Cascading Effects of UV Radiation on a Simple Marine Food Chain

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Ozone depletion at high latitudes continues to increase levels of harmful UV-B radiation. UV-B can penetrate into the water mass and is present in significant amounts up to 17.5 h each day in the Norwegian summer. Phytoplankton respond to UV radiation either by the synthesis of protective sunscreen compounds or by changes in fatty acid composition. In this experiment, a diatom is exposed to elevated levels of UV radiation. The diatom is fed to copepod nauplii that are in turn fed to larval cod. UV radiation induces fatty acid changes in the phytoplankton, but these changes do not propagate through the simple model food chain.

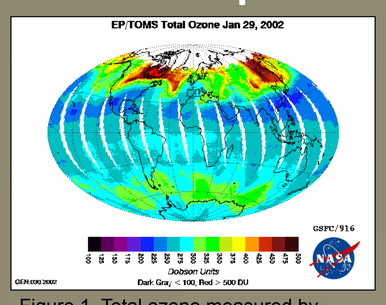

Figure 1. Total ozone measured by Earth-Probe Total Ozone Mapping Spectrometer, 2002.

Spectral irradiance levels were based on ambient conditions near the research site in Austevoll, Norway (60.08°N, 5.26°E). Between treatments, only UV-A and UV-B levels were altered; photosynthetically active radiation (PAR) remained constant.

Cascade Treatments	
PAR	No UV Radiation
UV	Ambient UV Conditions
UV+	Elevated UV Conditions

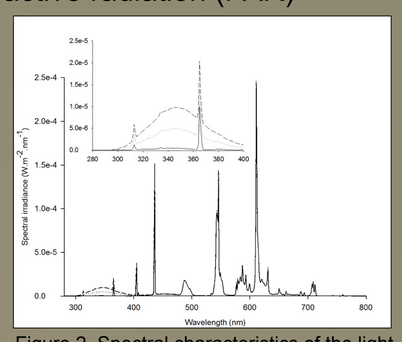

Figure 2. Spectral characteristics of the light treatments: Solid - PAR treatment; Dotted - UV treatment; Dashed - UV+ treatment

Phytoplankton

With increased UV exposure:

Total lipid content decreased

Long-chain PUFAs increased, while SFAs decreased

Cell diameter decreased

C:N decreased

No MAAs detected

Phytoplankton cultures exposed to UV light in quartz flasks

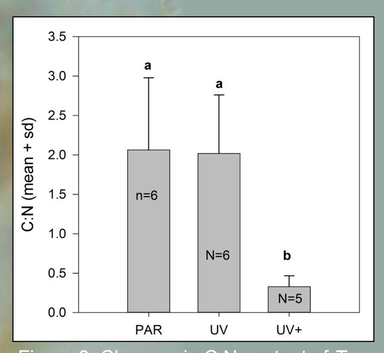

Figure 3. Changes in C:N content of *T. pseudonana* after UV exposure.

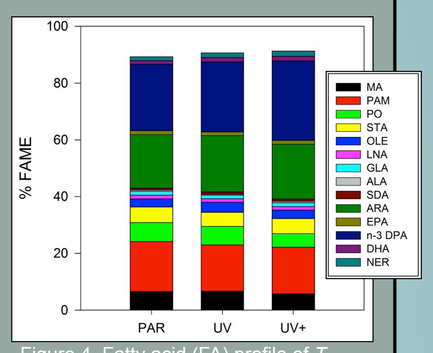

Figure 4. Fatty acid (FA) profile of *T. pseudonana* at 17 days exposure.

Zooplankton

After grazing on UV-exposed algae:

Similar changes in the FA profile were detectible but not significant

There was no change in total lipid content

There was no decrease in C:N

Adult Calanus can increase their food intake in response to UV-induced changes in the diatom *T. weissflogii*.

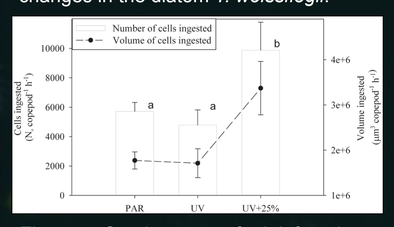

Figure 5. Grazing rates of adult female *Calanus finmarchicus* on *T. weissflogii* exposed to the same light treatments as the cascade (Fields et al. 2011).

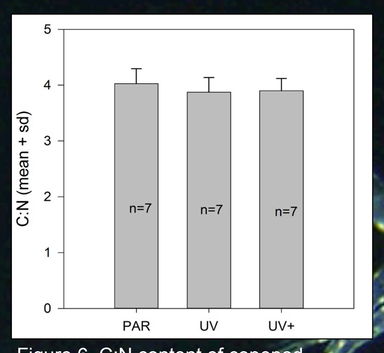

Figure 6. C:N content of copepod nauplii after grazing on UV-exposed algae.

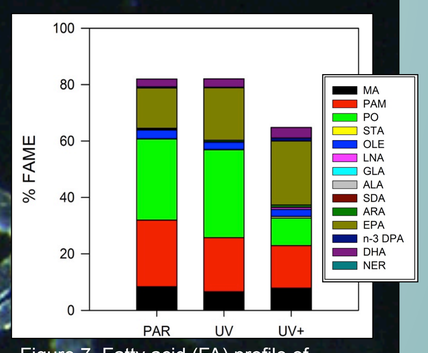

Figure 7. Fatty acid (FA) profile of copepod nauplii after grazing on UV-exposed algae.

Tank systems used to culture zooplankton and larval cod.

Fish Larvae

After grazing on nauplii:

No differences in the total lipid

No difference in the FA profiles

No difference in the C:N

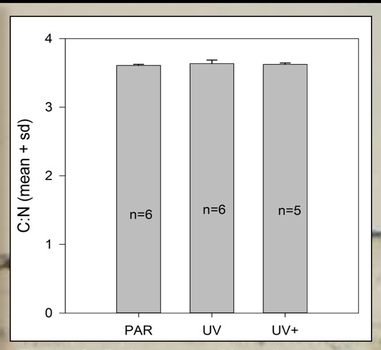

Figure 8. C:N content of larval cod tissue after feeding on nauplii who ingested UV-exposed algae.

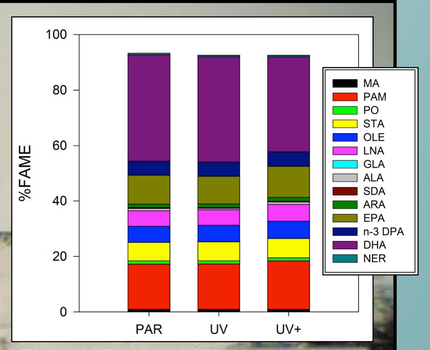

Figure 9. Fatty acid (FA) profile of larval cod tissue after grazing on nauplii.

Zooplankton compensated for a decrease in food quality, likely by increasing their feeding activity.

A suite of stressors is present in the natural environment of copepods, all of which may require compensatory adjustments, meaning that these results can only be extrapolated to other systems with caution.

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Durif CMF, Fields DM, Browman HI, Shema SD, Enoae JR, Skiftesvik AB, Bjelland RM, Sommaruga R, Arts MT (2015). UV radiation changes algal stoichiometry but does not have cascading effects on a marine food chain. *Journal of Plankton Research* 37(6), 1120–36. **doi: 10.1093/plankt/fbv082**