

Bolstered physical defenses under nutrient enriched conditions may facilitate a macroalgal species in the South Pacific

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Background

Human manipulations of top-down and bottom-up processes, through nutrient enrichment and overfishing, can cause a shift from dominance by corals to macroalgae on reefs.

Turbinaria ornata, a brown macroalga, is rapidly expanding in range and habitat across the South Pacific.

The relative importance of nutrient input and herbivory pressure, or an interaction between the two, in controlling its accumulation is previously unknown. Therefore, we investigated the impact of nutrients and herbivory on *T. ornata*.

Key Questions:

- (1) Does *T. ornata* grow in response to nutrients? (bottom-up control)
- (2) Does herbivory control *T. ornata* biomass? (top-down control)
- (3) Is there any interaction between nutrients and herbivory that may lead to the persistence of *T. ornata*?

Methods

(1) **Nutrient mesocosm** to test for nitrogen and phosphorus limitation to *T. ornata* growth

	-Nitrogen (N)	+Nitrogen (N)
-Phosphorous (P)	-N-P (ambient)	+N-P
+Phosphorous (P)	-N+P	+N+P

(2) **Nutrient and herbivory field experiment** to test for interactions between nutrient input and herbivory

	+Herbivory (H)	-Herbivory(H)
-Nutrients (N)	+H -N	-H -N
+Nutrients (N)	+H +N	-H +N

(3) **Agar palatability assay** to assess the impact of nutrient enrichment to chemical and physical anti-herbivory defenses

(4) **Thalli toughness test** to asses whether nutrient enrichment causes *T. ornata* to become tougher

Study species and site



Turbinaria ornata: a fleshy brown macroalga with anti-herbivory defenses



Mo'orea, French Polynesia: All surveys and experiments were conducted on two fringing reefs of the north shore

