce food through photosynthesis. However, they lack many other structures of true plants such as roots, stems, or leaves. Some algae also differ from plants in being motile (motility is the ability of an organism to move independently, using metabolic energy) and they may move with pseudopods or flagella.

Algae plays a significant role as the primary producer in aquatic ecosystems. They are the main component of phytoplankton that contribute to the food base of most marine ecosystems. There are three distinct marine macroalgae which are brown (phaeophyta), green (chlorophyta), and red (rhodophyta) algae.

Brown Algae (Phaeophyta)

Brown algae, from the phylum Phaeophyta (meaning "dusky plants"), is the most prevalent type of seaweed. They are found in the waters of both temperate or arctic climates. These algae typically have root-like structures called "holdfasts" that are used to anchor the algae to a surface. They have differentiated tissues, including an anchoring organ, air pockets for buoyancy, a stalk, photosynthetic organs, and reproductive tissues that produce spores and gametes. Some examples of brown algae include sargassum weed, rockweed, and giant kelp, which can reach up to 100 meters in length. There are about 30 kelp varieties and they only grow in salt waters.

Kelp contains many important vitamins and minerals including vitamin K, vitamin A, vitamin C, folate, vitamin E, vitamin B12, vitamin B6, thiamin, riboflavin, niacin, pantothenic acid, iodine, calcium, magnesium, iron, sodium, phosphorus, as well as small amounts of zinc, copper, manganese, and selenium.

Red Algae (Rhodophyta)

There are more than 6,000 species of red algae. Their cell walls consist of cellulose and many different types of carbohydrates. The ability to absorb blue light allows red algae to live at greater depths than either brown or green algae. These algae also contain the pigment phycoerythrin which is the source of their unique colors. Unlike other algae, these eukaryotic cells lack flagella and centrioles. They reproduce asexually by monospores (walled, spherical cells without flagella) that are carried by water currents until germination. Red algae also reproduce sexually and undergo alternation of generations.

Red algae grow on solid surfaces including tropical reefs or attached to other algae. Coralline algae is a subgroup of red algae and is important in the formation of coral reefs. Several types of red algae are used in food additives, and some are regular parts of Asian cuisine. Examples of red algae include Irish moss, coralline (Corallinales), and dulse (Palmaria palmata).

Green Algae (Chlorophyta)

There are more than 4,000 species of green algae. Green algae can be found in marine or freshwater habitats, and some even thrive in moist soils. These algae come in three forms: unicellular, colonial, or multicellular. Multicellular species usually group in colonies ranging in size from four cells to several thousand cells. They have cell walls made of cellulose, and some species have one or two flagella. For reproduction, some species produce non-motile aplanospores that rely on water currents for transport, while others produce zoospores with one flagellum for swimming to a more favorable environment.

Phytoplankton is made up of green algae and cyanobacteria, also known as blue-green algae.

Types of green algae include sea lettuce, horsehair algae, and dead man's fingers. Sea lettuce (Ulva lactuca) is commonly found in tidal pools. Codium is the favored food of sea slugs, while the species Codium fragile is commonly referred to as "dead man's fingers."

Dinoflagellates

Dinoflagellates are one-celled aquatic organisms bearing two different flagella. The group is an important component of phytoplankton in all but the colder seas and is an important link in the food chain. Dinoflagellates also produce some of the bioluminescence sometimes seen in the sea. Under certain conditions, several species can reproduce rapidly to form water blooms or red tides that discolour the water and may poison fish and other animals. Dinoflagellates range in size from about 5 to 2,000 micrometres (0.0002 to 0.08 inch). Most are microscopic, but some form visible colonies. Nutrition among dinoflagellates is autotrophic, heterotrophic, or mixed; some species are parasitic or commensal. About one-half of the species are photosynthetic; even among those, however, many are also predatory.

The dinoflagellate cell is banded by a median or coiled groove, the annulus, which contains a flagellum. A longitudinal groove, the sulcus, extends from the annulus posteriorly to the point at which a second flagellum is attached. The nuclei of dinoflagellates are larger than those of other eukaryotes. So-called armoured dinoflagellates are covered with cellulose plates, which may have long spiny extensions; some species lacking armour have a thin pellicle (protective layer). Photosynthetic dinoflagellates have yellowish or brownish plastids (pigment-containing bodies) and may store food in the form of starches, starchlike compounds, or oils.

Diatoms

There are around 16,000 discovered species of Diatoms (class Bacillariophyceae). They are either unicellular or colonial. The silicified cell wall forms a pillbox-like shell (frustule) composed of overlapping halves (epitheca and hypotheca) perforated by intricate and delicate patterns. They have light-absorbing molecules (chlorophylls a and c) that collect energy from the sun and turn it into chemical energy through photosynthesis. Food is stored as oil droplets, and the golden-brown pigment fucoxanthin masks the chlorophyll and carotenoid pigments that are also present.

Diatoms produce 50% of the air we breathe. Through carbon fixation, they remove carbon dioxide (CO_2) from the atmosphere. The CO_2 is converted to organic carbon in the form of sugar, and oxygen (O_2) is released. They also have ranges and tolerances for other environmental variables, including nutrient concentration, suspended sediment, flow regime, elevation, and for different types of human disturbance. As a result, diatoms are vital for assessment and monitoring biotic condition of waters.

+ Sources:

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Fondriest Environmental, Inc. “Algae, Phytoplankton and Chlorophyll.” Fundamentals of Environmental Measurements. 22 Oct. 2014. https://www.fondriest.com/environmental-measurements/parameters/water-quality/algae-phytoplankton-chlorophyll.

“What Are Diatoms?” Diatoms of North America, 2020. https://diatoms.org/what-are-diatoms.

Symbiosis

Hosts

The symbiotic association between the invertebrate phylum Cnidaria (Coelenterate) and the unicellular dinoflagellate algae, called zooxanthellae, is very common. The most well-known relationship is between zooxanthellae and hermatypic, or reef-forming, corals (Anthozoa). Sea Anemone (Anthozoa) and Jellyfish(Scyphozoa) also belong to the phylum Cnidaria and are hosts to zooxanthellae.

