Proceedings of the 4th International Conference on Materials Chemistry and Environmental Engineering
DOI: 10.54254/2755-2721/58/20240689

The review of how ocean acidification effect organisms and ecological environment

Yilin Lan

No. 37 Middle School of Chengdu Country, Chengdu, China, 610031.

3413672148@qq.com

Abstract. The pH of our sea water is decreasing nowadays. Therefore, ocean acidification has gradually become a problem that people have to face. Human activities since Industrial Revolution are making sea water more and more acidic. Human activity has done some damage to the environment that will directly or indirectly increases the amount of hydrogen ions in seawater, which will finally make the seawater more acidic. One of the result of this changes is ocean acidification. People should start playing attention on this problem. If people do not intervene in advance to acidify the oceans, this issue can cause some consequences that will hurt our environment. The following is the main content of this paper. The reason why carbon dioxide can cause ocean acidification, effects of ocean acidification on Marine ecological environment, the shape of Balanophyllia's bones changes in different PH environment and Changes in metabolic pathways of phytoplankton under ocean acidification.

Keywords: Ocean Acidification, Ecological Environment, Balanophyllia, Metabolism, Carbon Dioxide.

1. Introduction

Ocean acidification is a problem that humanity is now facing. Whereas, when we talk about the ocean acidification, many people may think that is nothing to do with my life, I will not effect by that. Therefore, many people will ignore the seriousness of ocean acidification and the importance in doing research on ocean acidification. However, this idea is completely wrong. The earth land and ocean are related. Even small changes in the ocean can have a greater or lesser impact on life on land. People should take ocean acidification issue seriously. Many people already do some research on this topic and had some findings. I have some understanding through read a lot of papers. This essay will talk about two effects of ocean acidification on organisms and ecological environment. It can help people learn more about how can ocean acidification effect organism and ecological environment. By study the effect of ocean acidification, people can predict what problems will ocean acidification cause and how can people limit the damage caused by ocean acidification. It can also let people realize the importance in protect our ocean from ocean acidification and try to guard our earth. This is essential for humanity. Whereas, there are also some consequences that people have not discover. Thus, people should continue work on this problem in order to discover more effect which are subtly affecting human life. Then, people can better solve problems caused by ocean acidification. Humans depend on ecosystems for their survival. So we should protect our ecosystem from being destroyed. Therefore, everyone has the responsibility to protect the ecological environment.

DOI: 10.54254/2755-2721/58/20240689

2. Causes and current situation of ocean acidification

The ocean acidification has gradually become a serious problem nowadays. The pH of ocean is obviously decreasing in the pass hundred years.

Seawater itself should be weakly alkaline, and the pH of the surface water of the ocean is about 8.2, but the pH of the ocean has fallen by 0.1 since the Industrial Revolution. With the increase of seawater acidity, the balance of seawater chemistry will be changed. Thus, it will make a variety of Marine organisms and even ecosystems face great threats.

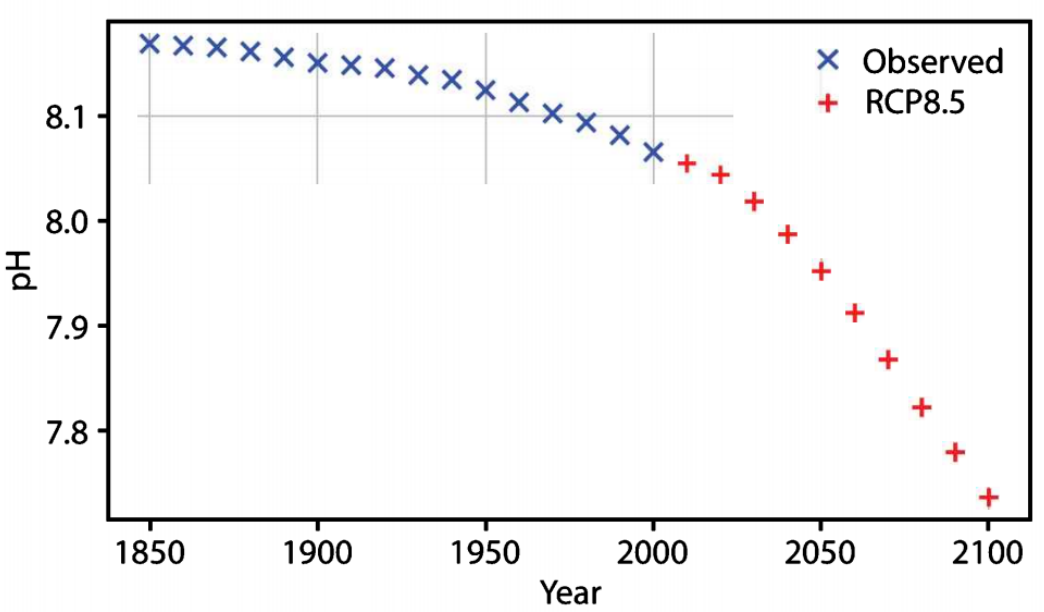

Figure 1. Change in pH over time.

