Biotic resistance against introduced barnacles on the Pacific coast of Hokkaido, Japan

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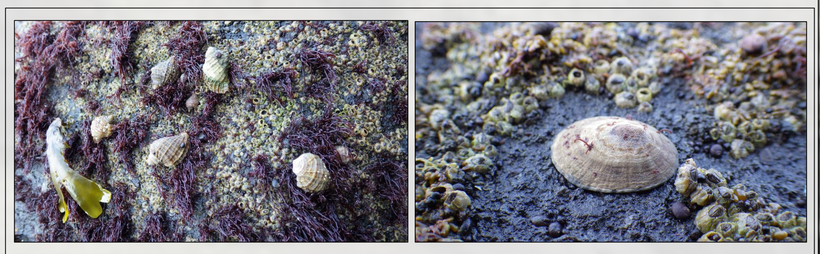
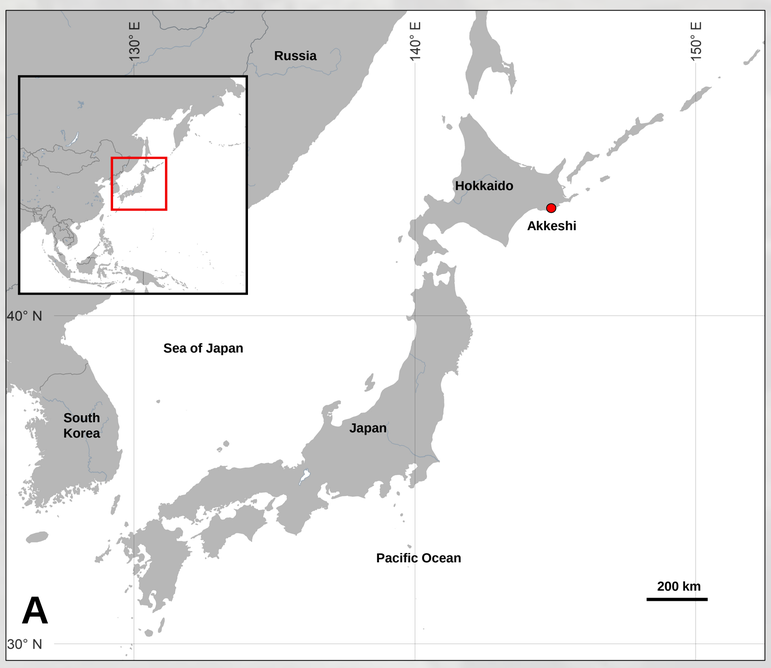
INTRODUCTION

Introduced species are a major threat to coastal biodiversity worldwide. Thus, understanding biotic resistance, the ability of native species to limit introduced species, is a central goal of invasion biology. This research project examined whether native predatory dogwhelks and herbivorous limpets contribute to biotic resistance against introduced barnacles in Hokkaido, Japan.

STUDY SYSTEM



Nucella lima | *Lottia cassis* | *Chthamalus dalli*[1] | *Balanus glandula*[2]



Here, native dogwhelks (*Nucella lima*), limpets (*Lottia cassis*) and barnacles (*Chthamalus dalli*) co-occur with introduced barnacles (*Balanus glandula*). We conducted our study in Akkeshi Bay **(A)**.

HYPOTHESES

We hypothesized that *N. lima* prefers (i) *B. glandula* individuals over *C. dalli* individuals and (ii) large over small *B. glandula* individuals because such preferences, that are likely driven by prey profitability, were previously found in congeneric dogwhelks on the North American Pacific coast. Furthermore, we hypothesized (iii) that predator chemical cues by *N. lima* would limit *B. glandula* recruitment as a previous study in North America found that cues by congeneric dogwhelks limit *B. glandula* recruitment by reducing *B. glandula* settlement. Finally, we hypothesized (iv) that limpet disturbance effects, mediated by *L. cassis* bulldozing and grazing barnacle recruits off the substrate, would limit *B. glandula* recruitment.

PUBLICATIONS

1. Yorisue T., J. A. Ellrich & K. Momota (2019) Mechanisms underlying predator-driven biotic resistance against introduced barnacles on the Pacific coast of Hokkaido, Japan. ***Biological Invasions*** 21(7): 2345-2356. Doi: 10.1007/s10530-019-01980-4

2. Ellrich J. A., T. Yorisue & K. Momota (2020) Limpet disturbance effects on barnacle recruitment are related to recruitment intensity but not recruit size. ***PeerJ*** 8: e9190. Doi: 10.7717/peerj.9190

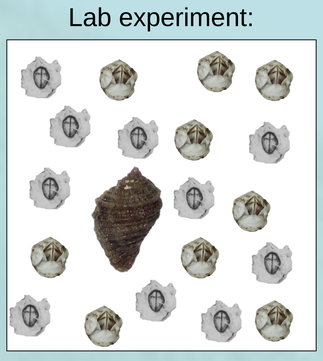
3. Ellrich J. A., T. Yorisue & K. Momta (2020) Predator snails fend off the invasion of barnacles in Japan. ***The Conversation***, 2 June 2020

1. 2. 3.