Corals, anemones and jellies are related and all classified in the phylum Cnidaria or “stinging needles.” The organisms in this group are aquatic, possess stinging cells within their tissues and have a body plan characterized by radial symmetry, which allows all parts of their bodies to be equally receptive and responsive to predator and prey. These animals have a single opening that serves as both the mouth and the anus. Tentacles with stinging structures, called nematocysts, usually surround this opening. These stinging cells, triggered by touch or chemical stimulus, can contain toxins or can be sticky. Anthozoa consists of 10 orders and thousands of species. Adults are attached to the seabed, but their larvae are free-floating and can drift to new settlements. Anthozoans can secrete a nonliving substance around the outside of the body to support and protect their soft body tissues. Coloration can vary from red, pink and purple to yellow, blue and orange.

Order Scleractinia

Order Scleractinia, Stony Corals: Stony or reef-building corals form a skeleton made of calcium carbonate under the polyps to create the hard structure that most people recognize as coral. These corals are responsible for forming the base structure of coral reefs. As older polyps die off, new polyps continue to build calcifications on the old skeletons, allowing for the huge scale of reefs in the Caribbean and the Great Barrier Reef. Not all stony corals are reef-building, though, as some are not able to produce enough calcium carbonate to facilitate reef formation.

Subclass Octocorallia

Subclass Octocorallia, Octocorals: Despite sharing a similar appearance with stony corals, soft corals, sea pens, gorgonians and sea fans do not build the hard, calcium-carbonate skeleton of stony corals. Instead, these corals may create some internal structural supports that allow them to grow vertically but still sway with ocean currents. Soft corals are always colonial and grow with eight-fold symmetry, which means their tentacles come in groups of eight — hence the name Octocoral. Octocorals include the orders Alcyonacea and Helioporace.

Order Corallimorpharia

Order Corallimorpharia, Anemone Corals or Mushroom Corals: Members of this order are sometimes called anemone corals or mushroom corals because they resemble anemones more closely than other types of corals due to their large, flat, disc-like shape and short tentacles. They grow like wheel spokes, radiating from a center and forming concentric circles. The diameter of the circle increases as they grow. This order is extremely popular in home aquariums.

Order Zoantharia

Order Zoantharia, Zoanthids: Zoanthids have long, prominent tentacles arranged in two rows. Unlike stony and soft corals, Zoanthids incorporate sand and other substrates into their colonies for structure. They may live as individual polyps or in colonial groups.

Order Actiniaria

Order Actiniaria, Anemones: Larger anemones tend to be solitary while smaller species may use asexual reproduction to propagate and live in large concentrations when there is suitable habitat. Anemones come in a wide range of colors, some owing their coloration to the zooxanthellae, microscopic algae, they host. They also have a disc-shaped bottom they use to attach themselves to rocks, in crevices and on other suitable surfaces, including the shells of other marine invertebrates.

Subclass Ceriantharia

Subclass Ceriantharia, Tube-dwelling Anemones: This subclass looks similar to sea anemones, but tube-dwelling anemones are known for being solitary and living buried in soft sediments. They live inside tubes made of secreted mucus and organelles, and can recede into these tubes for protection. Ceriantharia includes the orders Spirularia and Penicillaria.

Algae + Coral

The most abundant cnidarians containing dinoflagellates (zooxanthellae) are the stony corals which make up coral reefs in shallow, tropical waters (all reef building corals contain symbiotic algae). Stony corals are similar to sea anemones, but coral polyps are smaller (approx. 10 mm in diameter), and they excrete a calcium carbonate shell around their bodies. As the polyp dies, their shells do not decay and new polyps grow over them. After many years of this process, coral reefs are formed. Symbiotic algae (zooxanthellae) live within the digestive cavity of the coral polyp, and coral which have the algae grow much faster than animals without algae. The algae are known to stimulate calcification through their photosynthetic fixation of CO_2. The reaction rate of the calcification process is increased by the removal of CO_2.

The algae supply the animal host with oxygen, and carbon and nitrogen compounds. The animal host also obtains vitamins, trace elements, and other essential compounds from the digestion of plankton. Animal waste products are converted by the algae to amino acids, which are transferred to the animal host. Pigments produced by the symbiotic corals protect both the host and the algae from ultraviolet radiation. The algae also receives inorganic materials from its host. Under stressful conditions, such as high temperatures, coral polyps expel their zooxanthellae. The zooxanthellae aid in giving the reef-building corals their striking colors. When the zooxanthellae are expelled, the corals become white masses of calcium carbonate. The polyps can survive for a few months without zooxanthellae. If favorable conditions return, they collect new zooxanthellae, and return to their normal colors and continue growing.

Algae + Anemone

Sea anemones are known to have symbiotic algae living within their gastrodermal cells. They contain both zooxanthellae and zoochlorellae (single-celled green algae). An example of a sea anemone containing both species is *Anthopleura xanthogrammica*. The proportion of each symbiont is dependent upon the water temperature. At high temperatures (26 degrees Celsius), zooxanthellae are more abundant, and at low temperatures (12 degrees Celsius), zoochlorellae are more abundant. At intermediate temperatures, the numbers of each species are close to equal.

The zoochlorellae excrete only small amounts of fixed carbon, so when they predominate, the algae must supply something else to make up for it. Therefore, instead of the higher amount of carbon, they excrete nitrogen and phosphorus to stimulate growth in the sea anemone. Sea anemones position themselves in a way as to increase light exposure to their symbionts. When their tentacles are relaxed, the algae lie in a single layer. When they contract their tentacles, the gastrodermal cells shrink and the algae lie on top of each other. The zooxanthellae benefit by receiving carbon dioxide from the respiration of the host, nutrients such as nitrogen and phosphorus from the hosts metabolism which are then recycled back and forth between the host and the symbiont, and a shelter in which to live. The sea anemone benefits by receiving oxygen and food in the form of glycerol, glucose and alanine from photosynthesis.

