Chapter 1

Introductory Chapter: Marine Ecology—Biotic and Abiotic Interactions

Muhammet Turkoglu, Umur Onal and Ali Ismen

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.78296

1. Introduction

The vastness of the oceans, the largest continuous environment on earth, has provided a safe shelter for about 20% of all living organisms until the beginning of industrial revolution. Since then, this once invincible environment has been under constant change and destruction, the results of which now are threatening all life forms on earth. With this rate of destruction, we are possibly losing our window of opportunity to protect aquatic biodiversity and learn how aquatic organisms evolved to find ways for adapting life in water. Marine Ecology, in its simplest terms the study of marine organisms and their habitats, continues to provide fundamental information to better understand the effects of global changes on eco-biology of organisms.

In many cases, marine ecology is more intricate than the relatively simple study of a specific living organism or its environment due to various intra and inter specific interactions between other organisms and due to effects of numerous factors on a particular environment. Therefore, marine ecologists rather than concentrating on a single species, organism or habitat, often find themselves simultaneously focusing on interactions between organisms and the effects of environmental factors on these organisms. During the last decades, the complex nature of these interactions is being exacerbated due to the changes induced by a variety of factors such as increased ocean temperatures, dramatic changes in weather patterns, ocean acidification, melting of glaciers, and pollution. The effects of these man-made factors are occurring in a relatively shorter time scale and in many cases are beyond the capacity of organisms to adapt to these deviations. Throughout the world, new conditions are often manifesting themselves as loss of biodiversity accompanied with other major changes such as shifts in distributions of many species toward higher latitudes and changes in timing of life cycle events.

IntechOpen

© 2018 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/3.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. CC BY

One of the most important factors that influence life in the oceans is temperature. Temperature affects the rate biological processes proceed. In general, the metabolic rate of poikilotherms doubles with a 10°C increase in temperature. However, much less temperature differences are enough to trigger changes in weather patterns that have worldwide effects. Global mean temperatures are now 0.50°C higher than it was since 1960s [1]. A typical example of increased global temperatures is the El Niño phenomenon that occurs periodically over the Pacific Ocean and characterized by increased temperatures of surface waters. It is well established that increased water temperatures results in weakened currents and less rain in the Southern Ocean which in turn, results in dramatic changes in physicochemical and biological conditions. Fluctuation in nutrient concentrations is the most notable factor that altered circulation pattern effects. Such interruptions of nutrient fluxes have important consequences on the primary production which in turn affect fish stocks. The relationship between fluctuations in the abundance of anchovy in the Southeast Pacific Ocean [2] and the periodicity of El Niño has been established. The fluctuations in the abundance of these commercial fish stocks have important socioeconomic consequences due to enormous yields which fluctuated between 3 and 8 million tons during the last decade [3].

Another important parameter that influences life in the ocean is CO_2 levels in the atmosphere. As a result of global industrialization, CO_2 levels have increased over the last 100 years. Higher CO_2 levels in the atmosphere forces this gas into the surface waters which results in lower pH values. As a result, the mean pH value of the earth's oceans has fallen by 0.10 pH units [4]. Insignificant as it may seem, this drop corresponds roughly to 30% increase in the concentration of hydrogen ions. Organisms such as corals, bivalves, and calcareous plankton are susceptible to reduced pH levels as acidic conditions dissolve calcium carbonate. Therefore, the disruption of the calcification process may have serious consequences due to its potential to negatively affected calcareous species in the food web.

Another important factor that is becoming increasingly influential on all life on earth is the increasing rate of melting of ice in polar regions. The melting of ice causes a series of events including, sea level rise, freshening of seawater, and reduction in the speeds of major current systems in the oceans. While sea level rise will have catastrophic effects mainly for human habitation in coastal areas, freshening of seawater and its effect on currents will potentially affect all life forms due to the changes in global climate.

Although the effects of individual stressors are relatively well studied, there are limited data on compounded effects of multiple stressors [5]. Stressors such as temperature, salinity, UV, hypoxia, acidification, and pollution may be simultaneously experienced by marine organisms, especially in coastal areas. In many cases, organisms exposed to multiple stressors exhibit reduced resistance. For example, many coral reefs are simultaneously suffering from increasing temperatures, acidification, diseases, and silting [6]. Toxicity of pollutants has been shown to increase salinity or temperature stress [7]. This is particularly important because even if strict fisheries regulations become effective for a particular overexploited area in a heavily modified coastal system, expected recovery of stocks may not be possible due to increased vulnerability of early life stages to multiple stressors relative to juvenile or adult stages.