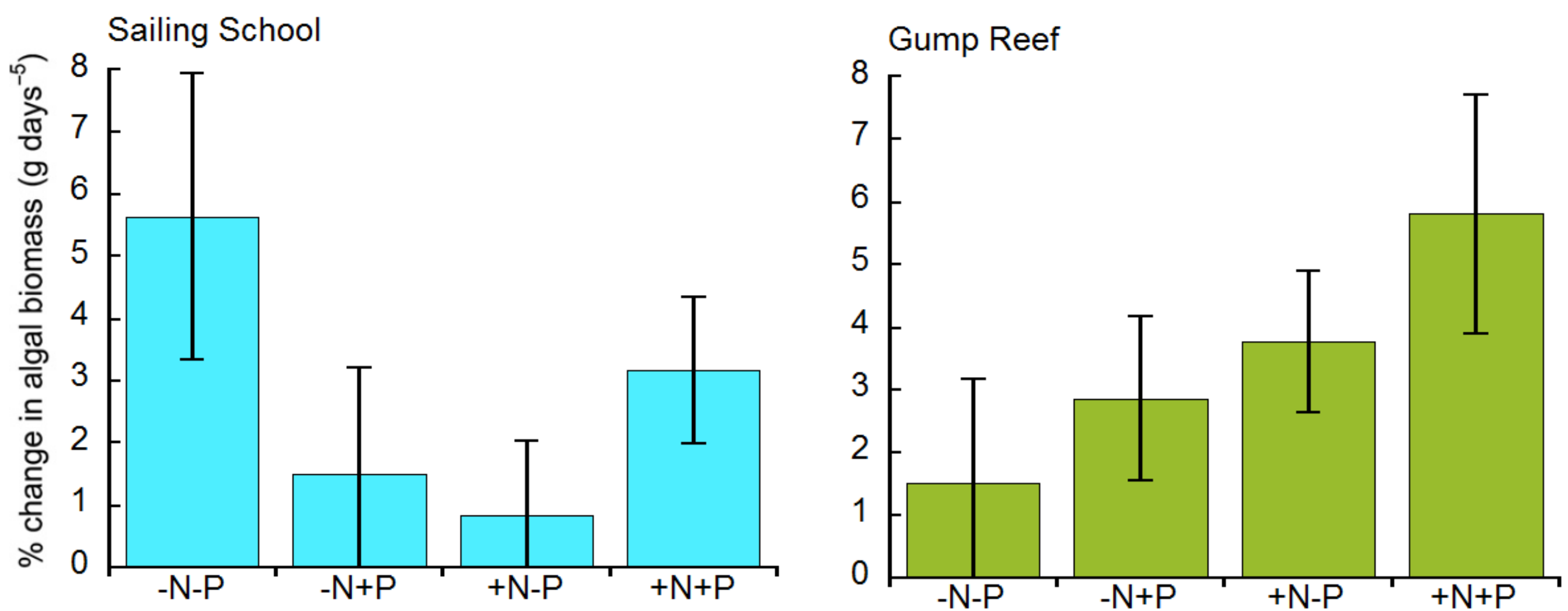


A dense *T. ornata* aggregation growing on the top of a *Porites* coral head



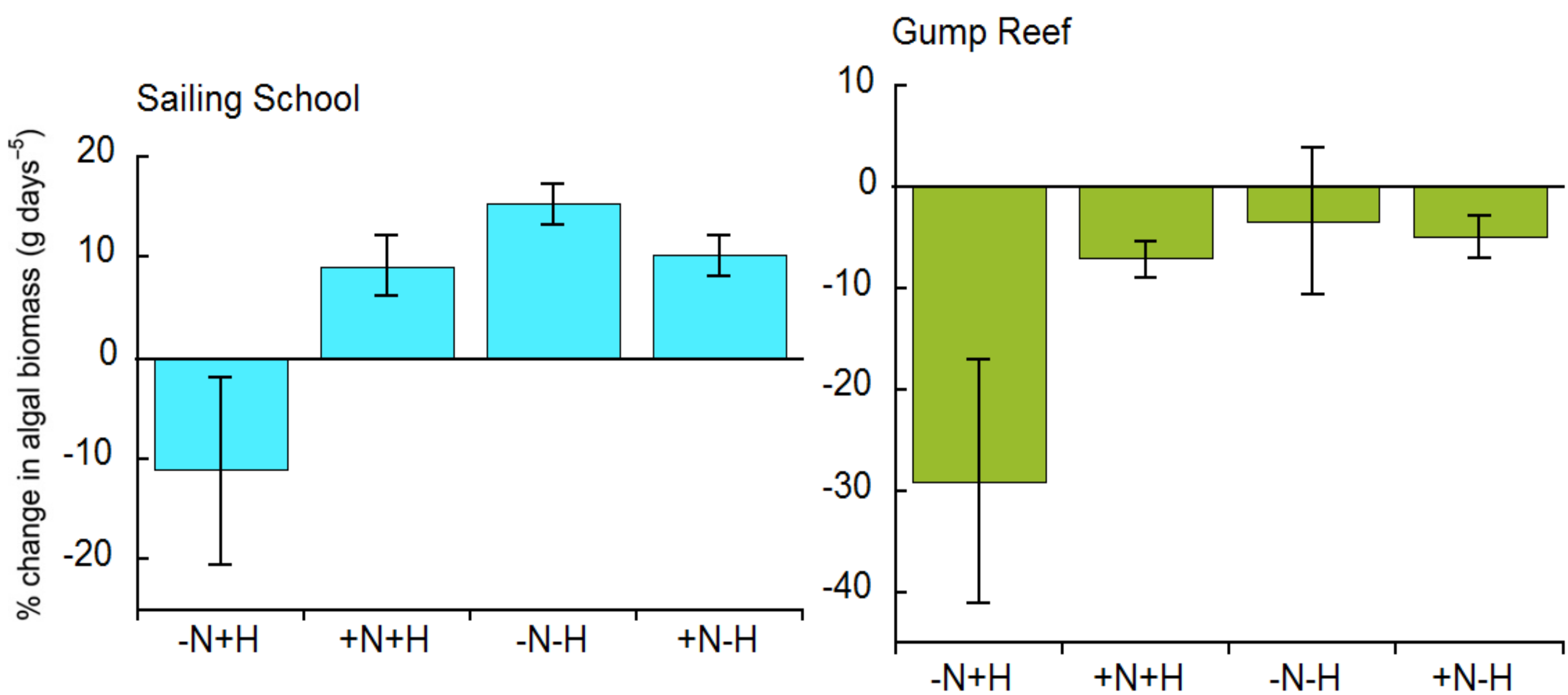
Buoyant *T. ornata* thalli detach by natural senescence and wave energy, forming large reproductive rafts