Algae + Jellyfish

Jellyfish are also exclusively marine animals. The species of jellyfish known as Cassiopeia xamachana has been used in studies regarding how an invertebrate selects its symbiotic algae. During the life cycle of Cassiopeia, algae is found in the sexual medusoid stage, but not found in the asexual polyp stage. The polyps mature after they have obtained a symbiont (Symbiodinium microadriaticum). The study allowed for the scientists to expose the jellyfish to different types of algae to see which kind are able to colonize with the jellyfish. They found that the animal host was able to recognize its symbiont after it was phagocytized. Cassiopeia xamachana does not swim freely, but instead lies upside down on the seafloor. This allows the zooxanthellae living in the jellyfish's tentacles to receive maximum daylight for photosynthesis.

+ Sources:

“Corals and Sea Anemones (Anthozoa).” Smithsonian's National Zoo, December 14, 2018. https://nationalzoo.si.edu/animals/corals-and-sea-anemones-anthozoa.

Ream, Christine. “Symbiosis.” SYMBIOSIS. https://cals.arizona.edu/azaqua/algaeclass/symbios.htm.

Resources

Additional Sources

Here are some additional sources to check out!

Bates, Marston. The Forest and the Sea: A Look at the Economy of Nature and the Ecology of Man. Guilford, CT: Globe Pequot Press, 1998.

Marston Bates was a cultural biologist and professor emeritus of zoology at the University of Michigan. Bates was known for his scientific writings and achievements such as his studies on mosquitoes which contributed to the understanding of the epidemiology of yellow fever in northern South America. The Forest and the Sea written by Marston Bates, was recommended to me by professor Kristian Bjornard. This book explores a wide range of biological information about the interrelationship of man and nature. “It probes deep into man's danger to himself and that interlinked organic web by which he lives,” commented anthropologist Loren Eiseley.

Klein, Naomi. This Changes Everything: Capitalism vs. The Climate. New York, NY: Simon & Schuster, 2014.

Naomi Klein is an award-winning journalist, columnist, and author of the New York Times and international bestsellers The Shock Doctrine, No Logo, This Changes Everything, and No Is Not Enough. In This Changes Everything Naomi Klein presses on the issues of the ever changing climate. Klein argues that climate change isn’t just another issue to be neatly filed between taxes and health care. It’s an alarm that calls us to fix an economic system that is already failing us in many ways. She writes about the issues of greenhouse emissions and the positive effects that addressing this issue would have. She also provides documentation of the inspiring movements that have already begun: “communities that are not just refusing to be sites of further fossil fuel extraction but are building the next, regeneration-based economies right now.”

Roberts, Callum. The Ocean of Life: The Fate of Man and the Sea. New York, New York: Penguin, 2012.

In The Ocean of Life, Callum Roberts writes about the earliest traces of life on earth to the current oceans. He writes about the impacts of fishing and ocean acidification, rising tides and warming seas, plastics and shifting currents, and reveals what actions must be taken in urgency to preserve our precious oceans. Roberts is a professor of marine conservation at the University of York and is the author of The Unnatural History of the Sea, a Washington Post Book of the Year and winner of the Rachel Carson Environment Book Award.

Sheppard, Charles. Advances in Marine Biology. 125 London Wall, London: Elsevier, 2019.

Advances in Marine Biology is written by Charles Sheppard and researches topics in marine biology such as fisheries science, ecology, zoology and biological oceanography, impacts of hydrocarbon contamination, pharmaceutical and personal care products in marine and coastal environments, characterization of nitrogen containing (PAHs) in crude oil and refined petroleum products, and etc. Charles Sheppard is a half-time professor in the School of Life Sciences at The University of Warwick, UK. He also works for a range of UN, Governmental and aid agencies in tropical marine and coastal development issues.

Smith, Richard. The World Beneath: The Life and Times of Unknown Sea Creatures and Coral Reefs. New York City, New York: Apollo Publishers, 2019.

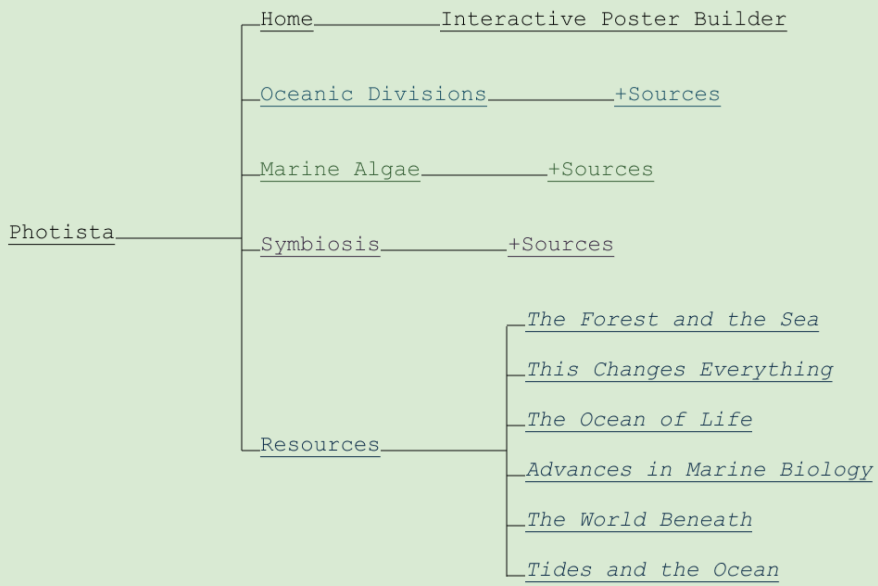
Dr. Richard Smith is a marine biologist and conservationist, an award-winning underwater photographer and videographer, and the list goes on. In 2018, he identified a new species of pygmy seahorse, having first photographed it five years previously. He has a bachelor's degree in Zoology, a master's degree in Marine Ecology and Evolution, and a PhD that he received for his pioneering research on pygmy seahorses; it was the first PhD ever awarded for the subject. His book, The World Beneath: The Life and Times of Unknown Sea Creatures and Coral Reefs, contains new underwater discoveries and over 300 colorful images of marine life from the Atlantic, Pacific, and Indian Oceans. You'll discover the habits and ecosystems of species ranging from all sizes such as the Cenderawasih fairy wrasse, polka-dot longnose filefish, baby-blue sponges, daffodil crinoids, and the list continues.

Thomson, William. Tides and the Ocean: Water's Movement Around the World, from Waves to Whirlpools. Philadelphia, Pennsylvania: Running Press, 2018.

