Marine Biology – The Very Short Introductions Podcast – Episode 64

Rebecca Parker 00:07
Welcome back to The Very Short Introductions Podcast. From public health to Buddhist ethics, soft matter to classics, and art history to globalization, we'll showcase a concise and original introduction to a wide range of subjects for, wherever your curiosity may take you. So here is today's very short introduction.

Philip Mladenov 00:26
Hello, everyone. My name is Philip Mladenov and I've been teaching and researching in the field of marine biology for over 40 years. As a budding researcher, I studied for an MSc in marine science at McGill University, carrying out my research at the Bellairs Research Institute on Barbados. From there, I completed my PhD in marine biology while at the Banfield Marine Sciences Center on the Pacific coast of Vancouver Island. My first academic appointment was at Mount Allison University in Eastern Canada, where I taught marine biology and carried out research on coral reef ecology and fisheries in the Caribbean. I then accepted the position of Professor of Marine Science at the University of Otago in New Zealand, where I now live. I am currently a ministerial appointee to New Zealand's Environmental Protection Authority.

Philip Mladenov 01:23
The title of my VSI is Marine Biology: A Very Short Introduction. Fundamentally, marine biology is the study of how oceanic organisms live and interact with each other and their physical environment. Marine biologists work within our planet's most imposing natural habitat, the oceans, which cover 71% of the globe. As the science writer Arthur C. Clarke once observed, "how inappropriate to call this planet earth when clearly it is ocean." This immense living space supports a remarkably diverse and exquisitely adapted array of life forms, ranging from microscopic viruses and bacteria to the largest animals now existing on Earth. It also hosts many of Earth's most intriguing, inaccessible, and hostile ecosystems.

Philip Mladenov 02:17
Ocean life provides benefits that are essential for human survival and well-being. For starters, they produce half of the oxygen on Earth. To put this into perspective, the oxygen in every second breath we take was produced by life in the oceans. But marine organisms do much more than this for us. They create ecosystems that protect our coasts from storms, supply us with large amounts of healthy food, provide natural products that we use for medicines and biotechnology, help moderate and stabilize the Earth's climate, support many forms of recreation and tourism, and, to top it all off, they create an environment that is immensely beautiful and spiritual for humans. The value of healthy marine life is thus incalculable. Life on earth as we know it would not exist without it. For these reasons alone, marine biology is a hugely significant and fascinating subject. However, now that Earth has entered the Anthropocene, a new geological epoch, in which we as humans are significantly altering the global environment, the oceans are undergoing profound changes that are threatening their ability to provide the ecosystem services I just listed. As a result, the study of marine biology is taking on added importance and urgency as people struggle to understand and manage these human caused impacts.

Philip Mladenov 03:49
The list of these impacts is daunting. It includes ocean warming and acidification, ocean deoxygenation and eutrophication, loss of habitat, marine pollution of many kinds, including plastic pollution and overfishing. I will come back to some of these impacts later in my podcast. My own interest in marine biology was fostered and shaped by a series of fortuitous events, and the opportunities provided by many remarkable mentors along the way. As an undergraduate at the University of Toronto, one of my professors took his class of third year students on a field trip to the tiny island of Carriacou in the Caribbean Sea. And I can still well remember my first dive and tropical waters, where I was overwhelmed by the beauty and diversity of tropical marine life. Shortly after that, I had the opportunity to be employed as a research diver in the Arctic Ocean. The first glimpse I got of this polar marine environment had a profound effect on me. I saw an ocean filled with swarms of beautiful planktonic creatures called ctenaphores, which emitted a sparkling bioluminescent light that penetrated the gloomy dimness of this under ice marine habitat. After those experiences, I was completely hooked on marine biology, and was determined to make my career, one that has sustained my curiosity and excitement for a lifetime.