The paper first find out how is pH calculated and why the ocean become more acidity. The acidification is depended on the content of hydrogen ion. One of the factors that can cause ocean acidification is carbon dioxide. Ever since the Industrial Revolution, humans have been pumping carbon dioxide into the atmosphere. This adds more and more carbon dioxide to the atmosphere. Some of that carbon dioxide is dissolved in seawater. When carbon dioxide in the air can dissolved by seawater, and the carbon dioxide in the water can react with H2O and creates carbonic acid.

$$H_2O + CO_2 = H_2CO_3 \quad (1)$$

However, carbonic acid is extremely unstable. It will resolve into bicarbonate radical and hydrogen ion. And bicarbonate radical can also resolve into carbonic and hydrogen ion which will create more hydrogen.

$$H_2CO_3 = HCO_3^- + H^+ \quad (2)$$

$$HCO_3^- = CO_3^{2-} + H^+ \quad (3)$$

Chemical reactions caused by carbon dioxide and other ocean elements can increase the amount of hydrogen ions in seawater, which will make the ocean more acidic.

The declining of pH will damage the environment which is terrible to animals live in ocean. The ecosystems of the land and the sea are linked, and the destruction of the ecosystems of the sea can also have serious effects on life on land, including humans. People must pay attention to the consequences of ocean acidification in order to arouse people's attention to ocean acidification. Through continuous human research, we have found some negative effects of ocean acidification on the Marine ecological

DOI: 10.54254/2755-2721/58/20240689

environment. These effects include changes to Marine life, reproduction, and predation. And also have some effect on ecological environment. Then, I'm going to focus on two of those effects.

3. The effect of ocean acidification on ecosystem and organisms:

3.1. The shape of Balanophyllia's bones will change in different PH environment

Firstly, one of the change that pH change can caused is about organism' forms. Many Marine plants and animals have different forms in different pH levels of water. A good example of this is the difference in the shape of Balanophyllia's bones at different PH level.

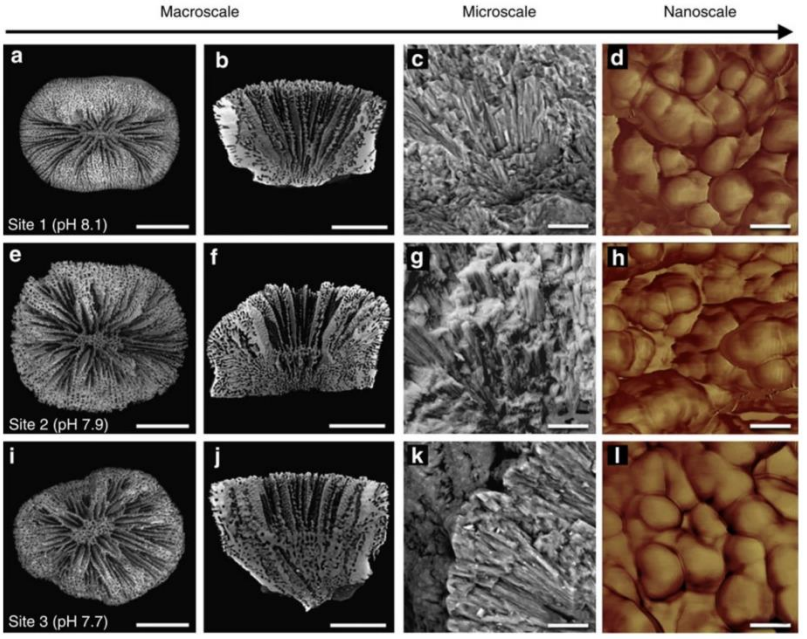

Figure 2. The change of Balanophyllia's bones in different pH [1].

This photo is about Skeletal morphology of Balanophyllia europaeagrowing under different pH conditions from the macro scale to the nanoscale. Each column in the figure relates to an alternate report site and test age is 9-11 years. Pictures are illustrative of all noticed skeletons. (a, e, and i) SEM images of coral skeletons with a marker of 5 mm at low magnification b,f,j) Inward segments of corallites from μCT pictures, marker 5 mm. (c,g,k) SEM pictures of whole skeletal strands from broke septage, marker 10 μm. (d, h, and l) 50 nm marker AFM images of mineral grains on the surfaces of skeletal fibers [1-2].