William Thomson is an artist, writer, and world traveler, who follows and lives along the coasts and maps the tides in a camper van. He is renowned for his hand-illustrated tidal charts and is the author of the UK bestseller Book of Tides. In Tides and Oceans, Thomson captures the cycles of the sea's movements and shows graphic renderings of unusual tidal maps and other forms of water movement.

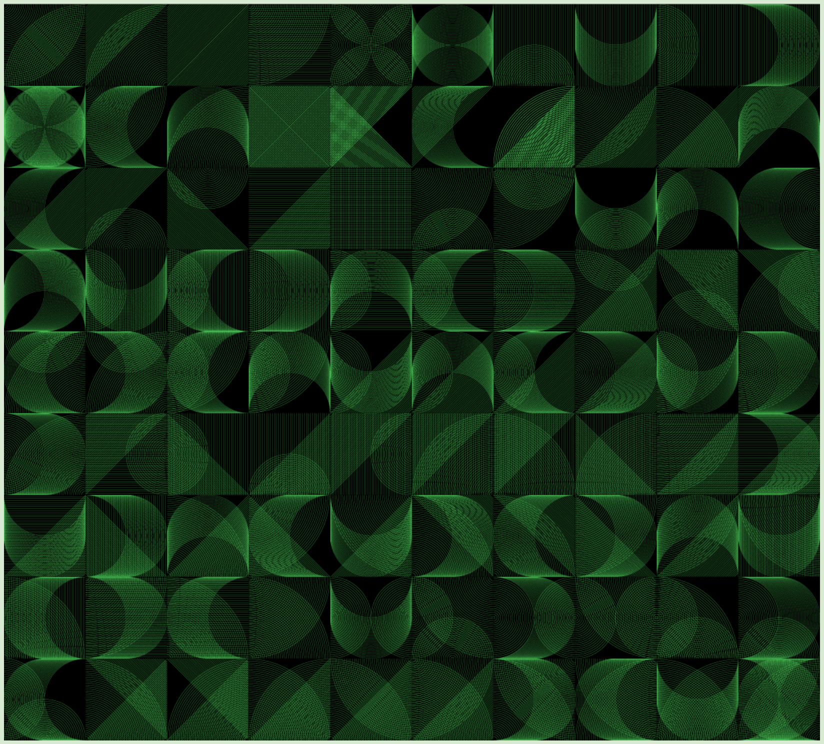
Sitemap

This sitemap shows the overall layout and navigation of the site: https://isuh.info/photista.



90P

90P is a series of 90 different explorations of patterns using circles and squares. The inspiration was from algae cells which tend to have circular or rectangular forms. These patterns were later used to create the animated background pages on the Photista site.



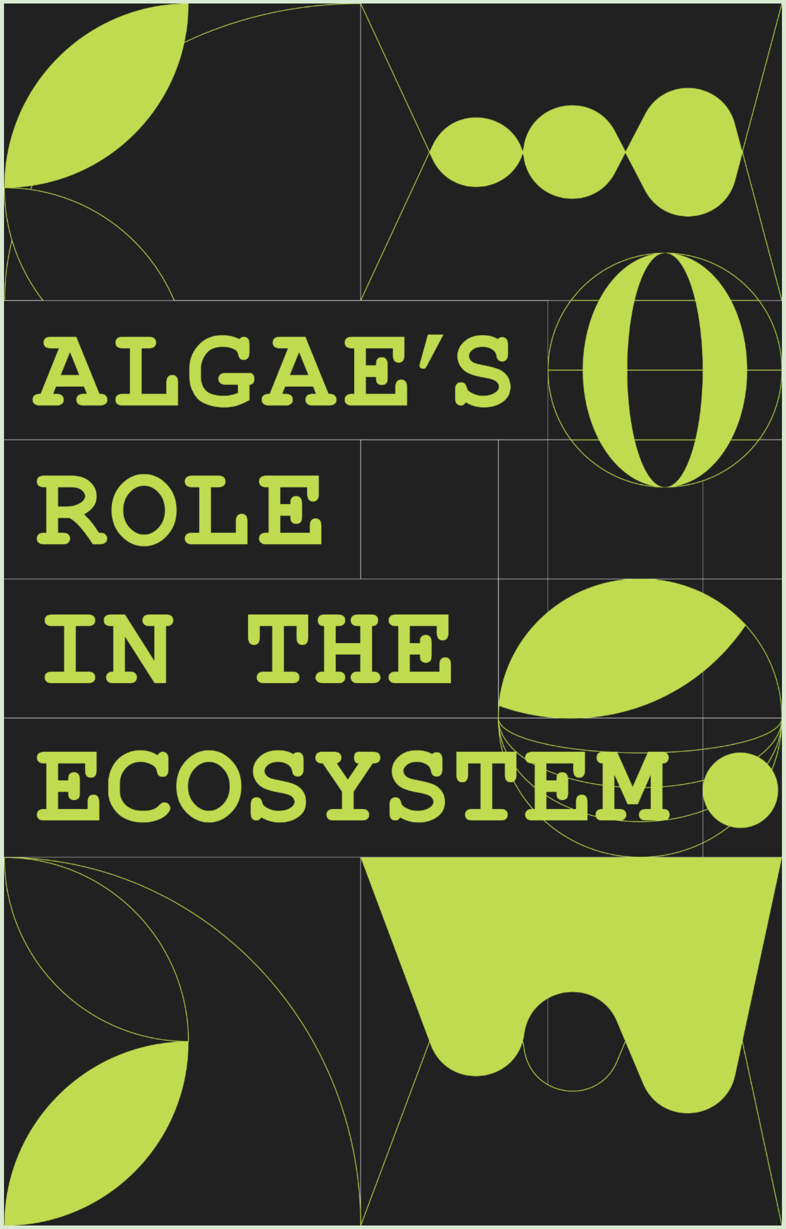
Algae Poster

This poster incorporates an aphorism about algae with organic and geometric visuals. The shapes are inspired by algae in their macro and micro levels. The grid and the typeface were used to express themes of the digital world.

