

Zooplankton state in response to red tides.

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FUTURE**

An investigation into the state of zooplankton abundances and composition, during a phenomenon known as a red tide, along the northern Pacific coast of Costa Rica.

Background

My original aim for this voyage was to investigate how the Costa Rican Dome (a weather phenomenon that creates upwelling in the Pacific) affects the distribution of zooplankton along the Pacific coast of Costa Rica. However, like often happens at sea, things did not go exactly to plan. The first obstacle I faced was that I had made it to Costa Rica, but the same could not be said for my luggage, which contained the scientific equipment needed for my research. Fast forward to five days later and I was finally reunited with my possessions, when the next challenge presented itself: a change in the ship's route. This meant that sailing was very focused along the north Pacific coast, and I could no longer look at the spatial changes in and around the Costa Rican Dome. However, my arrival coincided with a biological event known as a red tide, and I rapidly developed a new plan of research – flexibility was key to success!

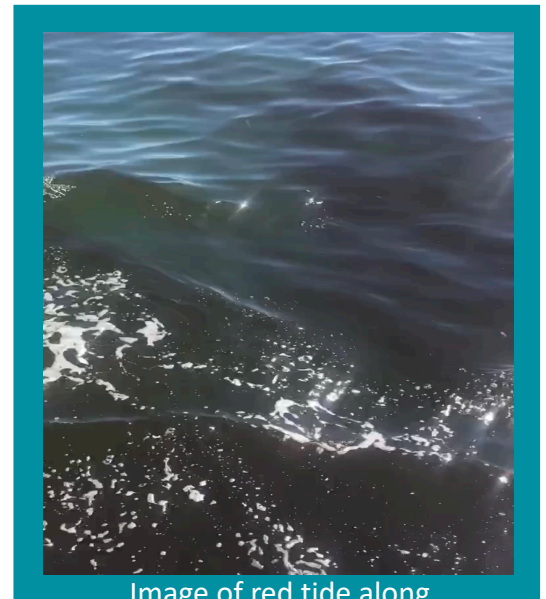


Image of red tide along Costa Rica's Pacific coast.

Study Preface

The tell-tale signs of a red tide are quite obvious. Waters surrounding the coast turn a red/brown colour, almost as if a shark had caught its prey. The cause of this wide-spread and alarming change is a small phytoplankton (roughly **30-50 μm** in size ^[1]) species known as *Cochlodinium*. Very specific oceanographic conditions trigger a rapid increase in *Cochlodinium* abundance to create what is known as a bloom. Though small, the impacts of *Cochlodinium* are mighty.

Cochlodinium is a highly toxic dinoflagellate that disrupts entire ecosystems, especially as toxins can bioaccumulate through the food chain [2].

Phytoplankton → Zooplankton → Fish → Mammals

This means that at each stage toxins will build up and can result in the death of consumers, such as fish and mammals [3]. There is little research on how or if zooplankton are affected by ingesting toxic phytoplankton. However, studies suggest that it is very case-specific and depends on the species of phytoplankton and zooplankton involved.

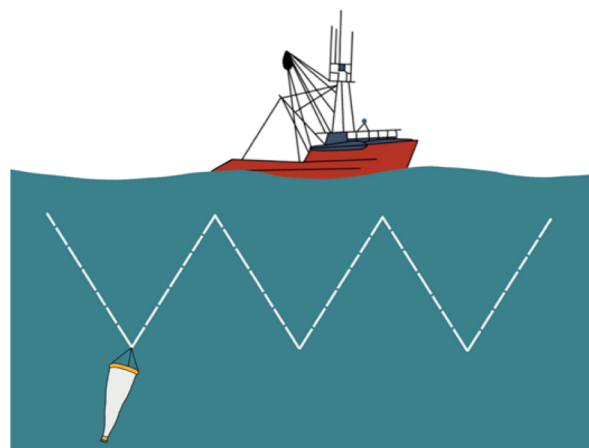
The presence of phytoplankton blooms also depletes oxygen in near-bottom water creating pockets of hypoxia/anoxia, as phytoplankton die and sink. The process of microbial decomposition consumes available oxygen [4]. This means that other organisms in these zones die and barren 'dead zones' are all that remain.



