Ecological Dynamics of the Green-lipped Mussel, *Perna canaliculus*, at Ninety Mile Beach, Northern New Zealand

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ABSTRACT

The New Zealand green-lipped mussel, *Perna canaliculus*, is farmed by an aquaculture industry (> NZ$ 150 million/year) that is dependent on mussel juveniles (spat) collected from unpredictable and unreliable wild sources for more than 80 % of its mussel seed requirements. Most wild-caught spat is collected from the surf zone at Ninety Mile Beach, northern New Zealand, where unique environmental conditions cause the accumulation and transport of spat attached to drift algae, which arrive to the shore in great quantities (up to 100 tonnes at once). This study is the first to investigate the ecology of mussels at Ninety Mile Beach throughout their life history, including reproductive behavior, micro-scale settlement patterns on filamentous macroalgae, accumulation and transport of mussel spat to the shore, colonization of the rocky intertidal, and adult population dynamics. Histologic investigation of 4 intertidal and 2 subtidal populations revealed that females and males were well-synchronized throughout their reproductive cycles, with a prolonged spawning season from June to December, when temperatures were lowest and rising. Comparisons of gonad indices and maximum shell length indicated high productivity in certain populations, which likely contribute to the high larval availability of the area.

Experiments showed that mussel spat preferentially settled on fine-branching natural and artificial substrata, with correlation evident between mussel shell size and degree of branching. Furthermore, greater numbers of mussels settled on node versus internode areas within natural and artificial substrata. Chemical cues for mussel settlement also were studied using phytogel plates spiked with algal extracts, which were

preferred over control plates by mussel larvae/post-larvae in the field, and by hatchery-reared larvae in the laboratory.

Three intertidal populations were investigated at different temporal and spatial scales. Mussel concentrations in seawater were higher after spawning for both small mussels (< 0.25 mm) in August, and for larger mussels (> 0.5 mm) in March. Settlement patterns within quadrats cleared of mussels in 2 habitats (adult mussel bed and adjacent areas covered with algae) were studied from July 1999-March 2001. Primary settlement (mussels < 0.5 mm) was found to dominate the algal habitats at the beginning of the spawning season in August, while secondary settlement (mussels > 2.0 mm) was higher in the adult mussel bed late in the spawning season (November-March). Monthly surveys of undisturbed quadrats indicated that a peak in new recruitment coincided with a peak in adult mortality in August. At Scott Point, massive mortality for 2 years in August was followed by a dramatic re-colonization of the empty spaces by juveniles.

Settlement patterns of mussels on suspended ropes in the water column were investigated at 3 water depths inside and outside Ahipara Bay during 2 spawning seasons (1999-2000). Mussel settlement was higher for small mussels (< 0.49 mm) in shallower water (2 m water depth) in August, and higher for larger mussels (> 1.0 mm) at greater depths (18 m water depth) in September-December. Mussels found on shallow-water ropes may have settled directly from the plankton, whereas mussels on ropes near the bottom (18 m) may have transferred from macroalgae tumbling on the seafloor.

Environmental conditions associated with mussel spat arrival to the beach (spatfall events) were studied by statistical analysis (1990-1998; daily, monthly, inter-annually) of wind speed/direction, tidal range, water temperature, swell height/direction,

and records of spatfall events/amounts. Spatfall events/amounts were more abundant during days of strong offshore winds. Swell height in the onshore direction was significantly correlated with spatfall events/amounts. Storm events (wind speeds > 20 m/s) were most frequent between May-August; spatfall events/amounts were more numerous 4 months later (September-October). Years with more storm events (El Niño/La Niña episodes) were associated with significantly higher spatfall events/amounts.

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When I was a little girl, I saw my father disappear between the rocks in the low intertidal on a receding wave. After what seemed like hours, he re-appeared, running away from what seemed to me a tsunami wave. As he just escaped the wave, by what I thought was magic, I saw a bundle of sea urchins, which he had just collected. That was my first experience with the majestic powers of the sea and the beginning of my love and admiration for its wonders and delicacies.

Andrea Casandra Alfaro

TABLE OF CONTENTS