Linear elongation (mean about 1 mm per year) at the macroscale (associated with feature sizes greater than 10 m) remained constant across sites, while the net calcification rate ($N=44$; $P<0.01$, hearty t factual test) and bone mass thickness ($N=44$, $P<0.001$, vigorous t measurable test) diminished essentially , and bone porosity and large scale porosity expanded ($N=44$; Strong t statistical test ($P<0.001$), The net calcification rate that differs between S1 and S3 is approximately -18%, the bulk density is approximately -7%, the porosity is approximately +21%, and the macro porosity is approximately +30%[3]. The CT coral compartment volume fractions varied between the various locations ($N=30$; $P<0.05$, the F test, and the Kruskal-Wallis 2 test,) but there was no significant pH dependence. The biometric information of corals didn't change at various sites [4-5].

DOI: 10.54254/2755-2721/58/20240689

3.2. Changes in metabolic pathways of phytoplankton under ocean acidification

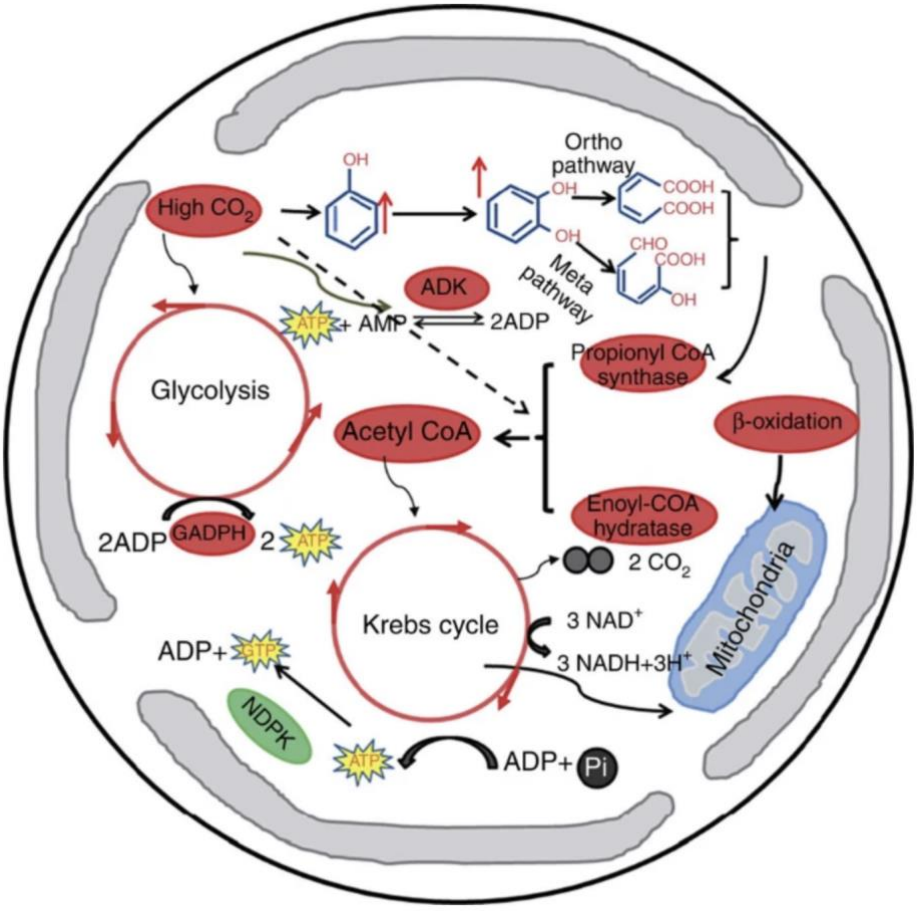

Figure 3. Metabolic pathways [6].

Second, metabolic pathways will also undergo some changes. Proteomics, physiological, and biochemical analysis of ocean acidification In HC-grown cells, more phenolic compounds are biosynthesized, biodegraded, and metabolized through beta-oxidation and the Krebs cycle, producing more ATP through mitochondrial respiration [7-8]. This additional energy can be used to counteract the effects of the environment's high CO2 and low pH pressures. In HC-refined cells, adenylate kinase (ADK) is upregulated and glycolysis is sped up. Under ocean acidification, new pathways like beta-oxidation and Krebs cycles are enhanced to meet the additional energy requirements for maintaining ecological balance [9]. The red and green symbols represent up-regulated and down-regulated proteins or processes, respectively. On the other hand, nucleoside diphosphokinase (NDPK) was down-regulated, indicating a slowing of ATP loss in HC-grown cells [10-12].

