Marine Biodiversity Essay: Protists and Eutrophication

by

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From the tinniest microorganisms, to the humans that walk the plains, to the mountains and arctic of Canada, we are a country as diverse as the people that live here. Unbeknownst to most, there also lies a much greater diversity that surrounds the country entirely. Bordered by the Atlantic Ocean in the east, the Pacific in the west, Hudson's bay, and the Arctic Ocean to the north, Canada is the perfect example of a country that has limitless potential in the study of marine biodiversity. The American Heritage Dictionary of the English Language definition of biodiversity is "the variability among living organisms on the earth, including the variability within and between species and within and between ecosystems." This definition can also be applied to marine biodiversity; comparatively a much less studied counter-part to terrestrial biodiversity. Biodiversity can be further broken down into three main categories: genetic diversity, species diversity, and ecosystem diversity.

Genetic diversity is essentially an evolution that takes place at the level of individual genes[1], in order for members of a population or species to overcome certain obstacles that may be present. While not always obvious to the naked eye, genetic

[1] Polymorphism

diversity exists in the similarities or differences in the genetic framework of an individual, a species, or a population. Diversity at this level is extremely crucial for a species ability to adapt and survive in an ever-changing environment. In sexually reproducing organisms it occurs due to the combination of alleles from the fusion of two chromosomes. Genetic mutation can also occur in an individual having more than one allelic variant; this variant is said to be polymorphic. There exists a delicate interdependence between biodiversity and genetic diversity; changes in biodiversity result in changes in the environment, requiring adequate adaptation of the remaining species.

The most commonly used synonym for biodiversity is species diversity. Species diversity is "the variation in the number and frequency of species in a biological assemblage or community."[2] Species is a broadly encompassing term that includes all taxa of vertebrates and invertebrates. There are currently believed to be a minimum of 2.1 million and a maximum of 100 million species in existence on the earth. Most of the unclassified species are invertebrates that reside in the ocean, or distant from the middle longitudes. The primary index used for species diversity is species richness, which is defined in terms of the number of species existing in a certain habitat. This index may not be the best estimate for species diversity. This is due to the fact that there are sometimes very minimal differences between species in a certain habitat, nonetheless, they are treated as two separate species. The species richness index may have to be discontinued or revised in the future.

Ecosystem diversity can exist on any scale, from a jar of pond-water to a full biosphere. Ecosystem diversity includes both biotic and abiotic components, therefore,

[2] Centre for Marine Biodiversity "What is Marine Biodiversity?"

differing from species and genetic diversity. There are currently no working classifications for ecosystem diversity as all ecosystems are not the same. The differences in each type of ecosystem are innumerable, and there are many, if not more different types of ecosystems. This is because the introduction of one new component or the removal of another can completely alter an ecosystem. It has become an inherent problem for the global community; human activity is introducing and removing new components to our biosphere, altering ecosystem diversity.

Almost everything done by humans will eventually affect the biosphere in some way and one of the areas most affected by human activity is biodiversity. World Governments are becoming increasingly aware of the dangers that are posed to biodiversity through human activity. The culmination of efforts to preserve biodiversity came at the Earth Summit UN Conference on Environment and Development in Rio De Janeiro, Brazil, 1992. Both IGO[3]s and NGO[4]s participated in the conference, including 172 governments and over 2,400 non-government representatives. The principal themes of the Rio summit were the environment and sustainable development. Sustainable development is "development balancing near-term interests with the protection of the interests of future generations"[5].

One of the main agreements signed at the Rio summit was *The UN Convention on Biological Diversity*. An astounding 150 government leaders at the conference signed the agreement in 1992, with another 38 countries joining the convention since. It was

[3] International Government Organizations
[4] Non Government Organizations
[5] United Nations Division for Sustainable Development

conceived as a practical tool for translating the principles of Agenda 21[6] into reality. An excerpt from the prelude of the convention is as follows

> "Conscious of the intrinsic value of biological diversity and of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components. Conscious also of the importance of biological diversity for evolution and for maintaining life sustaining systems of the biosphere. Affirming that the conservation of biological diversity is a common concern of humankind."

