How to be a diatom: constraints and patterns of multitrait evolution

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This template is an example of how to prepare an abstract for the 2021 MASTS Annual Science Meeting, to be held **7-9 October 2021**.

Please note that abstracts should be broad and applicable to a wide audience. The more succinct the better!

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How do we think about functional traits in phytoplankton beyond simple tradeoffs, and what does this tell us about how phytoplankton traits can – and cannot – evolve?

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Abstract.

Organisms, even those that are only one cell big, are made up of a number of interconnected traits that affect their fitness as well as their roles in trophic energy transfer, other ecosystem functions, and biogeochemical cycles. While different traits can have both functional and statistical correlations with each other, studies of phytoplankton have traditionally only dealt with pairwise tradeoffs between traits. Here, we look at how using trait scapes that represent multiple interrelated traits can be used to explore "how many ways there are to be a diatom" – how many growth strategies are accessible in a group of closely related species, and how evolution can (or cannot) change tradeoffs and correlations between traits. We will then explore how this affects projections of future diatom populations in changing oceans.

Acknowledgements

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The onset of the spring phytoplankton bloom in the Scottish coastal North Sea supports the Disturbance Recovery Hypothesis

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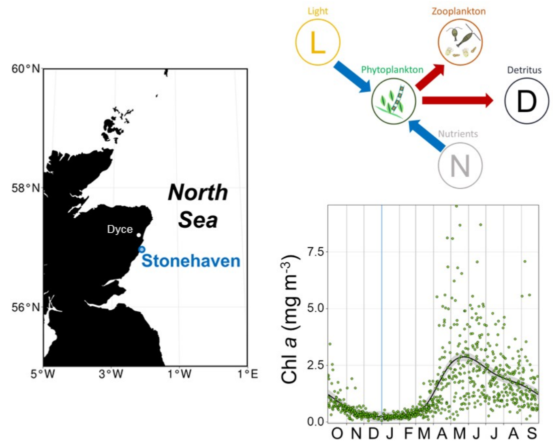
Tweetable abstract

During the spring bloom in the Scottish coastal North Sea, phytoplankton biomass starts to accumulate ~2 weeks after the winter solstice, when light limitation is strongest. The accumulation rate follows the rate of change in light. #MASTSasm2021 @rgonzalezgil

Complementary image for the tweetable abstract



Main text

The spring phytoplankton bloom is a fundamental process in temperate and polar seas that plays important biogeochemical and ecological roles. However, there is still considerable debate about how the onset of phytoplankton biomass accumulation is triggered during this event. While the more traditional hypotheses assume that the spring bloom onset occurs when light no longer limits phytoplankton growth, the Disturbance Recovery Hypothesis (DRH) claims that the onset responds to an imbalance between phytoplankton division and loss rates that can take place even when light is still limiting. This debate has been mainly focused on deep, oceanic waters, despite the spring bloom is also a major event in coastal ecosystems.

To address this question in the Scottish coastal North Sea, we combined 21 years of data (1997-2017) collected at the Stonehaven monitoring site with meteorological information. We found that the onset of phytoplankton biomass accumulation occurred around 16 days after the winter solstice each year, when light limitation was strongest. Also, we observed that the seasonal change from negative to positive accumulation rates of phytoplankton biomass (*r*) followed the rate of change in light availability rather than the amount of light itself. Our results support the DRH and suggest its applicability to other coastal regions.

Acknowledgements

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Application of Neural Networks for Chlorophyll a retrieval from ocean colour satellites

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Retrieval of chlorophyll a (Chl) from ocean colour remote sensing is problematic for turbid coastal waters due to the impact of non-algal materials on atmospheric correction and standard Chl algorithm performance. Multiple artificial neural network (NN) architectures are assessed to reach optimal performance for Chl retrieval in northwest European shelf seas over the 2002-2020 period. The networks operate on 15 MODIS-Aqua visible and short infrared bands and are tested using top of atmosphere reflectances. In each case, a NN architecture consisting of 3 layers of 15 neurons outperformed current state of the art algorithms, with the best performing NN reaching $R > 0.7$ and $MAE < 1.8$. Moreover, the NN algorithm provides data for regions where other algorithms are eliminated due to application of turbid water or low sun angle flags.

The success of the current NN approach and the potential for further refinement through expansion of training data sets over time confirms the potential for ocean colour remote sensing to provide quantitative Chl information for environmental monitoring in even the most challenging optically complex coastal waters

References

Hadjal et al., 2021 (forthcoming). An Artificial Neural Network Algorithm to Retrieve Chlorophyll a for Northwest European Shelf Seas from Top of Atmosphere Ocean Colour Reflectance.

Environmental monitoring in Loch Ewe with the COMPASS metocean buoy

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Twitter abstract

Twitter handle: @JenniferA_Scott

Join @JenniferA_Scott of @marinescotland at the #MASTSasm2021 to hear about the environmental monitoring data from the @Compass_MPA Loch Ewe metocean buoy, and how it and other monitoring activities give us with a detailed description of how our coastal waters vary through time

Twitter image: attached to email (Loch ewe data buoy image.png). Description of image for alt text: The Loch Ewe metocean buoy with the Isle of Ewe and hills behind it. The buoy is yellow and around 2 metres in height, with solar panels on each side which power the instruments. Credit Helen Smith (2021).

