



The Impact of Ocean Acidification on Marine Microalgae and Their Contribution to Primary Productivity

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Abstract

Ocean acidification, driven by the increasing atmospheric concentration of carbon dioxide, poses a significant threat to marine ecosystems. Microalgae, as primary producers, play a crucial role in ocean carbon cycling and support marine food webs. This study investigates the impacts of ocean acidification on marine microalgae, focusing on their growth, physiology, and contribution to primary productivity. By examining a range of microalgal species and environmental conditions, we aim to understand how ocean acidification affects microalgal diversity, community structure, and ecosystem functioning. Our findings will contribute to developing strategies for mitigating the negative consequences of ocean acidification on marine ecosystems and ensuring the sustainability of marine resources.

Introduction Ocean acidification, the ongoing decrease in seawater pH due to the absorption of atmospheric carbon dioxide, is a pressing global environmental issue with far-reaching implications for marine ecosystems. Microalgae, as the foundation of marine food webs and key players in carbon cycling, are particularly vulnerable to the effects of ocean acidification. This research aims to investigate the impacts of ocean acidification on marine microalgae, focusing on their growth, physiology, and contribution to primary productivity. By examining a diverse range of microalgal species and environmental conditions, we seek to elucidate the mechanisms through which ocean acidification affects microalgal diversity, community structure, and ecosystem functioning.

The study will employ a combination of laboratory experiments and field observations to assess the responses of microalgae to varying levels of ocean acidification. By integrating data from different species and environments, we aim to identify general trends and patterns in microalgal sensitivity to ocean acidification

Methodology

Experimental Design

- **Microalgal Culture:** A variety of marine microalgal species, including diatoms, dinoflagellates, and coccolithophores, will be cultured under controlled laboratory conditions.
- **Acidification Treatments:** Cultures will be exposed to a range of seawater pH levels, simulating future ocean acidification scenarios.
- **Environmental Factors:** Other environmental factors, such as temperature, light intensity, and nutrient availability, will be maintained at relevant levels.

Measurements

- **Growth Rates:** Microalgal growth rates will be measured using cell counts or optical density measurements.

Microbial Analysis

- **DNA Extraction:** DNA will be extracted from soil, water, and air samples using standard protocols.
- **Sequencing:** High-throughput sequencing techniques, such as Illumina or Nanopore sequencing, will be employed to characterize microbial diversity and composition.
- **Metagenomics:** Metagenomic analysis will be conducted to investigate the functional potential of microbial communities.
- **Metatranscriptomics:** Metatranscriptomic analysis will be used to study the gene expression patterns of microbial communities.

Material Methods:

Obtaining and preparing bones from embalmed human cadavers is a crucial step in various fields, including medical education, research, and forensic anthropology. I took a body (Embalmed Human Cadaver) from the Department of Anatomy, Ram Krishna Medical College Hospital and Research Centre, Bhopal, Madhya Pradesh.

This procedure involves a series of meticulous steps to effectively remove soft tissues, clean the bones, and preserve their integrity for various purposes.

- 1) **Maceration:** The initial step in bone preparation involves maceration, which is the process of softening and loosening the soft tissues adhering to the bones. This can be achieved using either enzymatic or chemical maceration methods.⁶

b.

Enzymatic Maceration: Prepare a maceration solution by dissolving appropriate enzymes in water. The specific enzymes used may vary depending on the type of soft tissue to be removed. Enzymatic maceration of bones Place the cadaver in the maceration solution, ensuring that all parts of the body are submerged. Monitor the maceration process regularly, changing the solution as needed to maintain optimal enzyme activity. The maceration time may vary depending on the size and type of bones, but it typically ranges from 2 days to 8 weeks.

- c. **Chemical Maceration:** Prepare a maceration solution by mixing water with a detergent or a combination of chemicals, such as sodium hydroxide (NaOH) and potassium hydroxide (KOH). Maceration of bones place the cadaver in the maceration solution, ensuring that all parts of the body are submerged. Monitor the maceration process regularly, changing the solution as needed. The maceration time may vary depending on the size and type of bones, but it typically ranges from 2 days to 8 weeks.⁷

- 2) **Boiling:** Once the maceration process has sufficiently softened the soft tissues, the bones are removed from the maceration solution and rinsed thoroughly with water to remove any residual chemicals or enzymes. Place the bones in a pot of boiling water. Boil the bones for 30-60 minutes, depending on the size and type of bones. Boiling helps to further remove soft tissue and sterilize the bones.
- 3) **Bleaching:** After boiling, the bones are allowed to cool completely before proceeding with bleaching. Prepare a bleaching solution by mixing hydrogen peroxide with water. The concentration of hydrogen peroxide may vary depending on the desired level of bleaching. Submerge the bones in the bleaching solution for

1-2 hours. Bleaching helps to whiten and brighten the bones, enhancing their visibility and providing a clearer view of their anatomical features.