Typeface: Courier New

Courier is a monospaced slab serif typeface. The typeface was designed by Howard “Bud” Kettler in 1955. The design of the original Courier typeface was commissioned in the 1950s by IBM for use in typewriters, but they did not secure legal exclusivity to the typeface and it soon became a standard font used throughout the typewriter industry. As a monospaced font, it has recently found renewed use in the electronic world in situations where columns of characters must be consistently aligned. It has also become an industry standard for all screenplays to be written in 12 point Courier or a close variant.

Colors: #212121 #C0DB4F #FFFFFF

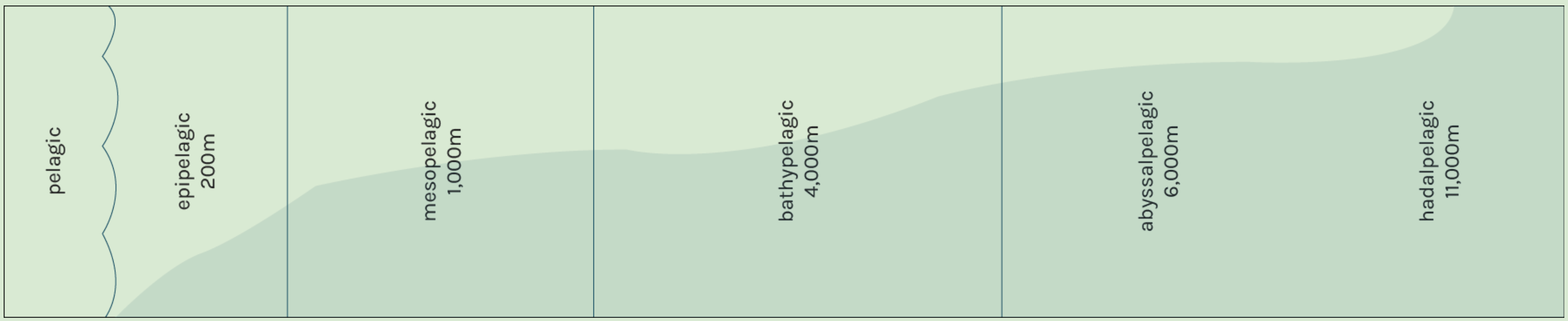


SVGs

The website is created entirely with code (no media files). For the images on the site, I drew them in illustrator and exported as svg code to be placed in the html of the site.

This first image is a diagram of the oceanic zones.

Colors: #212121 #184E63

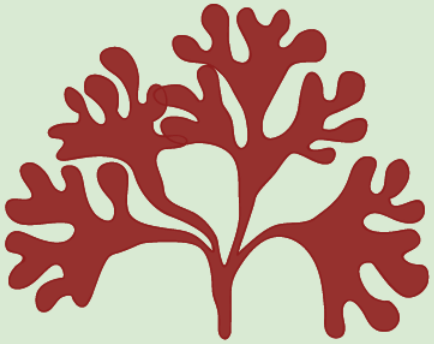


Laminaria (Brown Algae)

Color: #315c31

Rhodymenia (Red Algae)

Color: #8e1c1c

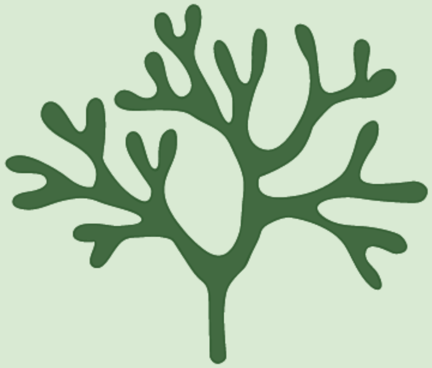


Giant Kelp (Brown Algae)

Color: #565b31

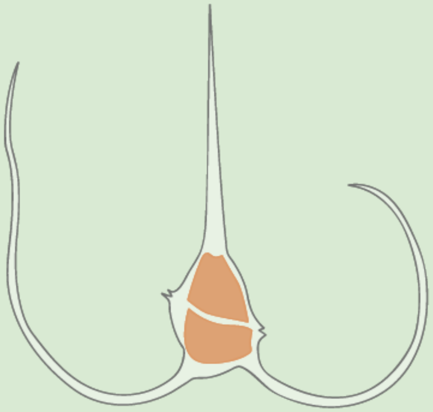
Codium (Green Algae)

Color: #315c31



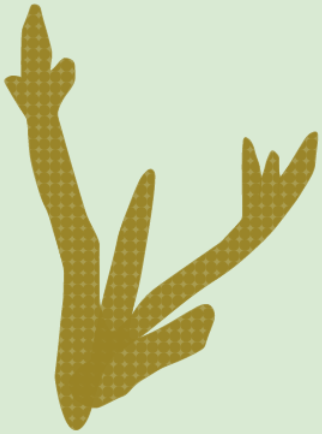
Ceratium Tripos (Dinoflagellate)

Color: #c65602



Staghorn (Stony coral)

Color: #998325



Zooxanthellae (Dinoflagellates)

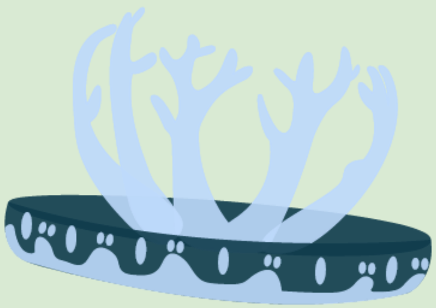
Colors: #315c31 #757c42 #e57529

Actinia tenebrosa (Sea anemone)

Color: #cc333e

Zooxanthellae (Dinoflagellates)

Colors: #0f3b4c #bedafc



Website Mockups

The website is live at: https://isuh.info/photista. The site consists of a homepage poster builder that generates random algae facts through a connected json file. The four additional pages have information about marine algae which was collected in this critical journal: Oceanic Divisions, Marine Algae, Symbiosis, and Resources. The pages have also been color-coded.

Colors: #184e63 #315c31 #382a42 #0b2b47

The site also uses the typefaces: Zilla Slab and Karla.