Also mentioned in the convention is the responsibility of sovereign states to conserve, sustain, and develop their biological diversity. The imbalance of benefits and costs of protecting biodiversity between states was also addressed.

Along with the realization that biological diversity is important, countries also realized that their marine biodiversity was equally pertinent. The difficulties with marine biodiversity are that little is known concerning the world's waterways; only 15% of all known species are described as being from marine systems, reflecting a poor understanding of the marine environment. Fossil records show that the ratio of new species versus the species that are becoming extinct is very unbalanced. This means that once a species is extinct, it will take significantly longer, in the order of millions of years, to rebuild the hole left in the ecosystem. This alone should be sufficient incentive to stimulate improved understanding of modern marine biodiversity, its controlling mechanisms, and its conservation.

Canada is one of the countries that has limitless potential for the research and understanding of marine life. Bordered by three major oceans, and having the largest freshwater bodies in the world, makes Canada a plethora of knowledge waiting to be

[6] Agenda 21 addresses the pressing problems of today and also aims at preparing the world for the challenges of the next century. It reflects a global consensus and political commitment at the highest level on development and environment cooperation.

discovered. Canada would be a perfect place to establish *Marine Biodiversity Discovery Corridors*[7], in each of the three oceans respectively. *Marine Biodiversity Discovery Corridors* would "be used to provide detailed estimates of biodiversity across all taxa and to provide focal points for studies of the processes affecting or maintaining biodiversity."[8] These corridors would reflect different ecosystems with different levels of human interference, such as: areas devoid of human influence, with heavy human influence, unique areas and other places where marine biodiversity could be effectively studied.

One of the little understood worlds of marine biodiversity is that of the kingdom Protista. All protists are classified as Eukaryotes because of the presence of a membrane-bound nucleus, membrane bound organelles, and chromosomes with complex DNA. Protists have characteristics of both plants and animals and exist in many different environments including fresh and salt water. Because the protist kingdom is so vast, the easiest form of classification is to classify them according to the larger organisms they most resemble. This classification of protists is broken down based on how they obtain nutrients. The first class are called the plant-like protists (*algae*); which means that they are autotrophs and can carry out photosynthesis similar to land plants. Animal-like protists *(protozoa*) represent another class; animal-like means they ingest food and carry out digestion. Some in this group can reproduce sexually or have distinct organs for motion. Finally, fungi-like protists are protists that absorb nutrients from the environment, are saprophytes and heterotrophic colonizers of any ecosystem. When in a

[7] From the Centre for Marine Biodiversity work-shop. Co-sponsored by the Canadian Department of Fisheries and Oceans and The Census Of Marine Life.
[8] Ibid

marine environment protists serve many purposes, such as congregation points and habitats for other marine life, development of coral reefs, and natural eutrophication.

The protist kingdom includes marine plants that serve as flourishing habitats to communities of marine life. The sargassum weed, commonly found in Atlantic waters and the Sargasso Sea, is host to marine life that are uniquely adapted to their habitat. These creatures, including the Sargassum Angler Fish (*Histrio histrio*), Sargassum Flying Fish (*Hirundichthys affinis)* and the Sargassum Crab (*Planes minutes*), are specifically adapted to their sargassum weed habitat. Bull kelp (*Nereocystis luetkeana*) and giant kelp (*Macrocystis pyrifera*) are two more prime examples of members of the protist family forming a habitat for marine life. These giant kelp are found in both Atlantic and Pacific oceans and may grow to an astounding length of 45 metres. In the forests that these giant kelp form, there have been 77 species of fish and 204 species of invertebrates identified. Prominent sea mammals such as the sea otter (*Enhydra lutris)* and seals (*Phocidae*) also reside in these kelp forests. Habitats formed by members of the protista family house animals that can only be found under their protective barriers and are a critical part of marine biodiversity.