Philip Mladenov 05:21
What I'd like to do now is briefly discuss just a few examples of some current marine biological issues that will give you a flavor for the many challenges facing marine biologists in today's world. A good place to start is to point out the incredibly important role of microorganisms in the economy of the oceans, something that has not been well appreciated until recently. Although difficult to comprehend, especially when you swim or dive through what appears to be clear sea water is that the oceans consist of a vast soup of microbial life, which marine biologists call the microbiome. Microbes are present in mind-boggling abundance. For example, there are over a billion bacteria in a liter of seawater and protists, a very diverse group of single-celled organisms, occur densities up to 100 million per liter. Photosynthetic bacteria and protists produce most of the primary production in the oceans, the base of the marine food web. One type of bacterium, Prochlorococcus, is probably the most abundant photosynthetic organism on the planet. And then there are other viruses, by far the most abundant life forms in the oceans, present in astonishing densities of up to 10 to 100 billion in a liter of seawater.

Philip Mladenov 06:42
Marine photosynthetic organisms require an adequate source of nutrients in the form of nitrogen and phosphorus. However, when these nutrients are present in unnaturally high concentrations, they cause great harm. Many coastal marine systems are now greatly altered by nutrient pollution caused by human activities, especially the excess use of agricultural fertilizers on land, some of which leach into rivers and hence into the oceans. These nutrients stimulate massive blooms of photosynthetic microbes, a process known as eutrophication. As this mass of primary producers dies and decays, it consumes the oxygen in the seawater, killing marine life and creating marine dead zones. The number of marine dead zones has roughly doubled every decade since the 1960s, and now sits at over 500. Apart from the overall destruction of natural marine systems, dead zones destroy commercial fisheries. This explosion in dead zones needs to be halted and ultimately reversed. One priority is the widespread implementation of agricultural practices that reduce fertilizer use.

Philip Mladenov 07:54
An important marine biological system is present in the extreme environment of the Arctic Ocean. Much of the Arctic Ocean is permanently covered by sea ice, which you might expect to be devoid of life. But sea ice actually harbors an abundant and diverse community of marine organisms, including photosynthetic bacteria and protists, which dwell in the bottom layers of the ice and are eaten by larger zooplanktonic animals. These zooplankton grazers are an important food for fish, such as Arctic cod, which are in turn consumed by squid, seals, and whales. The seals are an important food for the roughly 25,000 polar bears that currently inhabit the Arctic region. As a result of the climate crisis, the Arctic region is warming very rapidly, and this is having a great impact on the Arctic ocean ecosystem. One stark trend is the rapidly decreasing extent of ice cover in the summer, with the result that the Arctic Ocean will become nearly or completely ice free for several months in a frighteningly short period of time, certainly before 2040 and possibly within the next decade. Clearly, the Arctic Ocean as we have known it is about to disappear with profound effects on its food web. Marine biologists are working hard to better understand the Arctic's changing marine ecosystem, and will hopefully be able to provide guidance on how to best manage the future of such a human-altered marine system.

Philip Mladenov 09:30
At the other end of the globe is another tremendously important polar marine system, the Southern Ocean that surrounds the continent of Antarctica. The Southern Ocean is very nutrient rich, producing massive phytoplankton blooms in the spring. The support the Southern Oceans most important marine species, the shrimp like Antarctic krill, which are one of the most abundant animal species on the planet in terms of numbers and biomass. It is not surprising then that krill are staple food source for almost all of the Southern Oceans marine animals, including fish, squid, seals, penguins, seabirds, and whales. Southern Ocean marine resources such as seals and whales have been exploited ruthlessly in the past, and some species are still subject to extensive exploitation. For example, commercial fishing vessels harvest the Patagonian toothfish, which can grow to over two meters and weigh more than 130 kilograms. Demand for toothfish outstrip supply, which has led to considerable illegal fishing. Even krill are harvested, much of it is processed into fish meal or used as a health food supplement. The exploitation of Antarctic marine resources and the impacts of climate change belie the commonly held notion that the Southern Ocean is one of the planet's last pristine marine systems. There is obviously still a long way to go before enough of the Southern Ocean is properly protected from exploitation and climate change to allow the recovery of this important marine environment.