- 4) **Degreasing:** To remove any remaining fat and oils that may affect the preservation of the bones, they are degreased using a solvent like acetone or ethanol. Remove the bones from the bleaching solution and rinse them thoroughly with water. Place the bones in a container of acetone or ethanol. Degreasing removes any remaining fat and oils that may affect the preservation of the bones.⁸
- 5) **Drying:** Once the degreasing process is complete, the bones are dried to prevent moisture damage and preserve their integrity. Remove the bones from the degreasing solution. Allow the bones to air-dry completely. Alternatively, you can use a dehydrator to dry the bones more quickly.¹⁵
- 6) **Storage:** Proper storage is crucial for maintaining the quality of the prepared bones. They should be stored in a dry, cool, and dark environment to prevent damage from humidity, temperature fluctuations, and light exposure.¹⁷ Transfer the dried bones to storage containers. Label the containers with the donor information and date of preparation. Store the containers in a secure location, such as a laboratory or anatomical teaching facility.⁹

Additional Notes: Throughout the entire bone preparation process, it is essential to wear gloves and goggles to protect yourself from harmful chemicals and fluids. Use caution when handling boiling water and sharp bones. Dispose of all waste materials, including maceration solutions, bleaching solutions, and degreasing solvents, in accordance with local regulations.

Discussion:

The authors discuss the importance of careful attention to detail throughout the bone preparation process. They emphasize the need to use proper personal protective equipment, such as gloves and

goggles, to protect oneself from harmful chemicals and fluids. They also emphasize the need to dispose of all waste materials in accordance with local regulations. The authors also discuss the ethical considerations involved in the preparation of bones from embalmed human cadavers. They emphasize the importance of obtaining proper consent from donors or their families and of treating human remains with respect. The following journal articles provide additional information on bone preparation from embalmed human cadavers:

Ethical Considerations: The preparation of bones from embalmed human cadavers raises ethical concerns regarding the respectful treatment of human remains and obtaining proper consent from donors or their families. Ethical guidelines and regulations govern the procurement, handling, and storage of human anatomical specimens.¹⁶

Conclusion: The preparation of bones from embalmed human cadavers is a complex and delicate process that requires careful attention to detail and adherence to ethical guidelines. These prepared bone specimens serve invaluable educational, research, and forensic purposes, providing insights into human anatomy, health, and history.

8. Modi BS, Puri N, Patnaik V. Evaluation of techniques for cleaning embalmed cadaver bones. *Int J Anat Res* 2014; 2:810-3.
9. Ajayi A, Edjomari E, Osele O. A review of bone preparation techniques for anatomical studies. *Malaya J Biosci* 2016; 3:76-80.
10. Couse T, Connor M. A comparison of maceration techniques for use in forensic skeletal preparations. *J Forensic Investig* 2015; 3: 1-6.
11. Tobias PV. On the scientific, medical, dental and educational value of collections of human skeletons. *Int J Anthropol* 1991; 6:277-80.
12. Triaca A, Mahon TJ, Myburgh J. A comparison of different maceration techniques on burnt remains. *J Forensic Sci.* 2022 Mar; 67:676-682. doi:10.1111/1556-4029.14939. Epub 2021 Nov 7. PMID: 34747030.
13. Fenton TW, Birkby WH, Cornelison J. A fast and safe non-bleaching method for forensic skeletal preparation. *J Forensic Sci* 2003; 48:274-6.
14. Rennick SL, Fenton TW, Foran DR. The effects of skeletal preparation techniques on DNA from human and non-human bone. *J Forensic Sci* 2005; 50:1016-9.
15. Aggarwal N, Gupta M, Goyal PK, Kaur J. An alternative approach to bone cleaning methods for anatomical purposes. *Int J Anat Res* 2016; 4:2216-21.
16. Soni A, Kumar A, Sharma A, Vohra H. Comparison of maceration techniques for retrieval of bones. *J Anat Soc India* 2021; 70:93-6.
17. Eriksen A.M, Simonsen K.P, and Rasmussen A.R (2013). Conservation of mitochondrial DNA in fast enzyme-macerated skeletal material, *International Journal of Conservation Science*, 4 (2);127-132

References:

1. Offele, D, Harbeck, M, Dobberstein, R.C, von Wurmb-Schwark, N and Ritz-Timme, S (2007). Soft tissue removal by maceration and feeding of *Dermestes* sp.: impact on morphological and biomolecular analyses of dental tissues in forensic medicine. *International Journal of Legal Medicine*, 121(5), 341-8.
2. Christensen, A.M and Myers, S.W (2011). Macroscopic observations of the effects of varying freshwater pH on bone. *Journal of forensic sciences*, 56(2), 475-9.
3. Hefti, E, Trechsel, U, Rüfenacht, H and Fleisch, H (1980). Use of dermestid beetles for cleaning bones. *Calcified Tissue International*, 31(1), 45-47.
4. Backwell, L.R, Parkinson, A.H, Roberts, E.M, d'Errico, F and Huchet, J.B (2012a). Criteria for identifying bone modification by termites in the fossil record. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 337-338, 72-87, 3(1), 1-6.
5. Onwuama, K.T, Salami, S.O, Ali, M and Nzalak, J. O (2012). Effect of different methods of bone preparation on the skeleton of the African giant pouched rat (*Cricetomys gambianus*). *International Journal of Morphology*, 30(2), 425-427.
6. Bartels, T and Meyer, W (1991). A quick and effective method for the maceration of vertebrates. *DTW. Deutsche tierärztliche Wochenschrift*, 98(11), 407-9.
7. Simonsen, K.P, Rasmussen, A.R, Mathisen, P, Petersen, H and Borup, F (2011). A fast preparation of skeletal materials using enzyme maceration. *Journal of Forensic Sciences*, 56(2), 480-4.