Seasonal variation and trophic modification of Antarctic benthic macroalgal fatty acid trophic biomarkers

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In this project, we used a trophic biomarker approach to integrate across biological and trophic level responses to the abiotic environment to which an organism is exposed. Marine food webs are recognized as rich resources for essential FA, which include FA that cannot be synthesized *de novo* by many invertebrates but can be synthesized by primary producers (Dalsgaard *et al.* 2003). Because of the importance of lipids and many essential FA ω-3 and ω-6 polyunsaturated FA in regulating organism reproduction, physiology, and energy resource allocation, these molecules are important indicators in marine food webs (Dalsgaard *et al.* 2003), and can be used for inference of the diet of wild consumers (Aumack *et al.* 2017, Schram *et al.* 2019). We hypothesized that consumer FA profiles will vary with the degree of sea ice coverage because this environmental disturbance can alter coastal benthic community composition and thus the essential FA available to consumers. Additionally, due to changes in the availability of primary producers with seasonal transitions, in part due to changes in sea ice cover, we anticipate shifts in consumer FA profiles for some consumer species.

Due to setbacks associated COVID-19, I present preliminary results that represent a small part of our ongoing data analysis for additional macroalgal and invertebrate consumer samples collected. As a result, I compared the FA of tissues collected from two common Antarctic grazers, the sea star *Odontaster validus* and limpet *Nacella concinna*. Tissue samples were collected during our 2019 Austral winter cruise along the sea ice gradient and compared to samples collected in the summer of 2019-2020 at Palmer Station. I identified 63 FA in the *O. validus* and *N. concinna* tissues but focused my data analysis on those FA whose mean contribution was ≥ 0.5% (*O. validus* N = 18, *N. concinna* N = 20). To compare multivariate FA matrices (Euclidean distance), I performed two-way permutational multivariate analysis of variance (PERMANOVA, 9999 permutations, fixed effects, Type III sum of squares) in R (version 4.0.5) using the vegan package (Oksanen *et al.* 2019). Data were visualized in R using non-metric multidimensional scaling (NMDS) plots (for more detailed methods see Yoshioka *et al.* 2019).

We found that the FA of *O. validus* statistically differed by sea ice and season (Table 1). There is a much clearer pattern of separation based on season rather than sea ice cover associated with the collection sites in the NMDS plots. However, there is separation of the winter *O. validus* data into two distinct groups, suggesting that we may still be missing an environmental or ecological factor; this conclusion is supported by the relatively low R^2 value for these analyses (Table 1). Similarly, we found that the FA profiles of *N. concinna* differed based by sea ice cover and season (Table 1). In contrast to *O. validus*, the FA of *N. concinna* spatially separated more consistently based on the sea ice cover rather than by season when data are plotted using NMDS.

Based on the preliminary analyses presented here, we have been able to detect differences in the FA profiles of two common grazer species found along the wester Antarctic Peninsula. The influence of sea ice cover and season differed by species, with greater separation in *O. validus* profiles based on season and in *N. concinna* based on sea ice cover. These results may suggest that *O. validus* consumes different food sources seasonally while *N. concinna* tends to rely on more

similar food sources throughout the year, but the quality of the food may be influenced by sea ice cover or other abiotic factor. It also currently appears likely that there are influential abiotic or latitudinal factors that remain unidentified in our data. We will continue our FA data analysis as planned to compare the FA profiles of summer algal collections with those from the existing project (winter sea ice gradient collections) and quantify trophic modification of amphipods maintained on monospecific diets in austral summer 2019-2020 to better identify potential sea ice and seasonal signals in FA data.

References

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Table 1. Analysis results of PERMANOVA comparison of FA proportions contributing ≥ 0.5% of identified FA for *Odontaster validus* and *Nacella concinna*. Df = degrees of freedom, MS =

Species	Factor	df	MS	F. Model	R^2	p-value
Odontaster validus	% Ice cover	6	327.06	4.68	0.15	< 0.001
	Season	1	1889.15	27.05	0.15	< 0.001
Nacella concinna	% Ice cover	6	92.44	4.54	0.28	< 0.001
	Season	1	74.88	3.68	0.04	0.02