In addition, the HC-grown cells had significantly higher expression of ADK, an important enzyme in energy metabolism that catalyzes a reversible transphosphorylation reaction that converts ADP to ATP and AMP. Therefore, in order to support the aforementioned hypothesis, at least two lines of evidence must be presented: specifically, an increased mitochondrial respiration rate and a higher phenolic compound content in E. huxleyi grown under high CO2 conditions.

4. Conclusion:

The decreasing pH in the ocean can cause a lot of consequences, including change the shape of Balanophyllia's bones and metabolic pathways of phytoplankton. There was a difference between the sites in the CT corallite interseptal volume fraction, but there is no significant pH dependence. The

DOI: 10.54254/2755-2721/58/20240689

biometric information for the corallites did not differ between locations [1]. Additionally, at least two lines of evidence must be presented to back up the preceding hypothesis: specifically, an increased mitochondrial respiration rate and a higher phenolic compound content in E. huxleyi grown under high CO2 conditions [7].

However, there may also be biological and environmental effects of ocean acidification that humans have not yet discovered. Those undetected effects can also have a subtle impact on ecosystem and human life. People should continue to study the impact and harm of ocean acidification on organisms and ecosystem, so as to make people realize the importance of protecting the ocean and reducing pollution. Earth is a big family, many of these changes will disrupt the balanced and stable ecological environment of the ocean and thus affect the ecological stability of the entire planet. In addition, the research about ocean acidification can help people predict the harm caused by ocean acidification. In this way, human will be able to intervene in advance and limit the damage. The activity of people have already made a lot of damages to earth. Those damages will eventually affect human beings which will destroy the home on which mankind depends. All in all, people should reduce the damage to the environment, such as reducing the emission of carbon dioxide and reduce tree felling. This is the common responsibility of all the people on the earth.

References

[1] Fantazzini, P.et al.(2015) 'Gains and losses of coral skeletal porosity changes with ocean acidification acclimation',Nature Communications, 6(1). doi:10.1038/ncomms8785.

[2] Lin, S. (2023) 'Phosphate limitation and ocean acidification co-shape phytoplankton physiology and community structure',Nature Communications, 14(1). doi:10.1038/s41467-023-38381-0.

[3] Mongin, M.et al.(2016) 'The exposure of the Great Barrier Reef to ocean acidification',Nature Communications, 7(1). doi:10.1038/ncomms10732.[4]Liu, Y.-W.et al.(2018) 'A coastal coccolithophore maintains ph homeostasis and switches carbon sources in response to ocean acidification',Nature Communications, 9(1). doi:10.1038/s41467-018-04463-7.

[4] Liu, Y.-W.et al.(2018) 'A coastal coccolithophore maintains ph homeostasis and switches carbon sources in response to ocean acidification',Nature Communications, 9(1). doi:10.1038/s41467-018-04463-7.

[5] Luo, Y., Boudreau, B.P. and Mucci, A. (2016) 'Disparate acidification and calcium carbonate desaturation of deep and shallow waters of the Arctic Ocean',Nature Communications, 7(1). doi:10.1038/ncomms12821.

[6] Jin, P.et al.(2015) 'Ocean acidification increases the accumulation of toxic phenolic compounds across trophic levels',Nature Communications, 6(1). doi:10.1038/ncomms9714.

[7] Luo, Y.-W.et al.(2019) 'Reduced nitrogenase efficiency dominates response of the globally important nitrogen fixer Trichodesmium to Ocean Acidification',Nature Communications, 10(1). doi:10.1038/s41467-019-09554-7.

[8] O'Dea, S.A.et al.(2014) 'Coccolithophore calcification response to past ocean acidification and climate change',Nature Communications, 5(1). doi:10.1038/ncomms6363.

[9] Ramajo, L.et al.(2018) 'Reply to "increased food supply mitigates ocean acidification effects on calcification but exacerbates effects on growth"',Scientific Reports, 8(1). doi:10.1038/s41598-018-27670-0.

[10] Wu, H.C.et al.(2018) 'Surface Ocean ph variations since 1689 CE and recent ocean acidification in the tropical South Pacific',Nature Communications, 9(1). doi:10.1038/s41467-018-04922-1.

[11] Zhang, F.et al.(2022) 'Phosphate limitation intensifies negative effects of ocean acidification on globally important nitrogen fixing cyanobacterium',Nature Communications, 13(1). doi:10.1038/s41467-022-34586-x.

[12] Zhang, H. and Cao, L. (2016) 'Simulated effect of calcification feedback on atmospheric CO2 and ocean acidification',Scientific Reports, 6(1). doi:10.1038/srep20284.