# INCREASINGLY DIFFICULT RESPIRATION OF AEROBIC ORGANISMS IN THE MESOPELAGIC LAYER: POSSIBLE ADAPTATION STRATEGY

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## Abstract

The provision of intermediate waters that are hospitable for aerobic life is a major service supplied by the sea, but respiration is becoming increasingly difficult for mesopelagic aerobic organisms: oxygen is decreasing in minimum oxygen zones in many regions, and increasing carbon dioxide contributes to lower the free energy from respiration. Reduction of this service calls for adaptation because the increasingly difficult mesopelagic respiration will be accompanied by a reduction of biodiversity that may progress so rapidly that many taxa may disappear before we know they exist. With them would disappear their potential services. The only possible adaptation strategy may be to accelerate the study of diversity in intermediate waters, which is more vulnerable to climate change than diversity in surface or deep waters.

*Keywords: Oxygen, Biodiversity, Intermediate Waters, Global Change*

INTRODUCTION

The long-term provision of intermediate waters (from 100 to 1000 m) that are generally hospitable for aerobic life is a major service that is presently supplied by the sea. However, respiration is becoming increasingly difficult for aerobic organisms in the mesopelagic layer (also called twilight zone) for two reasons.

METHODS AND STUDY SITES

Firstly, concentrations of dissolved oxygen are decreasing in minimum oxygen zones (OMZs, generally between 300 and 700 m) in many regions [3, 4], and are predicted to continue to decrease in coming decades and centuries [2]. The presently existing major OMZs with very low oxygen concentrations are located in the Eastern South Pacific Ocean, Eastern Tropical North Pacific Ocean, Arabian Sea and Bay of Bengal. A reduction of oxygen by 20-40% is predicted in deeper oceanic waters over the coming 700 years, but this should not lead to extensive deep-ocean anoxia [2]. Hence, climate change threatens dissolved oxygen more in intermediate waters than in surface or deep waters.

Secondly, the concentration of total carbon dioxide is progressively increasing in surface and intermediate waters. The energy from respiration that can be converted into work by organisms (called free energy) is related directly to dissolved oxygen and inversely to dissolved carbon dioxide [1]. Hence, the combination of decreasing oxygen and increasing carbon dioxide is presently reducing and will continue to reduce the free energy of respiration. This will make respiration of aerobic organisms in intermediate waters increasingly difficult.

RESULTS AND DISCUSSION

The combination of the above two processes will reduce a service that the sea had been providing to aerobic life for millennia. This serious environmental problem should be an additional incentive for governments to address the mitigation of global change internationally and without delay. However, even if mitigation policies were implemented efficiently and rapidly, the respiration of mesopelagic aerobic organisms would nevertheless become increasingly difficult in many areas. These respiration problems will lead to a reduction in the biodiversity of mesopelagic pelagic aerobic organisms. Hence, reduction of the above service calls for an adaptation strategy as discussed in the next paragraph.

On the one hand, diversity of the biota in intermediate waters is still largely unknown, and represents a nearly untapped reservoir of future services to humans. On the other hand, respiration problems may progress so rapidly in intermediate waters that many groups of organism there may disappear before we even know they exist, and with them would disappear their potential services. Hence, the only possible adaptation strategy available to human societies may be to accelerate the study of biodiversity in intermediate waters. The previous discussion has shown that mesopelagic biodiversity is more vulnerable to the strain exerted on aerobic respiration by climate change than biodiversity in surface or deep waters.

The above conclusion should reinforce the resolve of the international oceanographic community to target intermediate waters for priority studies in the coming years and decades (e.g. the international programme "Integrated Marine Biogeochemistry and Ecosystem Research", IMBER). Mediterranean researchers should take part in this international effort.

## References

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