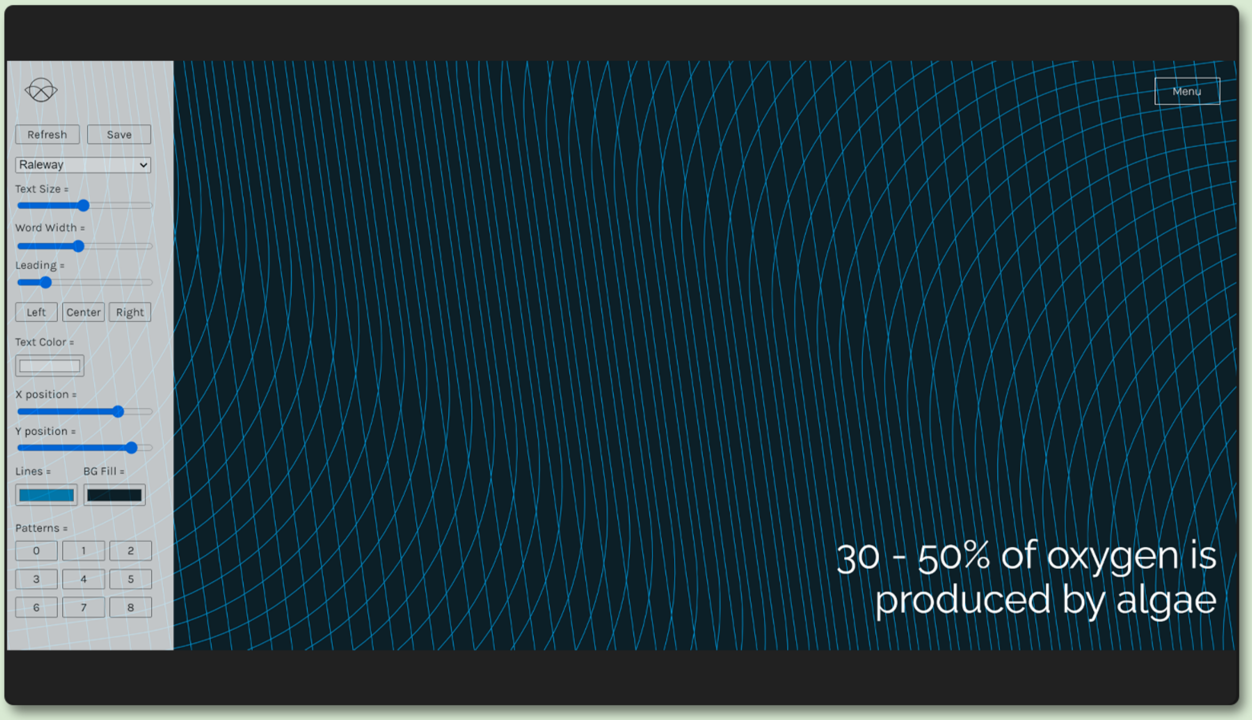
Typeface: Zilla Slab

Zilla Slab is Mozilla's core typeface, used for the Mozilla wordmark, headlines and throughout their designs. A contemporary slab serif, based on Typotheque's Tesla, it is constructed with smooth curves and true italics, which gives text an unexpectedly sophisticated industrial look and a friendly approachability in all weights.

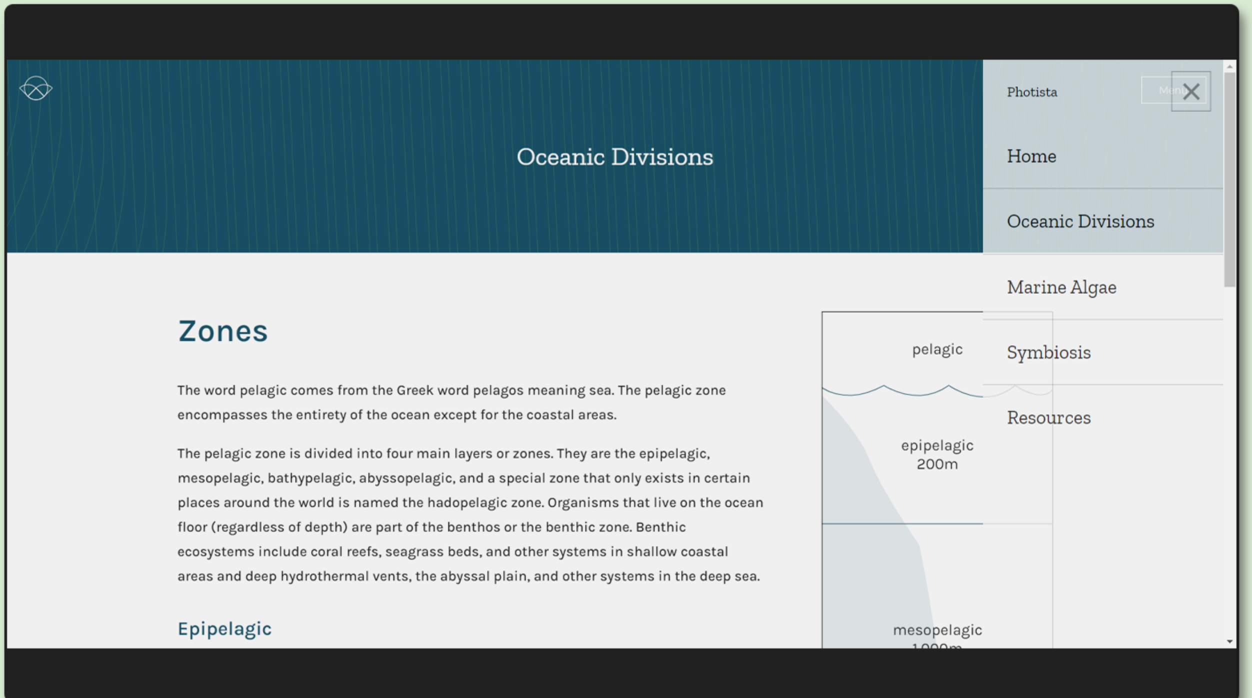
Typeface: Karla

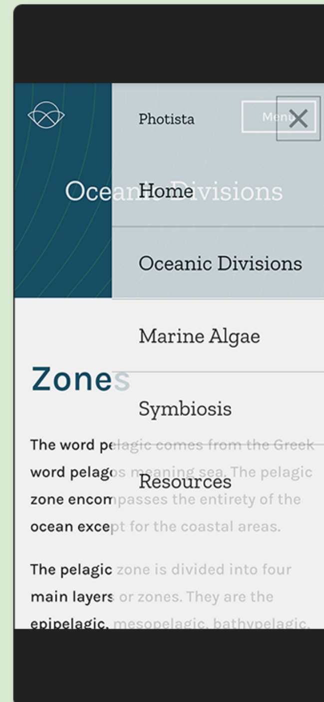
Karla is a grotesque sans serif family designed for the Latin and Tamil scripts. This is the Latin part of the family, which has been expanded now to a variable font with a weight axis ranging from ExtraLight to ExtraBold plus full support of Western, Central, and South-Eastern European languages.