1) Nutrient Mesocosm



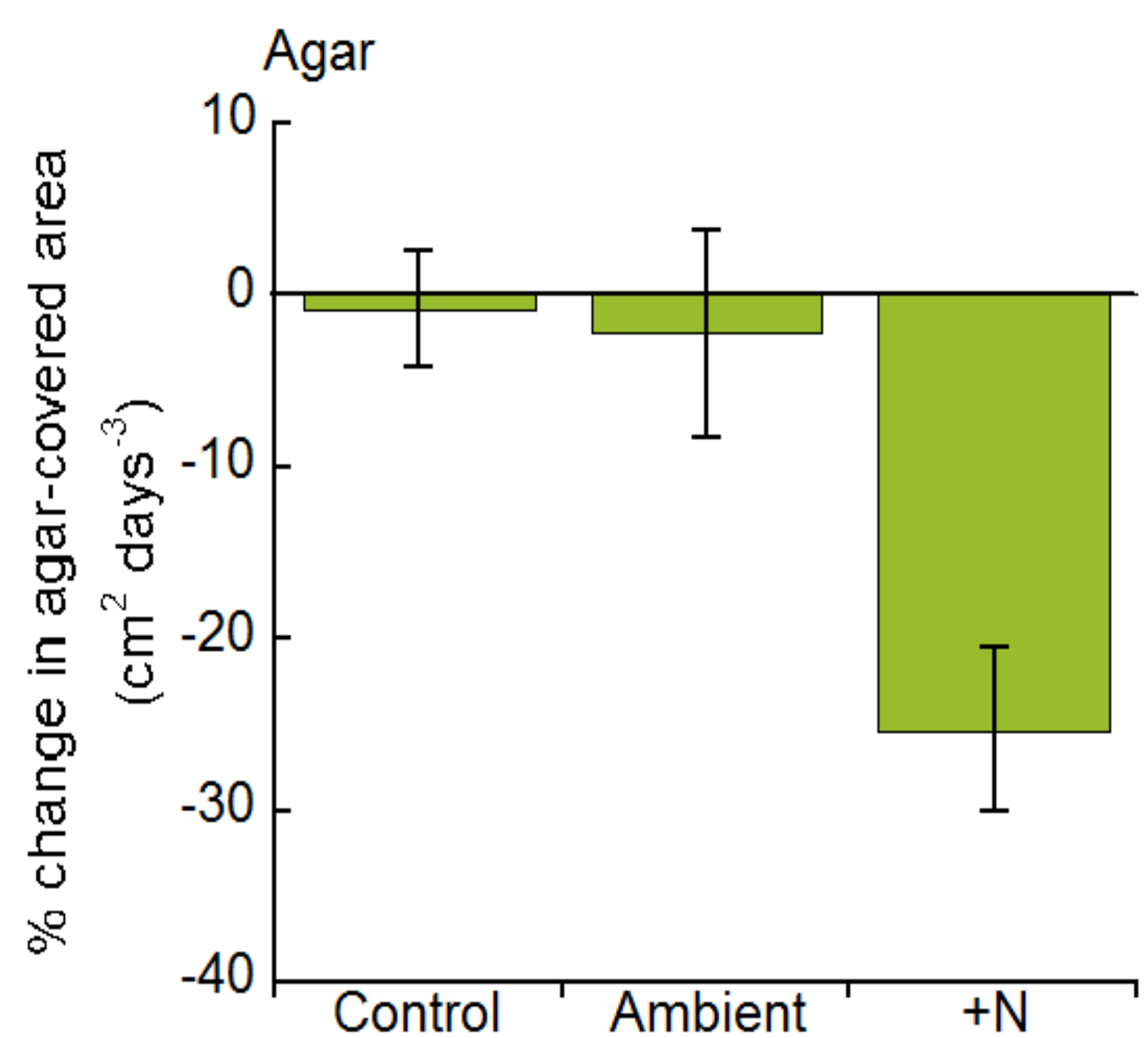
T. ornata growth is not nutrient limited and is slow at both sites

