Antarctic Algae and UVB

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Abstract. The effect of UV radiation on productivity in bottom ice algae at Cape Evans, Antarctica was found to be minor. The role of mycosporine-like amino acids as possible photoprotectants is still being investigated.

Introduction

Sea ice exerts a unique and overwhelming influence on marine ecosystems in the Antarctic. Each year, approximately 16 million km2 of this vast roof over the sea melts. The sea ice can host a large community of single cell plants, and this constitutes a huge biomass that is released into the food web when the ice melts. These algae may be damaged by UV radiation during spring, when the antarctic ozone hole is at its maximum, and UVB radiation is unseasonably high. Coincidentally, at this time of year, sea ice can be quite transparent to UVB radiation.

This study measured the impact of UV radiation on ice algae growing on the bottom surface of the sea ice. This was achieved by modifying the UV radiation environment over the algae by laying nearly 200m2 of different plastics with varying UV transmissions on the ice surface, and supplying additional UVB radiation with UVB fluorescent tubes.

Methods

The study region was on sea ice at Cape Evans, Ross Island Antarctica. At the time of the study (October 2001) the ice was approximately 2.1m thick with a light (1-2 cm) covering of snow. Bottom ice algal samples were collected from an untreated region of sea ice for several days to establish baseline levels. Samples were collected using a petrol powered ice auger, drilling to about 1.9m, and then the final 0.2m was cored using a SIPRE drill. Approximately 200m2 of plastic was then laid over the sea ice, and samples of bottom ice algae were taken every 2-3 days over a period of two weeks to establish temporal trends. Several hundred samples were individually melted, divided and analysed for chlorophyll content, MAA, C, N, P, cell numbers, and species identifications.

The plastics used to cover the ice were

- Polycarbonate UV stabilised Ultros – blocks all UV radiation, but transmits visible light.
- Mylar – blocks UVB only, transmits UVA and visible.
- PVC – transmits all UV and visible radiation. This area served as a control block with the same albedo as the rest.
- A fourth region was marked out and left uncovered as an another control region.

In addition, a light fitting with 6 UVB fluorescent tubes was set in a shallow trough cut in the ice to provide additional UVB radiation above ambient. The enhancement was about 7% above ambient, although this varied with distance from the radiation source. Under ice levels of UV and visible radiation were measured several times during the two-week exposure period using a PUV 500 submersible multi-channel radiometer.

Results and Discussion

Initial results show a steady increase in the level of chlorophyll-a per m^2 during the course of the experiment (Fig 1a). Increased levels of chlorophyll per unit area indicate increased biomass, but no trends with additional UVB radiation can be observed. However, these results await statistical analysis. More useful data will be obtained once we can normalise the chlorophyll data to the carbon content, and to cell numbers.

Compounds such as mycosporine-like amino acids (MAAs) may have a UVB protective function similar to that of flavonoids in higher plants. Only preliminary analyses of the MAA samples have been undertaken so far in IRL (Lower Hutt), but these show that low levels of MAAs were present (Fig 1b, c). These low levels suggests that the sea ice algae may not be well protected from UVB radiation with these compounds. The possibility that MAAs create a self shading layer in algae closer to the surface was examined by taking a series of samples along the ice core. Preliminary observations of profiles in 3 cores (Fig 2) show that most of the MAAs are concentrated in the bottom most 5cm portion (portion a, Fig2). Note however in these cores that the UVB treated core had higher levels of MAA than those receiving lower levels of UV. These observations await statistical analysis.

Preliminary examination of the biodiversity data suggests that both the number of species, and their relative proportions did not change significantly with UV treatment.

Conclusions

Initial indications from this work are that UVB has a minor effect on primary productivity and biodiversity in sea ice algae.

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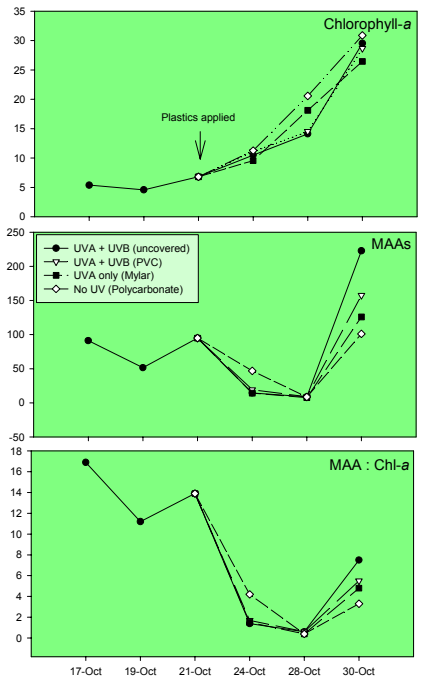

Figure 1. a. Chlorophyll-*a* content per square meter for different UV treatments. b. MAA content (arbitrary units) per square meter. This data is not yet calibrated. c. MAA content per mg Cholorophyll-*a*.

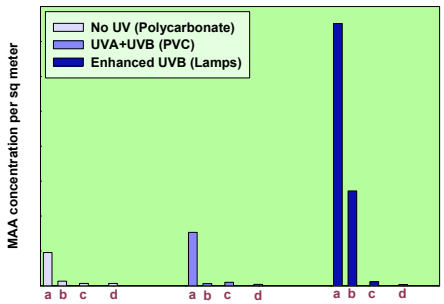

Figure 2. Profiles of MAA content per square meter along ice cores under with different UV treatments. Portion "a" is closed to the ice-water interface, and portion "d" is closest to the surface.