Native clams facilitate invasive species in an eelgrass bed

Laura F. White & Lindsay C. Orr generously funded by the Pacific Northwest Shell Club

Eelgrass beds are highly productive and important for sediment deposition, substrate stabilization, benthic oxygen production, as substrate for epiphytic seaweeds and invertebrates, and as nursery grounds for many species of economically important fish and shellfish (Williamson 2006). In British Columbia (BC), Canada, these include the commercially important

Non-native *Sargassum muticum* attached to native gaper clam siphon.

Dungeness crab (*Cancer magister*) and Pacific herring (*Clupea pallasi*). South of BC in Puget Sound, eelgrass beds have shown staggering declines, a trend that has been observed in many areas of the world as a result of various types of disturbance in coastal and estuarine environments, including industrial, residential, and recreational development (Short et al. 1986, Short & Wyllie-Echeverria 1996). In BC, specific contributors to eelgrass decline include pollution, dredging, and anchor dragging. Due to their coastal habitat, eelgrass beds are exposed to high invasion pressure. The number of reports of introduced species in eelgrass beds globally has increased over recent decades (Williams 2007).

An invasive seaweed from southeast Asia, *Sargassum muticum* was accidentally introduced to BC around the 1940's with Japanese oysters (*Crassostrea gigas*) that were imported for aquaculture. *S. muticum* is both a fouling species and an opportunist. It is well established in low intertidal habitats, in many places becoming a conspicuous dominant, displacing native seaweed species. Concerns surrounding potential impacts of *S. muticum* on native eelgrass were alleviated as despite the 2 species occupying the same tidal height, they have differing substrate requirements. Eelgrass colonize soft sediments of sand and mud, whereas *S. muticum* requires a solid substrate for attachment. However, the 2 species can coexist when the substrate is mixed and eelgrass is in decline (den Hartog 1997).

We found the introduced seaweed *Sargassum muticum* colonizing the distal end of the clam species *Tresus capax* siphons within an eelgrass bed at the head of Bamfield Inlet, Bamfield, British Columbia, Canada. Native to the Pacific Northwest, the gaper clam (*Tresus capax*) is abundant in the low intertidal zone, burying to depths of 1m in sand and mud substrates, from the lower littoral down into the sub littoral, occurring above, in, and below eelgrass.

A filter-feeding bivalve, *T. capax* possesses a long (~30 cm) fused siphon, extending from the soft sediments into the overlying water column. The shells are flared around the siphon and individuals are unable to completely close or fully retract their siphons within their shells. At low tide, the extended siphons lie on the surface of the mud, retracting when disturbed and pulling the attached *S. muticum* down into the substrate!

The native clam is facilitating incursion of the non-native seaweed into the eelgrass bed through habitat provision of a solid substratefor attachment. Physical facilitation of non-native *S. muticum* into the eelgrass by the gaper clam may be tempered by algal quality or condition. We used field sampling and experimental trials to investigate if algal condition differs between the 2 attachment substrates (clam siphon and rock) as a proxy for habitat quality.

Is new niche too much of a drag for Sargassum muticum

Attachment substrate promoted different morphologies of S. muticum; individuals attached to clam siphons expressed morphologies consistent with sheltered areas compared to individuals attached to rock expressing wave exposed morphologies. Habitat association with the different morphologies supported differences in the epibiont communities colonizing S. muticum. Further, S. muticum was subsequently facilitating incursion of the non-native tunicates Styela clava and Botrylloides violaceous (*photo right*) into the eelgrass bed through habitat provisioning. By facilitating 2 additional invaders, S. muticum enhances the level of invasion in the eelgrass bed.

The algal-invertebrate interaction documented here is an example of habitat provision by the native gaper clam for the incursion of non- native S. muticum into the mudflat and its associated eelgrass ecosystem. S. muticum subsequently facilitates the non-native tunicates S. clava and B. violaceous through habitat modification and provision. While seaweeds colonizing mollusc shells is not unusual, we know of no other invasive seaweeds exploiting native mollusc siphons as habitat. S. muticum has found a novel means to colonize within the eelgrass bed.

While the impacts of the invasive species were beyond the scope of the present study, S. muticum has the potential to disrupt the persistence of eelgrass in this system. The main competitive effects of S. muticum are shading and the preemption of space (Britton-Simmons 2006, White & Shurin 2007). S. muticum has perennial basal axes that persist in a vegetative state over winter and thus is poised to preempt space from eelgrass following any disturbance that results in eelgrass declines or loss, such as habitat fragmentation, eutrophication, disease, or impacts of introduced species. Eelgrass is unable to regain space preempted by S. muticum, a pattern observed in other regions (Critchley et al. 1987, den Hartog 1997).

Future investigations

The positive interactions between these invasive species and the potential for compounded negative effects to this eelgrass system are the next step in untangling the effects of multiple invaders to this sensitive eelgrass bed.

References

Britton-Simmons KH (2006) Functional group diversity, resource preemption and the genesis of invasion resistance in a community of marine algae. Oikos 113 (3):395-401

Critchley AT, Nienhuis PH, Verschuure K (1987) Presence and development of populations of the introduced brown alga Sargassum muticum in the southwest Netherlands. Hydrobiologia 151/152: 245-255 den Hartog C (1997) Is Sargassum muticum a threat to eelgrass beds? Aquatic botany

Short FT, Mathieson AC, Nelson JI (1986) Recurrence of the eelgrass wasting disease at the border of New Hampshire and Maine, USA. Mar Ecol Prog Ser 29:89-92

Short FT, Wyllie-Echeverria S (1996) A Review of Natural and Human-induced Disturbance of Seagrasses. Env Conserv 23 (1):17-27

White LF, Shurin JB (2007) Diversity effects on invasion vary with life history stage in marine macroalgae. Oikos 116:1193-1203

Williamson KJ (2006) Relationships between eelgrass (Zostera marina) habitat characteristics and juvenile Dungeness crab (Cancer magister) and other invertebrates in southern Humboldt Bay, California. Master of Science thesis, Humboldt State University, Arcata, CA