Philip Mladenov 11:11
Turning now to tropical waters, coral reefs embody the archetypal image of a tropical marine environment. These rain forests of the ocean are very complex systems that are home to an incredible diversity of marine organisms. They have tremendous intrinsic value as anyone that has snorkeled or dived on a healthy reef can attest, but they also provide food for hundreds of millions of people, serve as natural protective barriers, sheltering coastal and island communities from hurricanes and typhoons, and employ millions of people in the tourism industry. Coral reefs are under serious threat from a wide range of human disturbances, but their ultimate peril is ocean warming. Temperature-stressed corals undergo bleaching, in which they expel symbiotic micro organisms from their tissues, and then generally die. Starting in 1980, coral bleaching events began to occur with rapidly increasing frequency and intensity. To make matters worse, the increasing concentrations of carbon dioxide in the

atmosphere are making sea water more acidic, which makes it more difficult for corals to manufacture their calcium carbonate skeletons. The health of coral reef ecosystems is thus deteriorating rapidly, and the future is very bleak. Coral dominated ecosystems will disappear entirely from Earth in the next 50 years if current greenhouse gas emission reduction goals are not met. Even if they are achieved 70 to 90% of the planet's corals will disappear by about 2050. We are thus sadly at the point where coral reefs are becoming legendary ecosystems. Fortunately, passionate coral biologists, philanthropists, and NGOs are now working together to develop new approaches to conserve at least some coral reefs in a relatively natural state, and perhaps, hopefully, to reestablish them at some future time when the climate stabilizes.

Philip Mladenov 11:11
At the start of my podcast, I mentioned that the oceans contain some of the most inaccessible habitats on Earth. The deep ocean is, of course, one of these, encompassing 90% of the oceans living space. It is a cold, dark, extremely pressurized and food-limited habitat, a very harsh environment from a human perspective. And yet, this extreme environment possesses a great diversity of marine life, beautifully specialized for living under such conditions. There are some remarkable features on the deep ocean floor known as hydrothermal vents, which eject superheated fluids from deep in the earth. Marine microorganisms use the chemical energy in these fluids as a food source, a process known as chemosynthesis. These microorganisms in turn support an astonishing animal community found only advanced systems. Many of these organisms contain genetic resources with medical and industrial applications. Also, vent fluids contain valuable elements including gold and silver, which are deposited around the vent. These resources are attracting initiatives to commercially mine hydrothermal vents zones, which would destroy these unique habitats. Marine biologists and policymakers are thus currently working on measures to protect such resources from deep ocean mining.

Philip Mladenov 14:49
I'll finish this podcast with a brief overview of some key aspects related to the harvesting of food from the oceans. These days, fishing the oceans takes place globally at an industrial scale and provides the human population with its last significant source of wild food. Unfortunately, global seafood catches peaked in the 1990s and are now stagnant or in decline, and fully a third of all fish stocks are overfished and facing collapse. Overfishing is seriously impacting not only the target species, but also the functioning of entire marine ecosystems. Marine protected areas will play a crucial role in rebuilding fish stocks and marine ecosystems. A key question is how much of the global ocean needs to be protected to bring about a meaningful recovery? The consensus among marine biologists is that a network of "no take" marine protected areas, covering greater than 30% of the area of the global ocean, needs to be established and effectively managed to achieve this. The good news is that United Nations member states have very recently agreed on an historic treaty to legally protect the high seas, which had helped to achieve this target.

Philip Mladenov 16:13
Well, my time is up. I hope what I have discussed has sparked your interest in the exciting and rapidly evolving field of marine biology. Society needs people from all walks of life, not just scientists, to become marine literate and get involved in marine biological issues. Their participation will create the knowledge base, policies, and social contracts that will allow us to set about restoring marine

ecosystems to a state that allows them to support an earth system in which 10 billion people will soon live and hopefully thrive.

Rebecca Parker 16:55
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