2) Nutrient and Herbivory Field Experiment



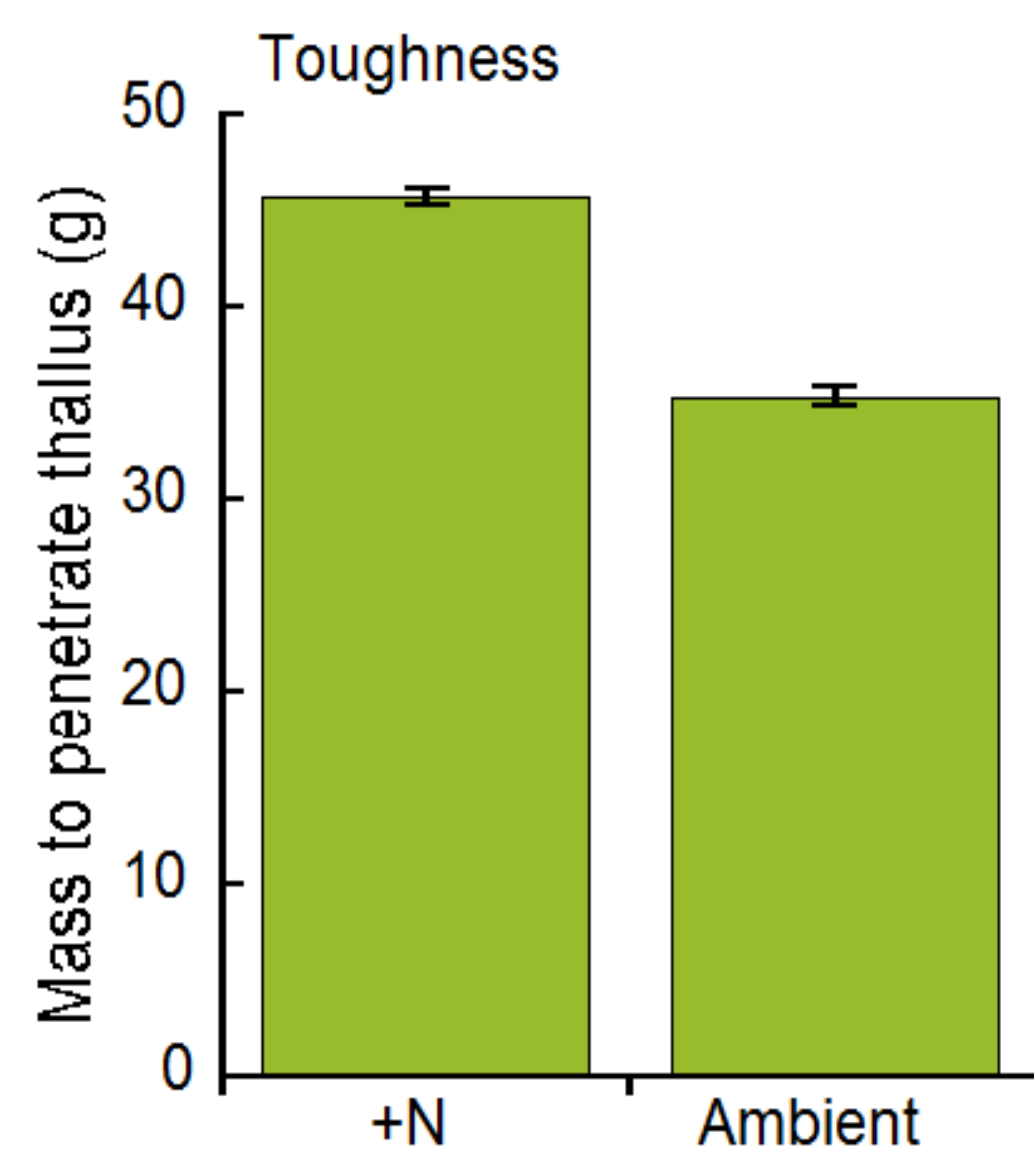
Nutrient enrichment DECREASES herbivory at both sites (compare +H-N to +H+N)