Main abstract

The Loch Ewe metocean buoy was deployed in December 2020 by Marine Scotland Science though the INTERREG VA COMPASS project, replacing previous oceanographic instrumentation deployed since 2018. The metocean buoy is located in the outer basin of Loch Ewe, a sea loch on the west coast of Scotland. It adds to the COMPASS monitoring network of buoys across the regional seas of West Scotland, Republic of Ireland and Northern Ireland, with the ultimate aim of the project to collect sustained meteorological and oceanographic observations in the region. It measures the surface water temperature and salinity, current speed and direction throughout the 40 m water column, wave height and direction, and meteorological conditions at the site every 10 minutes, with the data available in real time.

In Loch Ewe, the COMPASS metocean buoy is collecting data to complement the observations from the COMPASS pCO_2 sensor (deployed since 2018) and the Scottish Coastal Observatory's weekly monitoring programme (started in 1999). These provide additional measurements of carbonate chemistry, water properties, nutrient concentrations and the plankton community. This environmental monitoring provides us with a detailed description of how our coastal waters vary through time. We will use the data from the COMPASS metocean buoy to characterise the oceanographic conditions in Loch Ewe, investigate forcing mechanisms behind the variability we are able to capture with the high sampling rate, and compare the data to other monitoring activities in the area.

Acknowledgements

This project is supported by the European Union's INTERREG VA Programme, managed by the Special EU Programmes Body (SEUPB). The views and opinions expressed in this abstract do not necessarily reflect those of the European Commission or the Special EU programmes Body (SEUPB). The authors would like to acknowledge all the Marine Scotland Science staff that have worked on the Loch Ewe Scottish Coastal Observatory, particularly Steve Hay, Jane Grant, John Fraser, Jennifer Hindson, and Pamela Walsham.

Microplastics: All Up in the Air?

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Tweetable Abstract

It is often assumed that the main way in which microplastics enter the oceans is via rivers. But recently it has been proposed that deposition from the atmosphere may also be important. If correct, this would help explain the finding of microplastics in remote regions and lead to revision of ideas of how the global budget operates.

Abstract

It is frequently said that plastics, and particularly microplastics (<5 mm), are all around us, especially in the oceans where there is much concern about their possible harmful effects on marine life. Rivers are often assumed to be the primary route of entry for plastics to the marine environment after their production and use on the land through a whole host of processes. However, in discussions of sources and routes of transport to the ocean, the atmosphere is seldom mentioned, although it may be this path that facilitates the spread and ubiquity of microplastics around the globe.

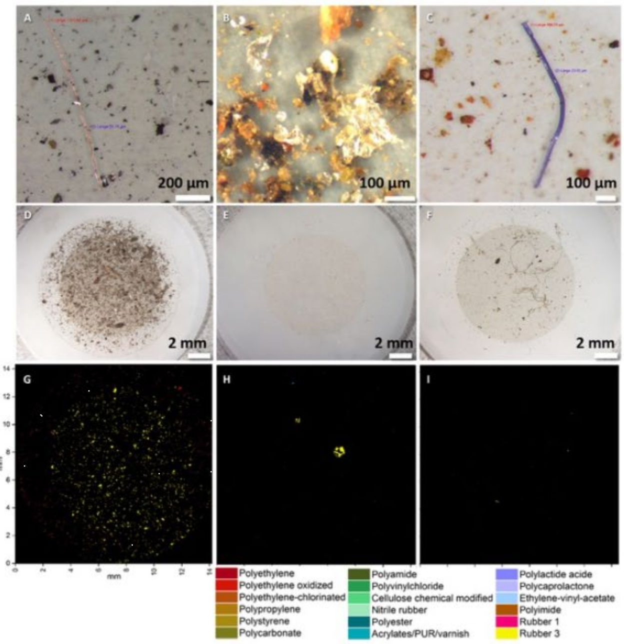
Until very recently there were essentially no measurements of microplastics in the marine atmosphere which could be used to test this idea. However, in a recent paper Allen et al. (2019) reported significant amounts of microplastics measured in air at a remote terrestrial site in the Pyrenees. Using this data to estimate the potential size of the deposition flux of microplastics to the global oceans, atmospheric deposition and the riverine flux appear to be of similar magnitude (Liss, 2020). Although clearly a long extrapolation, if correct the occurrence of microplastics in remote parts of the globe (e.g. in Arctic snow (Bergmann et al., 2019)) is easier to explain than if they are only transported through the river input – ocean circulation route. Indeed, it may be necessary to substantially revise our understanding of the global budget of microplastics and how they circulate in the environment.

References

Allen, S. et al. (2019). Atmospheric transport and deposition of microplastics in a remote mountain catchment. Nature Geoscience, **12**: 339-344.

Bergmann, M. et al. (2019). White and wonderful? Microplastics prevail in snow from the Alps to the Arctic. Science Advances, **5**: eaax1157.

Liss, P.S. (2020). Microplastics: All up in the air? Marine Pollution Bulletin, 153: 110952.



Bergmann et al., 2019

Photographs of microplastic particles in snow from remote locations.