While it is relatively easier to observe the effects of altered physicochemical conditions over larger scales, the effects of pollution and over exploitation are relatively easier to observe in smaller scales. A typical example is the Black Sea which is closed basins with limited water exchange rates and relatively smaller surface areas. Between the period 1950 and 1970, the Turkish Black Sea fishery was characterized by larger predators such as tuna, swordfish, and bonito. Following a decrease in top predators as a result of increased fishing pressure, industrial fishing operations concentrated on small pelagic fish species such as anchovy and sardine. Therefore, after 1970s, there was a major shift in commercial fishing operations [8]. Due to the developments in industrial fishing methods, a steady increase was observed until late 1980s with a maximum of 600,000 tons in 1988. This increase in fish productivity was correlated with a 10-fold increase in phytoplankton biomass in the 1980s compared to that of 2–3 g m^{-2} in 1960s [8]. This dramatic increase was due to increased inputs of agricultural nitrates and phosphates into the Black Sea through rivers and the subsequent mixing of these nutrients in the water column. As a result of this enrichment, primary production was able to support—despite increased fishing pressure—high yields of small pelagic fishes for almost a decade before a major collapse observed after late 1980s. For example, in 1990, anchovy landings were only 66,000 tons, which was less than ¼ of that in 1988. This collapse in small pelagic fisheries was also experienced by other nations bordering the Black Sea and as a result, total landings dropped down to 200 thousand tons in 1991, compared to that of 900 thousand tons in 1988. It is believed that overexploitation was not the only factor for the simultaneous collapse in small pelagic fish stocks experienced throughout the Black Sea. The lobate ctenophore, *Mnemiopsis leidyi* A. Agassiz, 1865, which was reported for the first time in the Black Sea in 1982, had reached a biomass of up to 1 kg m^{-3} by the end of 1980s [9]. Its broad tolerance to a variety of physicochemical conditions, rapid growth and voracious appetite for zooplankton, fish eggs, and larvae has contributed significantly to the collapse of Black Sea fisheries. After 1990s, although reductions in concentrations of agricultural nutrients in the Black Sea and the introduction of *Beroe ovata* Mayer, 1912, the pink comb jellyfish that feeds on *M. leidyi* tipped the balance in favor of recovery of small pelagic fish stocks, we are still miles away from the point of sustainable management of fisheries in the Black Sea. Yet, even over a relatively smaller scale and with no diverse multinational management strategies that can limit the success of management programs, fisheries in the Sea of Marmara is almost an identical episode of what was experienced in the Black Sea. For example, a comparison of catch rates in 1990 and 2015 showed a 1.50- to 130-fold decrease in all reported demersal species [10] as a result of eutrophic conditions as indicated by increased periodicity and intensity of phytoplankton blooms [11–14], introduction of *M. leidyi* in early 1990s [15], continuous heavy fishing pressure and lack of effective management strategies. Recovery efforts for these two interconnected ecosystems will require a multidisciplinary approach to rebuild fishery resources. Unfortunately, decreasing fish stocks is not only an issue of semi-closed basins with highly populated areas. It is estimated that globally up to 63% of fish stocks are in need of rebuilding [16] and efforts toward rebuilding diversity will meet major challenges considering human-induced and global-scale impacts.

This book includes contributions from a variety of ecosystems around the world and presents comprehensive information on the present or recent status of a diverse group of marine

organisms including primary producers, zooplanktons, shellfish, crustaceans, and fishes. The valuable information gathered from researchers all around the world will not only explain the current status of these organisms and the environment in which they thrive but it will also provide a reference for future studies to help compare how predicted or unpredicted changes will affect these organisms in coming years.

