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Scientific Article Summary

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Ocean acidification may increase calcification rates, but at a cost

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Summarized by Brittany Parry

Abstract

The oceans pH level has been dropping as a result of more carbon dioxide uptake from the atmosphere. The term that is being used to describe the lowering of pH in the oceans is called ocean acidification. There has been previous work on the biological consequences of ocean acidification that has suggested that organisms have lowered metabolic and calcification abilities in water with a lower pH. Here it is shown that in the ophiuroid brittlestar *Amphiura filiformis* (a calcifying organism) actually increases metabolism and calcification in increased seawater acidity. However, these increases may seem positive yet they come at a great cost of muscle wastage in the ophiuroid brittlestar.

Introduction

Carbon Dioxide is entering the ocean at a higher rate than ever before. When CO_2 enters the ocean it reacts with seawater and changes the chemical property (Zeebe & Wolf-Gladrow 2001). Part of the changes that occur is the production of hydrogen ions thus increasing the acidity of the ocean. This phenomenon has been termed as Ocean Acidification. The ocean's natural buffering capacity hasn't been enough to keep the acidity at a normal pH of about an 8, and has been predicted to drop to a pH of 7.7 by 2100 (Caldeira & Wickett 2003). This will only worsen as time goes on as carbon dioxide is built up in the atmosphere.

Many different marine animals cope with pH changes in different ways. Here we will see what changes occur in the ophiuroid brittlestar in ocean acidification. The ophiuroid brittlestar *Amphiura filiformis* is an echinoderm that lives on the ocean floor. It burrows into the sediment irrigating it for them. That movement helps other microscopic organisms in the sediment as well. The brittlestars skeleton is made of magnesium calcite. The brittlestar has the ability to regenerate lost arms which will help show the effect different pH levels of water has on the organisms original arms as well as regenerated arms.

Materials and Methods

Set-up

The experiment was carried out in a mesocosm facility over a 20-week exposure. Ophiuroid brittlestar were collected from Plymouth Sound, UK, were maintained in sediment cores (five individuals per core) supplied with filtered seawater of allocated pH (pH modified using CO_2). Each pH treatment (8.0, 7.7, 7.3, and 6.8) had four cores (20 individuals per pH). Half the individuals in each treatment had one arm removed and the rest had two arms removed. Total CO_2 content, pH, salinity, and temperature were measured three times a week.

Oxygen uptake

Closed-bottle respirometry technique, dissolved O_2 measured using an automated titration system with photometric endpoint.

Arm regeneration

Regenerated arm was discernible from original arm by lighter color. They were measured to 0.05mm with vernier calipers.

Measurement of calcium content

Arms were digested in nitric acid and the total calcium content determined using atomic absorption spectrophotometer.

Arm structure and measurement of egg size

Central discs were embedded in methacrylate, sectioned with a glass knife and stained. Egg ferret diameter was measured by image analysis software using a digital image.

Statistical analyses

All statistical analyses were run using Minitab v. 14. The two-way analysis of variance was used to test for effects of pH treatment or number of arms regenerating on O_2 uptake, calcium content, arm regeneration rate, egg size and arm structure. A Kolmogorov-Smirnov test was used to test for normality.

Results

The ophiuroid brittlestars that were in lowered pH treatments had a greater percentage of calcium in their regenerated arms than individuals from control treatments. Established arms had a significantly lower percentage of calcium carbonate content than regenerated arms.

Rates of oxygen uptake were significantly greater in reduced pH than in controls. There was also an increase in growth and metabolism in the individuals in reduced pH.

Although the regenerated arms in the lower pH samples looked the same as the established arms, there was a distinct loss of muscle mass as pH decreased.

Egg size and structure were not affected by seawater acidification. However, the timing of the study was in a latent period of egg growth. A further experiment encompassing the egg growth phase should be properly done to assess the impact of ocean acidification and egg development.

Discussion

This study has shown that the effects of ocean acidification increase both the rate of metabolism and calcification on the ophiuroid brittlestar of the echinoderm species. One consequence of that increase is a significant decrease in muscle mass of regenerated arms.

The ophiuroid brittlestar uses its arms to collect food particles and irrigate its burrow. The muscle loss that occurred can be expected to result in a loss of arm movement and will affect feeding, burrow creation, burrow aeration (Woodley 1975), predator avoidance (O'Reilly et al. 2006), and ultimately survival.

Looking at the effects around the area that the ophiuroid brittlestar is naturally present and how that environment can be affected just by the changes in its muscle loss is also disconcerting. In areas where the ophiuroid brittlestar is present the creation and irrigation of its burrow is responsible for 80% of all bioturbation in the surrounding environment (Vopel et al. 2003). The flatfish dab which feeds on the brittlestar would also negatively be affected by the decrease of muscle mass because the nutritional value would also be decreased

The Intergovernmental Panel on Climate Change predicts that looking at the worst case scenario of carbon dioxide emissions the pH level in seawater will reach the experimental level of 7.7 by 2100. Here it is shown that some species can modify themselves according to a change in pH levels yet it is at a significant cost.

References

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