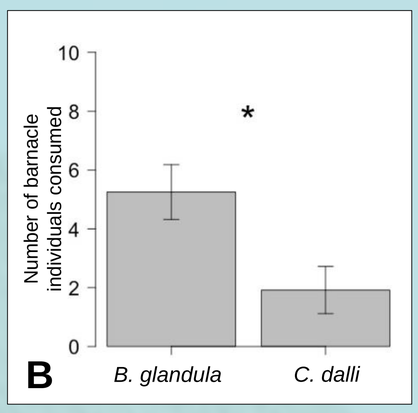
FINDINGS

Dogwhelks prefered *B. glandula over C. dalli* prey

Lab experiment:



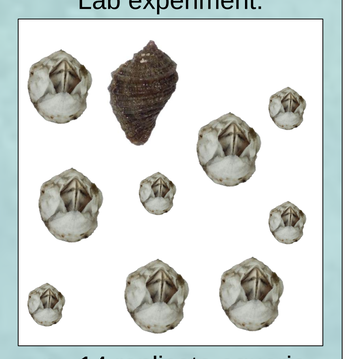
n= 12 replicate aquaria



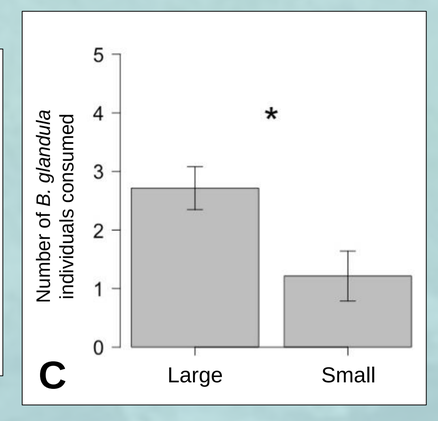
When offered equal-sized *B. glandula* and *C. dalli* prey, dogwhelks consumed 64% more *B. glandula* than *C. dalli* individuals indicating that dogwhelks prefer *B. glandula* over *C. dalli* **(B)**.

Dogwhelks prefered large over small *B. glandula* prey

Lab experiment:



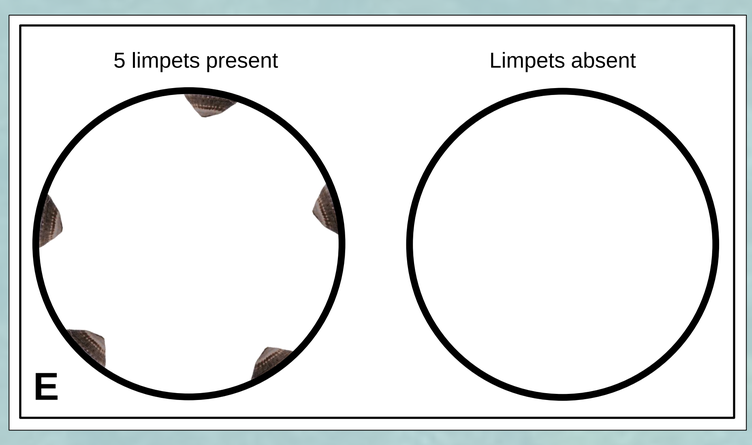
n= 14 replicate aquaria



When offered large and small *B. glandula* prey, dogwhelks consumed 55% more large *B. glandula* individuals indicating that dogwhelks prefer large over small *B. glandula* prey **(C)**.

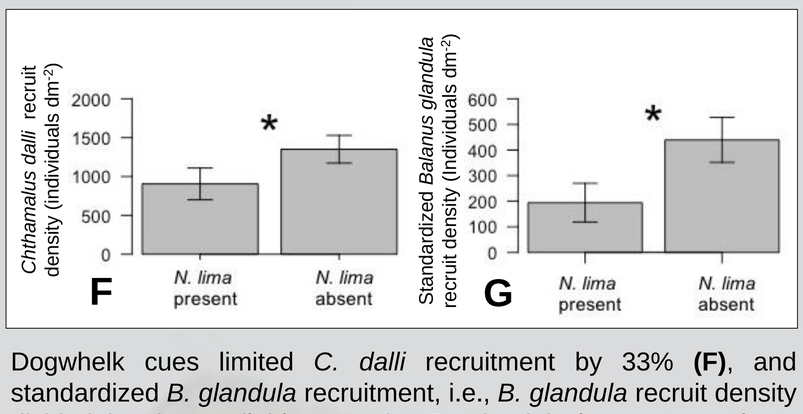
Dogwhelk cue and limpet disturbance effects on *C. dalli* and *B. glandula*

Cages to examine dogwhelk cue effects on barnacle recruitment. The caged dogwhelks could not reach the barnacle recruits **(D)**.



