

# SEASONAL CHANGES IN THE EFFECTS OF UV RADIATION ON ANTARCTIC MARINE MICROBES

Scientists have shown that the effects of damaging ultraviolet light on microscopic marine organisms, changes with changing ozone concentrations.



Marine protists were incubated for 13 or 14 days in these 650 L tanks. Reflective tubes conducted sunlight from the domes in the container roof. Screens on the top of each tank removed different amounts of UV radiation from the sunlight.

Stratospheric ozone protects life on Earth from ultraviolet B radiation (UVBR, 280-320 nm wavelength). However, ozone depletion over Antarctica results in 50 to 130% more UVBR reaching the Earth's surface. High energy UVBR is especially damaging, reducing the growth, production and survival of marine protists (microscopic marine plants and animals). Ultraviolet-A radiation (UVAR, 320-400 nm) can also be damaging, and causes most of the UV-induced reduction of photosynthesis in the ocean.

Marine protists possess diverse means of tolerating and repairing UV-induced damage, and the effectiveness of these tolerance mechanisms determines a protist's susceptibility to UVBR. Large differences in the susceptibility of different species to UVBR result in changes in the composition of protist communities, favouring species that can tolerate and repair the damage they sustain.

Over a summer at Davis, in east Antarctica, we assessed the impacts of UV radiation on marine protists. In three experiments, natural communities were incubated for 13 or 14 days in 6 x 650 L tanks. Each tank was exposed to sunlight with different amounts of UV radiation removed by screens. The results were surprising, showing a transition from UVAR to UVBR-induced effects over the summer.

UVB is considered the most damaging of solar wavelengths, but our first experiment in November indicated that UVBR was beneficial for the protist community. At this time, ozone concentrations were high – 363 to 316 Dobson units (DU) – and extensive areas of the coastline off Davis were covered by fast ice. These high ozone concentrations meant the protist community was exposed to relatively low UVB radiation.

In contrast, UVAR reduced chlorophyll concentrations by up to 71% and strongly inhibited the growth of the most abundant phytoplankton species. Recent research shows UVA radiation reduces the survival of Antarctic protists that are physiologically adapted to low light. Thus, the UVA-induced effects we observed appear to result from the sudden exposure of our community – which was obtained from beneath the sea ice – to full sunlight. This is a significant finding as this sudden exposure is a widespread, natural occurrence when the sea ice breaks out, or when currents carry protists from beneath the sea ice into open water.

The second experiment in December showed that UVAR and UVBR had little effect on the protist community. By this time, stratospheric ozone concentrations had declined to between 341 and 306 DU, causing phytoplankton to be exposed to more damaging UVBR. In addition, the extent

of fast ice in the region had declined. Thus, phytoplankton carried by currents to the site where the community was obtained were likely to be accustomed to a higher light climate, reducing the shock of exposure to full sunlight during the experiment.

The final experiment in January, however, showed UVBR inhibited overall chlorophyll biomass by 22% and severely inhibited concentrations of the most abundant diatom species. This experiment was performed when the ozone concentrations had declined to 313-288 DU, exposing phytoplankton to further damaging short wavelength UVBR. However, fast ice had completely disappeared from the sample site and, as for experiment two, UVAR had a little effect on the phytoplankton.

This finding agrees with recent research showing adverse effects of UVBR at ozone concentrations less than 300 DU. A synoptic-scale study (see page 6) found that the growth of phytoplankton was reduced by up to 56% when ozone concentrations fell below 300 DU. Furthermore, models of UVB-induced impacts at Davis showed a 300 DU threshold, below which UVB caused substantial changes to the structure and function of marine microbial communities.

Why is this significant? Using the Total Ozone Mapping Spectrophotometer (TOMS) satellite data, we found that thin summer ozone (less than or

A shipping container at Davis station housed the experimental tanks with UV-transmissive domes that allowed sunlight to enter.

equal to 300 DU) is an annual, widespread event over the Southern Ocean from January to April. This period sees up to 47% of the annual primary production in the Southern Ocean. Therefore, enhanced UVBR at this time may be exerting widespread negative impacts on the protist communities of the Southern Ocean, potentially reducing the food available for higher organisms.

Most UVR research has concentrated on the impacts of ozone depletion in spring, when the Antarctic ozone hole is large. In contrast, the consequences of thinning ozone from January each year appears to be largely unrecognised by the scientific community. When coupled with mounting evidence for a 300 DU threshold for negative UVB impacts, it appears that the effects of UVB on Antarctic protists may have been underestimated. However, our field data are limited to only one summer at Davis and further studies are needed between January and April to more precisely determine the effect of declining ozone on these ecologically important organisms.

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