

Short Note

Palatability of living and dead detached Antarctic macroalgae to consumers

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Introduction

Macroalgae form impressive undersea forests along the western Antarctic Peninsula with large brown algae in Order Desmarestiales usually accounting for most of the biomass (Wiencke & Amsler 2012). Macroalgal carbon has been traced to numerous groups of shallow water consumers via stable isotope methods and has also been implicated as an important carbon source in deeper waters (reviewed by Wiencke & Amsler 2012). However, the vast majority of the standing macroalgal biomass is represented by chemically defended algae which are not readily consumed by grazers (Amsler *et al.* 2005, Wiencke & Amsler 2012), raising the question of how the carbon reaches the consumers. We chose to explore part of this question by examining how palatability to grazers of one of the two most abundant brown algae, *Desmarestia anceps* Montagne, is impacted by detachment and death.

Materials and methods

Ten *D. anceps* individuals were collected at 15–30 m depth near Janus and DeLaca islands, Antarctica (64°46.77'S, 64°06.73'W) on 1 April 2011. Each individual was divided into two portions. One portion, hereafter referred to as “live”, was held in mesh bags (mesh size 8 mm) in a flow through aquarium with natural and artificial light. The other portion, hereafter referred to as “dead”, was killed by anoxia. Filtered seawater was sparged with nitrogen via an air stone for over 30 min. The water was transferred to ten 1 litre plastic bottles and chilled to ambient temperature (1°C). As much of each individual alga as would possibly fit was stuffed into these bottles. The alga-filled bottles were held at 1°C in the dark for 21 days.

Samples (30–80 g) containing a main axis and numerous lateral branches were selected from each portion, marked with cable ties around the main axes for positive identification, and put into numbered mesh bags. These were placed along the bottom at 17 m depth, attached to the anchor chain of a shipwreck off DeLaca Island (64°46.84'S, 64°05.78'W). This is a flat area where macroalgal drift commonly accumulates, often but not always covering the bags with up to c. 25 cm of drift algae.

Lateral branch tips were removed from each alga before they were transferred to the field (time 0). Every week for four weeks divers retrieved the bags, removed additional lateral branch tips, and returned the bags to the benthos. Thereafter the bags were left for an additional 39 weeks (over the winter) before being resampled. No-choice feeding bioassays using the amphipod *Gondogeneia antarctica* Chevreux were performed with the live and dead branch tips following the methods of Amsler *et al.* (2009).

Feeding rates over the entire experiment were compared with univariate repeated measure analysis of variance (ANOVA) using SPSS software (SPSS Inc). Differences between successive weekly samples as well as differences between live and dead portions in each weekly sample were compared with paired *t*-tests using SPSS and corrected for type 1 error by the sequential Dunn-Sidak method (Sokal & Rohlf 1995). One-sample *t*-tests (SPSS) corrected with the Dunn-Sidak method were performed on each measurement to compare the rates to zero consumption.

Results and discussion

Detached macroalgae including *D. anceps* are usually capable of growth after being dislodged from the substrate (e.g. Fairhead *et al.* 2006, Aumack *et al.* 2011) so it was necessary to actively kill the algae in order to examine post-mortem palatability. Previous studies examining the decomposition of macroalgae, including *D. anceps*, have used heat to kill the thalli (Smith & Foreman 1984, Brouwer 1996). However, since these temperatures could potentially degrade defensive compounds and would not occur naturally in the subtidal, we chose anaerobic conditions as a manner in which a subtidal alga could naturally be killed. The three week anoxia treatment time was chosen after an initial trial with a three day treatment that failed to kill the algae.

There were no significant changes in the palatability of live algae over the 43 weeks of the experiment ($F_{1,8} = 1.670$, $P = 0.232$; Fig. 1) and amphipod feeding rates were never significantly different from zero ($P > 0.05$). Although the mean consumption was greater at week 43 (Fig. 1), this was entirely due to a single replicate which appeared unhealthy and was consumed at a much greater rate than the other eight remaining replicates (one live alga was not recovered at week 43).

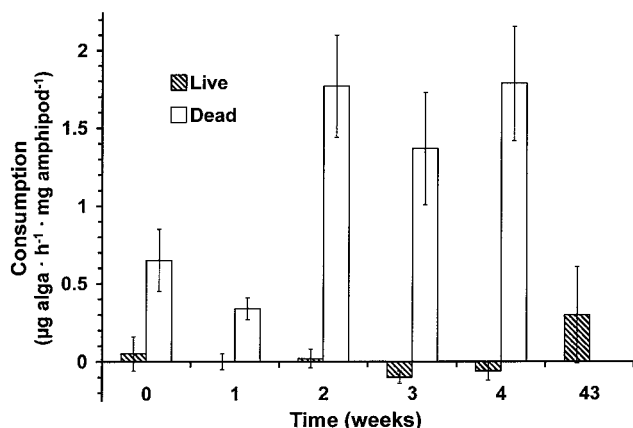


Fig. 1. Consumption rate of the amphipod *Gondogeneia antarctica* on live and dead *Desmarestia anceps* branch tips over time. Means \pm 1 standard error. No dead branch tips remained at week 43.

The dead portions fragmented somewhat over weeks 0–4 but branch tips could always be recovered from marked individuals. At week 43, no dead material could be identified for six individuals. In the other four, small pieces of heavily degraded main axis material were present but no lateral branches remained attached. Consumption rates on dead macroalgae between week 0 and 4 were significantly different from zero and from corresponding live material at each time point ($P < 0.05$; Fig. 1). Repeated measures ANOVA revealed a significant change in consumption over this period ($F_{1,9} = 7.844$, $P = 0.021$). Pair-wise comparisons of successive time points identified the interval between weeks 1 and 2 as the only period at which palatability significantly changed ($P < 0.05$). However, even the highest consumption rates measured are less than one third those on the palatable red alga, *Palmaria decipiens* (Reinsch) Ricker, assayed with the identical experimental setup (Amsler *et al.* 2009).

These results indicate that dead thalli of chemically defended macroalgae can become available as food sources for amphipods and, presumably, other grazers within weeks of death. Degradation of the potent chemical defences present in *D. anceps* (Amsler *et al.* 2005) would be necessary for this to occur but bacterial colonization and degradation of the thallus could have simultaneously been increasing its nutritional quality (Reichardt & Dieckmann 1985). However, simply being detached was sufficient to increase thallus palatability in only one (which appeared unhealthy at week 43) of nine individuals, even over the short daylengths of winter in a location where they were probably covered by other drift algae much of the time. As noted previously, macroalgal carbon has been traced by stable isotope methods to benthic consumers in both hard and soft substrate shallow Antarctic communities.

Our work and the previous report of detached but live *D. anceps* apparently remaining healthy for over 44 weeks (Brouwer 1996) indicates that for this important species at least, something must kill the alga for the carbon to become available to grazers. Reichardt & Dieckmann (1985) reported preliminary evidence that “degradation” also increased the palatability of the other major brown algal carbon contributor, *Himantothallus grandifolius* (A. Gepp & E.S. Gepp) Zinova, although no details of what degraded the algae were presented. In addition to exposure to anoxia as used here, other possible situations which could kill macroalgae include prolonged periods of total darkness at the bottom of deep piles of drift algae or in non-anoxic sediments, as well as desiccation or freezing in the intertidal.

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