Photista - Home

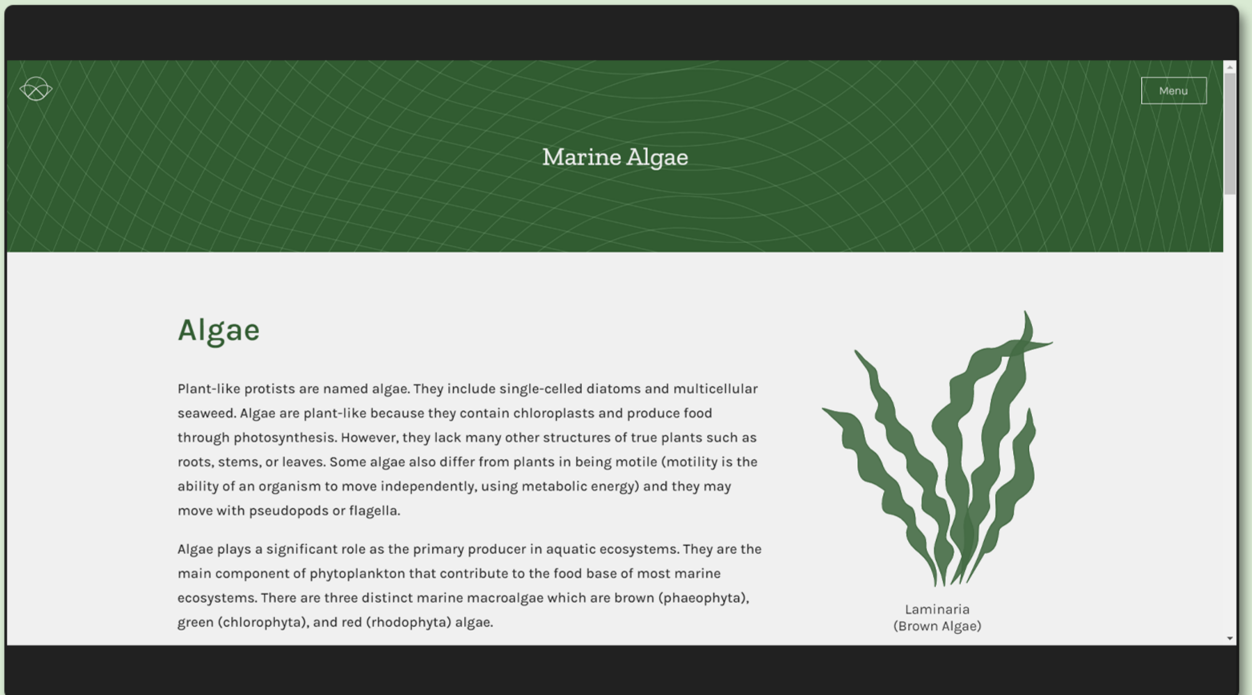


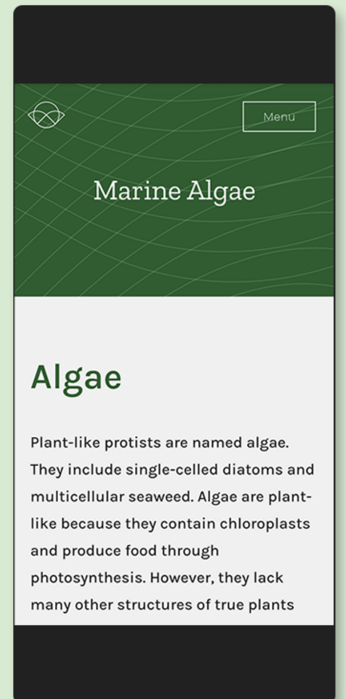
Photista - Oceanic Divisions



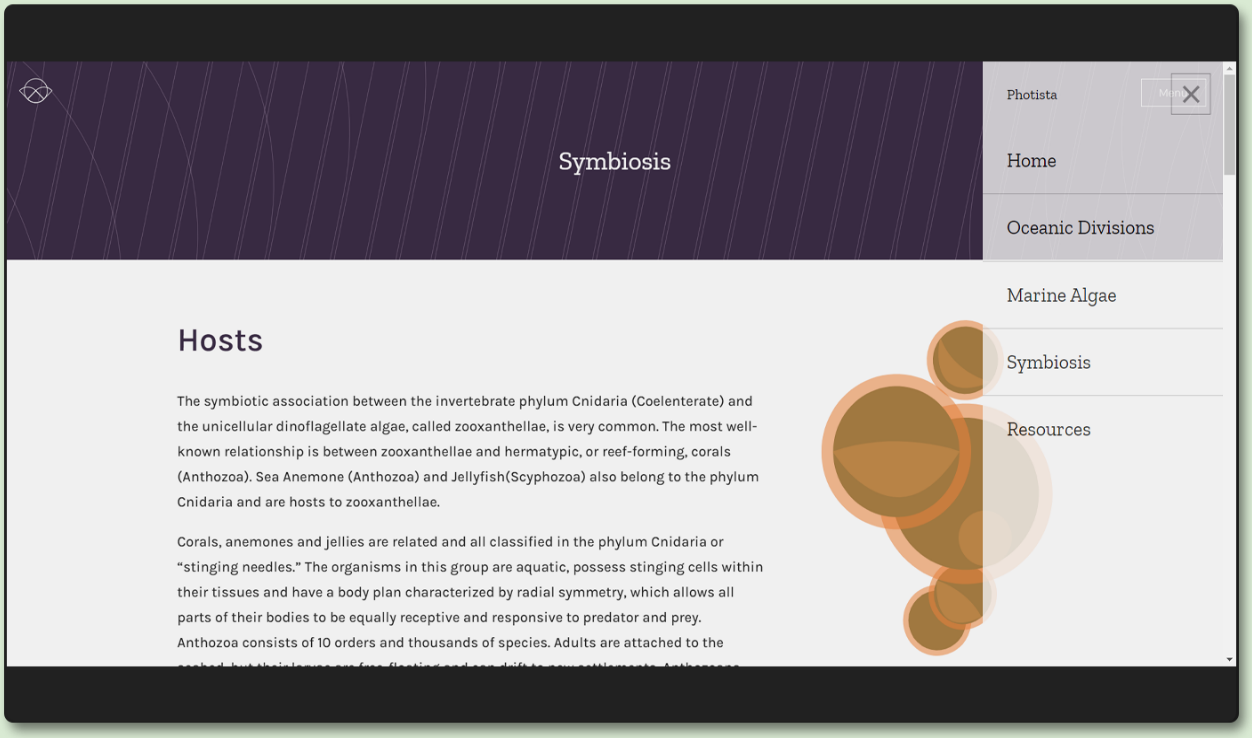


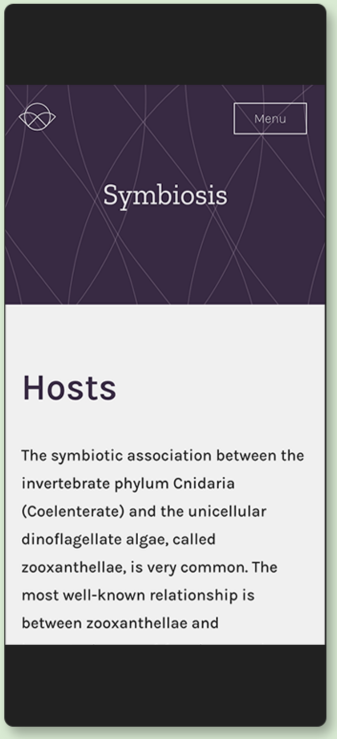