Author details

Muhammet Turkoglu*, Umur Onal and Ali Ismen

*Address all correspondence to: mturkoglu@comu.edu.tr

Çanakkale Onsekiz Mart University, Marine Sciences and Technology Faculty, Terzioglu Campus, Çanakkale, Turkey

References

[1] Core Writing Team, Pachauri RK, Reisinger A. Climate Change 2007: Synthesis Report. A Report of the Intergovernmental Panel on Climate Change (IPCC), Geneva: IPCC; 2007. 104 p

[2] Chavez FP, Ryan J, Lluch-Cota SE, Niquen M. From anchovies to sardines and back: Multidecadal change in the Pacific Ocean. Science. 2003;**299**:217-221. DOI: 10.1126/science.1075880

[3] FAO. Food and Aquaculture Organization of the United Nations. Fisheries and Aquaculture Department. 2017. Available from: htpp://www.fao.org/fishery/species/2917/en [Accessed: 30-April-2018]

[4] The Royal Society. Ocean Acidification Due to Increasing Atmospheric Carbon Dioxide. London: The Royal Society; 2005; 60 p

[5] Puccinelli E. How can multiple stressors combine to influence ecosystems and why it is important to address this question? Integrated Environmental Assessment and Management. 2012;**8**:201-202. DOI: 10.1002/ieam.1250

[6] Carpenter KE, Abrar M, Aeby G, Aronson RB, Banks S, Bruckner A, Chiriboga A, Cortés J, Delbeek JC, Devantier L, Edgar GJ, Edwards AJ, Fenner D, Guzmán HM, Hoeksema BW, Hodgson G, Johan O, Licuanan WY, Livingstone SR, Lovell ER, Moore JA, Obura DO, Ochavillo D, Polidoro BA, Precht WF, Quibilan MC, Reboton C, Richards ZT, Rogers AD, Sanciangco J, Sheppard A, Sheppard C, Smith J, Stuart S, Turak E, Veron JE, Wallace C, Weil E, Wood E. One-third of reef-building corals face elevated extinction risk from climate change and local impacts. Science. 2008;**321**:560-563. DOI: 10.1126/science.1159196

[7] Lange R, Marshall D. Ecologically relevant levels of multiple, common marine stressors suggest antagonistic effects. Scientific Reports. 2017;**7**:6281. DOI: 10.1038/s41598-017-06373-y

[8] Oguz T. The effects of climate change and environmental factors on fisheries in the Black Sea. In: Fisheries Symposium on Black Sea; October 13-14, 2016; Sinop, Turkey (in Turkish)

[9] Vinogradov ME, Shushkina EA, Musayeva EI, Sorokin PY. A newly acclimated species in the Black Sea: The ctenophore *Mnemiopsis leidyi* (Ctenophore: Lobata). Oceanology. 1989;**29**(2):220-224

[10] Demirel N, Gul G. Demersal fishes and fisheries in the Sea of Marmara. In: Ozsoy E, Cagatay MN, Balkis N, Balkis N, Ozturk B, editors. The Sea of Marmara: Marine Biodiversity, Fisheries. Istanbul, Turkey: Conservation and Governance. Turkish Marine Research Foundation; 2016. pp. 630-643

[11] Turkoglu M. Synchronous blooms of the coccolithophore Emiliania huxleyi (Lohmann) Hay & Mohler and three dinoflagellates in the Dardanelles (Turkish Straits System). Journal of the Marine Biological Association of the United Kingdom. 2008;**88**(3):433-441. DOI: 10.1017/S0025315408000866

[12] Turkoglu M. Winter bloom and ecological behaviors of coccolithophore Emiliania huxleyi (Lohmann) Hay & Mohler, 1967 in the Dardanelles. Hydrology Research. 2010; **41**(2):104-114. DOI: 10.2166/nh.2010.124

[13] Turkoglu M. Red tides of the dinoflagellate *Noctiluca scintillans* associated with eutrophication in the sea of Marmara (the Dardanelles, Turkey). Oceanologia. 2013;**55**(3):709-732. DOI: 10.5697/oc.55-3.709

[14] Turkoglu M. First harmful algal bloom record of Tycoplanktonic Dinoflagellate *Prorocentrum lima* (Ehrenberg) F. Stein, 1878 and real time hydrography in the Dardanelles (Turkish straits system, Turkey). Journal of Coastal Life Medicine (JCLM). 2016;**4**(10):765-774. DOI: 10.12980/jclm.4.2016J6-184

[15] Shiganova T, Tarkan AN, Dede A, Cebeci M. Distribution of the Ichthyo-Jellyplankton *Mnemiopsis leidyi* (Agassiz, 1865) in the Marmara Sea (October 1992). Turkish Journal of Maritime and Marine Sciences. 1995;**1**(1):3-12

[16] Murawski SA. Rebuilding depleted fish stocks: The good, the bad, and, mostly, the ugly. ICES Journal of Marine Science. 2010;**67**:1830-1840. DOI: 10.1093/icesjms/fsq125