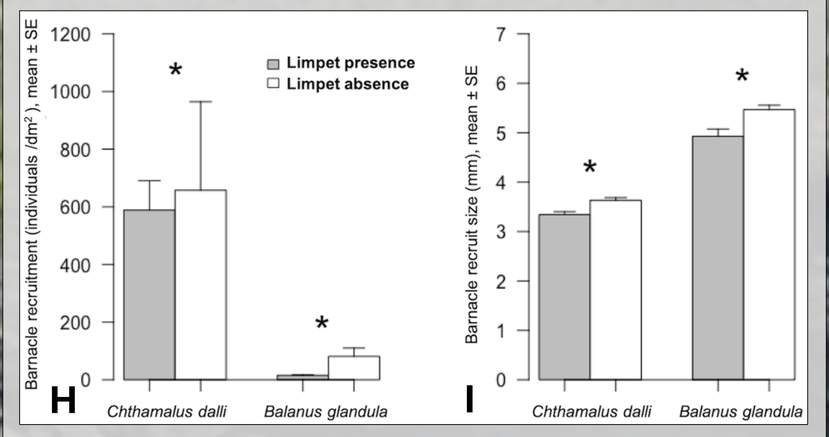
Ring-shaped cages with a smooth inner surface to standardize limpet disturbance effects and measure barnacle recruitment **(E)**.

Dogwhelk cues limited *C. dalli* and *B. glandula* recruitment



Dogwhelk cues limited *C. dalli* recruitment by 33% **(F)**, and standardized *B. glandula* recruitment, i.e., *B. glandula* recruit density divided by the available area for *B. glandula* larvae to settle to account for small among-plate differences in free area caused by *C. dalli* recruits, by 56% **(G)**.

Limpet disturbance limited *C. dalli* and *B. glandula* recruitment and recruit size

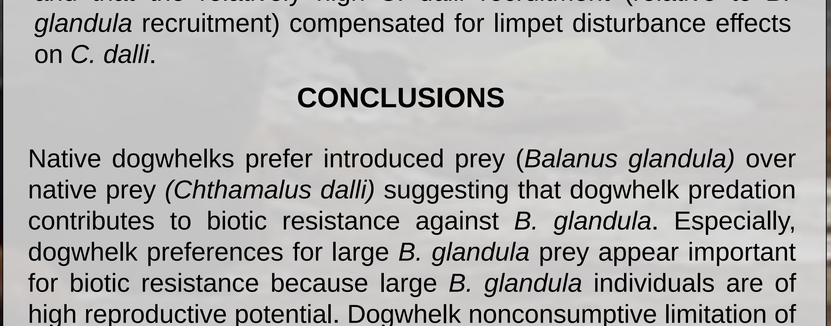


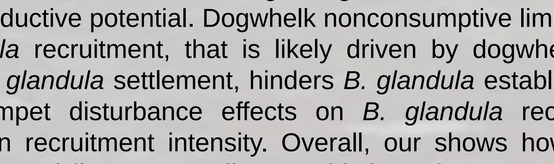
Limpet disturbance limited *C. dalli* recruitment by 10%, *B. glandula* recruitment by 81% **(H)**, *C. dalli* recruit size by 8% and *B. glandula* recruit size by 12% **(I)**. Limpet disturbance had equal effects on recruit size in the small *C. dalli* and the large *B. glandula* indicating that limpet disturbance affects both barnacles and that the relatively high *C. dalli* recruitment (relative to *B. glandula* recruitment) compensated for limpet disturbance effects on *C. dalli*.

CONCLUSIONS

Native dogwhelks prefer introduced prey (*Balanus glandula)* over native prey *(Chthamalus dalli)* suggesting that dogwhelk predation contributes to biotic resistance against *B. glandula*. Especially, dogwhelk preferences for large *B. glandula* prey appear important for biotic resistance because large *B. glandula* individuals are of high reproductive potential. Dogwhelk nonconsumptive limitation of *B. glandula* recruitment, that is likely driven by dogwhelk cues limiting *B. glandula* settlement, hinders *B. glandula* establishment. Finally, limpet disturbance effects on *B. glandula* recruitment depend on recruitment intensity. Overall, our shows how native dogwhelks and limpets contribute to biotic resistance against *B. glandula* in Hokkaido.

SUMMARY





BARNACLE PICTURE CREDITS

[1]Miller K. M. et al. (1989) Journal of Crustacean Biology 9(2): 242-256.

[2]Kerckhof F. et al. (2018) BioInvasions Records 7(1): 21-31.