Photista - Marine Algae



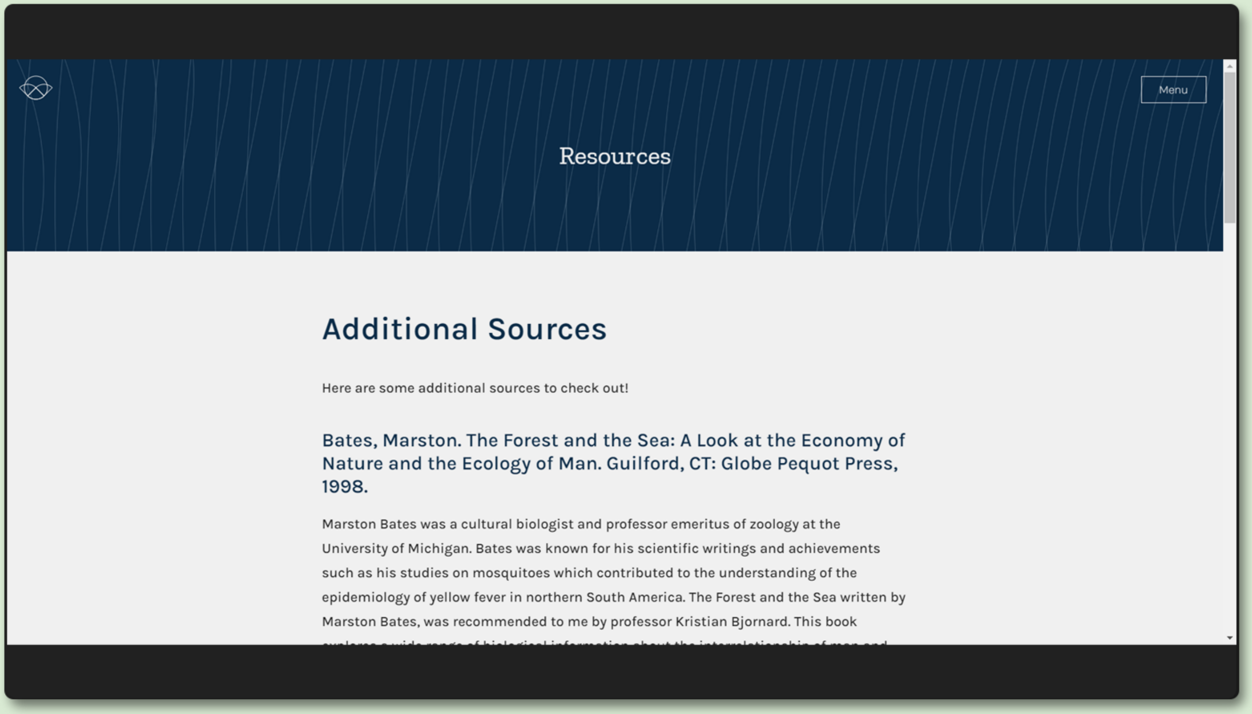


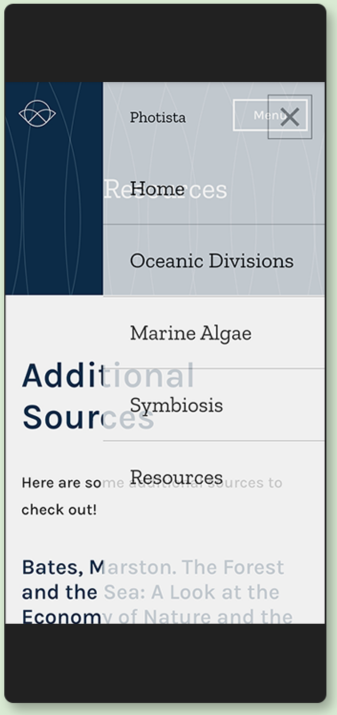
Photista - Symbiosis





Photista - Resources





Photista is live @ isuh.info/photista

Thank You!