Locations of the 5 sample sites along Costa Rica's Pacific coast.

Experimental design

Water column sampling took place in 5 locations along the Pacific coast. Zooplankton data was collected using a 100 μm plankton net. The net is released upside down at the ocean's surface, where it descends through the water column. Once the net has reached 6 m depth, it is raised. This process is repeated three more times, creating a total of 36 m of water column trawled. This method is known as a double oblique tow and is undertaken at 1 knot.



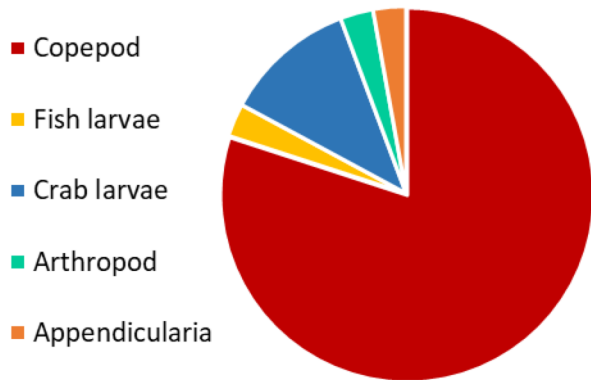
Once retrieved, nets were washed with freshwater till 1 L of sampled water was formed. From this, 10 ml sub-samples were taken three times and examined under microscopes for zooplankton using Bogorov chambers.

Findings

Results showed that copepods were the most abundant zooplankton found at all sample locations. Their highest abundance was observed in Culebra Bay, in northern Costa

Rica, at **71** zooplankton per m³. However, the rest of the samples taken yielded much lower abundances. In total, the average zooplankton number across the 5 locations was **32 per m³**.

Zooplankton composition



The samples revealed very low biological diversity. This means that the population of zooplankton are comprised of only few types of organisms, in this case just 5. Copepods make up over $\frac{3}{4}$ of the composition and are most dominant. Studies by Bednarski and Morales-Ramírez [5] in this area also found copepods to be most abundant. At the time of our survey, copepods may have dominated, because they are less affected by red tides than other sub-classes of zooplankton. Previous studies have highlighted that copepods can consume toxic phytoplankton with no ill effects [6]. Analysis under a microscope revealed that copepods are indeed grazing on the dinoflagellates, as their translucent bodies allow the red pigment to be seen.

So, what does this all mean?

Anthropogenic influence on red tides is increasing, making their frequency more common. In Costa Rica, runoff from plantations contributes large quantities of fertiliser into coastal waters. The resulting excess nutrients in seawater are utilised by the phytoplankton, which results in blooms. This process is known as **eutrophication** and can cause the onset of toxic red tides. This raises concerns for the future of ocean health, as more frequent red tides means that ecosystems have less time to recover between events.

In this study we were unable to look at the water column before the red tide began, so it is difficult to determine what change the red tide had on zooplankton abundance. However, it could be hypothesised that red tides reduce the diversity of zooplankton, as previous research found **16** different species of zooplankton [5] in the same location, which is significantly greater, compared to the 5 types of zooplankton we found.



Copepoda



Cochlodinium

The future

In Costa Rica's case, the land use and urbanisation around the coastline only aids the influx of pollution (including nutrients) into the sea. In previous years, the high amount of deforestation increased the amount of run-off, as trees were no longer there to reduce the flow of water. However, the ban of deforestation and monetary incentives for farmers to protect their watersheds have aided the development of secondary forests. In this sense, the future looks promising for Costa Rica as national parks increase in area and more land becomes protected.



Though red tides do act as a major food source for the marine food web^[2], the increasing frequency of toxic tides is concerning. Even with increased vegetation and the possible reduction in eutrophication along Costa Rica's coastline, it is likely that climate change and varying oceanographic conditions will continue to promote these toxic blooms. This will impede fisheries and cause great economic loss ^[7], not just for Costa Rica, but worldwide.

Lessons

This experience has taught me a lot of valuable lessons when it comes to field data collection. If I were to undertake this study again I would:

- Take repeats from sample locations.
- Sample with nets of different aperture sizes at each site.
- Take samples before and after a red tide.

References

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