3) Agar Palatability



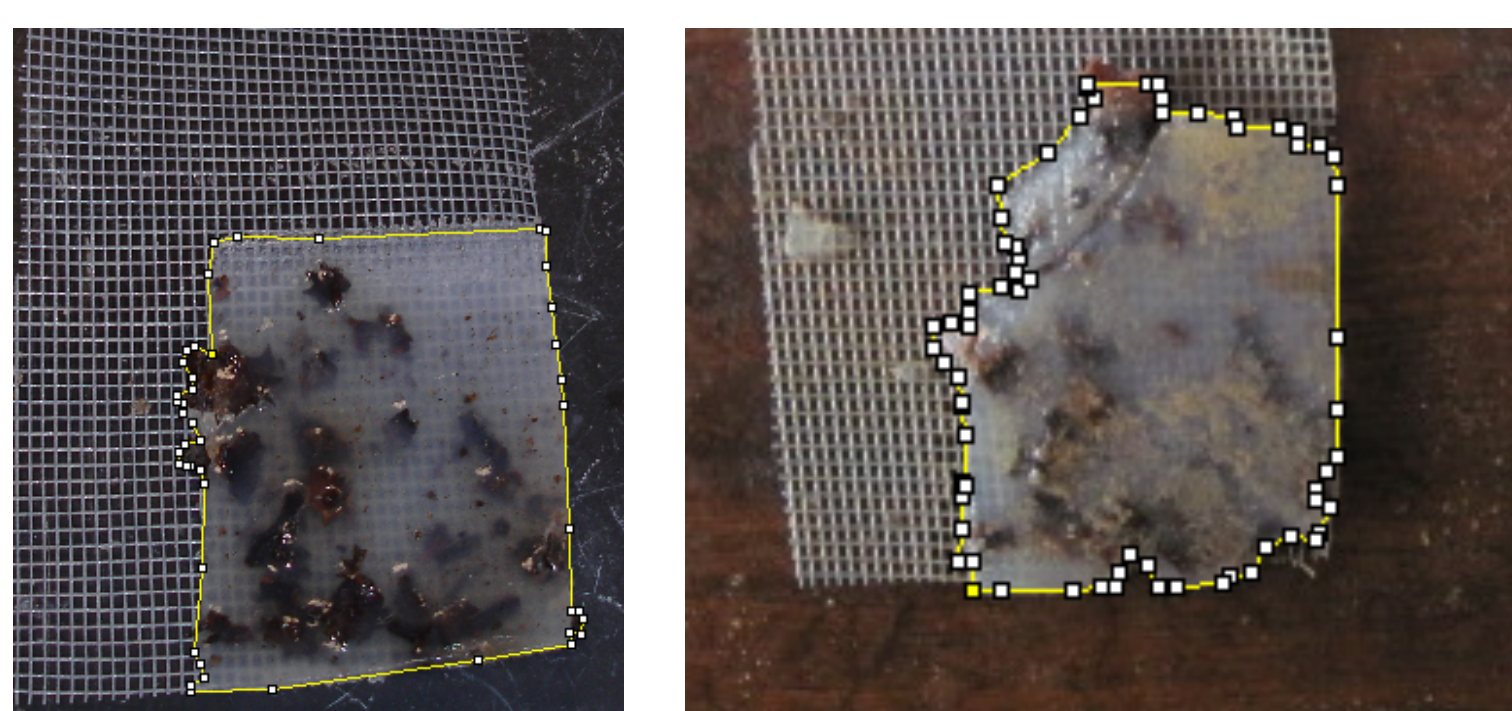
In the absence of physical structure herbivores prefer nutrient enriched thalli (+N)

4) Thalli Toughness



Nutrient enriched (+N) thalli are tougher than ambient thalli

Example of an initial and final agar plate analyzed for grazing in ImageJ



Penetrometer and *T. ornata* blade for toughness test



Conclusions

- T. ornata* **growth** is not limited by nutrients
- Instead, nutrients release *T. ornata* from herbivore control through increased thalli toughness
- Unique **interaction** between nutrients and herbivory may allow expansion of *T. ornata* to habitats usually controlled by herbivory



Acknowledgments

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