A group of protists called phycobilins (*Division Rhodophyta*) have photosynthetic pigments called phycoerythrin that allow them to exist in deep ocean waters that are only reached by blue and green light. These specialized pigments allow the phycobilins to perform photosynthesis with light of shorter wavelengths. A division of the phycobilins called *Coralline Algae*, secrete a hard calcium carbonate ($CaCO_3$) shell. These calcareous protists are a crucial factor in the creation of coral reefs, more so than many other organisms. Two common examples of these *Coralline Algae* are *Corallina* and

Ceramium virgatum; they exist in warm tropical waters and have been in the marine environment for millions of years.

Along with salt-water protists, fresh water protists and fresh water biodiversity are also important areas of study. Most lakes and rivers mainly drain into the oceans; everything is connected, and issues that affect inland marine environments also affect oceans. There is also the issue of up to one third of the world's population facing moderate to high water stress. Attention should also be paid to fresh-water biodiversity.

Eutrophication is a natural process that has now become a major problem mainly for fresh-water biodiversity. Natural eutrophication is the process by which lakes gradually age and become more productive. It occurs due to algae (*Division Chlorophyta*) taking nutrients, mainly phosphorus and nitrogen, from the water to aid in photosynthesis. The problem that has arisen is due to excess chemicals from human activity entering the watershed. One such problem arises from phosphorus, a common element found mainly in the form of phosphates. It is present in many detergents, human urine and feces, and fertilizers used by farmers on their land. These phosphates generally end up in the watershed, where they provide excess nutrients to algae.

When excess nutrients are introduced into an ecosystem, the primary producers reap the most immediate benefits. Algae will experience a massive increase in population, deemed an algal bloom. Algal blooms resemble a large green mat of sludge that has been draped over the surface of the water. These algal blooms are hazardous to the marine ecosystem because they limit the sunlight that reaches bottom dwelling organisms. Plants at the bottom of the aquatic environment do not receive sunlight that they require for photosynthesis, rendering them unable to provide nutrients for

themselves, nor the oxygen required for other organisms to live. Under eutrophic conditions the oxygen levels in the ecosystem rapidly deplete after the bottom plants have died. Microorganisms then feed on the dead plants and the excess algae, using more oxygen, while none is being reproduced. Hypoxia then occurs and fish or other marine mammals may suffocate. In extreme cases a completely anaerobic environment occurs, promoting growth of bacteria such as *Clostridium Botulinum* which produce toxins deadly to birds and mammals.

Some algal blooms created by eutrophication are toxic to plants and animals. These blooms can work their way up the food chain through primary producers and can even harm livestock and humans. Marine mortality has been observed due to toxic algal blooms, along with the presence of neurotoxins and hepatotoxins in livestock. These toxins have already worked their way up to humans, as in the cases of shellfish poisoning in the early 1990s. Biotoxins created by algal blooms resided in shellfish, which resulted in cases of poisonings in humans.

Eutrophication is a process that is very hard to reverse, as excess phosphorus that has leeched into the watershed settles to the bottom of an aquatic environment. In Canada, the great lakes have been greatly affected by eutrophication since they are major centers of human activity. Different sources, including farmers, and detergent and waste management companies have been cited as the source of excess phosphorus. *The Freshwater Institute*[9] has done research backed by the federal government into the causes of eutrophication. Canada also has a designated research area of lakes, aptly titled "Canada's Experimental Lakes Area," where most of the research into fresh-water

[9] Winnipeg, Manitoba

problems is preformed. The general consensus reached by researchers is that emissions of phosphates must be reduced in order to maintain a healthy ecosystem in Canada's lakes.

It is essential that the youth of today be educated in aspects of biodiversity if plans of sustainable development hope to be accomplished. The youth are the ones who will carry on the research and provide the knowledge for future generations. Pertaining to the issue of destruction of biodiversity and the biosphere, all nations and their current and future generations must unify to reduce the negative effects that have been created by blatant ignorance. With knowledge comes possibilities, and with increased knowledge and awareness of the diverse environmental issues that affect the world it is possible have to take the first steps in rebuilding our oceans and territories.

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Universities I am considering application to:

St. Francis Xavier

Acadia University

St. Mary's University