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Evaluation of methods for assessing the retention of seed mussels (*Perna canaliculus*) prior to seeding for grow-out

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Abstract

The process of catching and relaying wild seed green-lipped mussels, *Perna canaliculus,* onto grow-out farms in New Zealand is extremely inefficient with the majority of the seed mussels being lost after transfer, mostly due to secondary settlement behaviour of the seed. In an attempt to identify the causes of this behaviour the retention of seed mussels was experimentally determined after exposure to three sub-lethal stressors, desiccation, starvation, and temperature fluctuation. In addition, two types of mussel seed behaviour were tested for their potential for developing a commercially useful method for identifying seed mussels with high retention properties prior to seeding. The two behaviours were the ability of seed mussels to attach by byssus threads to the substrate in slow flowing water, and the ability of seed mussels to pedal walk vertically up through a substrate filled column. Of the three stressors tested only desiccation and starvation significantly reduced mussel seed retention compared to "unstressed" controls by 38% ($P<0.05$) and 42% ($P<0.05$) respectively. Of the two types of mussel seed behaviour used for attempting to sort seed mussels, only the ability of seed mussels to attach by byssus threads to the substrate in slow flowing water showed any sensitivity for identifying individuals with higher retention properties ($P<0.05$). Seed mussels that failed to byssal attach had a 23% lower mean retention, after 10 d experimental grow-out compared to seed that successfully attached. Although significant, this difference was relatively small and is unlikely to provide the basis for the development of a useful commercial seed mussel sorting method. Desiccation and starvation are both stressors that seed mussels are likely to experience during their commercial harvesting, transportation and seeding process. Consequently, seed mussels need to be relayed quickly and under moist conditions to reduce the potential for starvation and desiccation stress. Identifying seed mussels in poor nutritional condition and feeding them prior to seeding out on farms could also help to prevent the intermittent large scale seed mussel losses currently experienced. The application of these findings will assist in making more efficient use of the wild seed mussel resource and significantly lower financial losses to growers in New Zealand.

Keywords: Retention; Mussel; *Perna canaliculus*; Seeding; Quality; Fitness; Stressor

1. Introduction

The Greenshell™ mussel, *Perna canaliculus*, is extensively cultured in New Zealand and accounts for ~5% of global mussel production (Spencer, 2002),

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with export earnings in 2005 totalling around US$ 120 million. The industry is wholly reliant on wild caught seed, with around 20% caught on fibrous ropes suspended near mussel farms, and the majority supplied from the occasional strandings of macroalgae covered in mussel seed at a single locality in northern New Zealand (Hickman, 1976; Jeffs et al., 1999). Following collection, the seed mussels attached to the catching ropes or macroalgae are transported to mussel farms and seeded onto nursery longline ropes for ongrowing. Subsequent loss of seed mussels from the nursery ropes is generally high, in some instances the loss can exceed 95% and is typically more than 50% (Hayden, 1994a,b). This inefficient use of the wild seed resource makes the management of the nursery phase more costly, unpredictable and ultimately results in large production and financial losses. Consequently, there is a pressing need to identify the factors that cause poor retention following seeding so that they might be addressed to improve seed mussel retention. Improvements could also come from the development of a practical method to sort and remove seed mussels with poor retention properties prior to seeding.

Poor retention of seed mussels is thought to be due to the secondary settlement behaviour of this species, whereby seed mussels sever their byssus threads and secrete mucus strands that enable them to passively drift into new and potentially more favourable settlement locations (Buchanan and Babcock, 1997). The factors that trigger secondary settlement remain unclear, but it is likely that seed mussels exposed to a potential stressor, for example desiccation or starvation, may be highly motivated to initiate secondary settlement in an effort to escape the stressor. The converse is also equally plausible, a potential stressor may adversely impact on the physiological state of the seed to such an extent that secondary settlement is no longer possible.

The behavioural response of early juvenile bivalves has been used as a tool for assessing the quality, or fitness, of seed prior to ongrowing where a consistent link can be established between seed quality and either some behaviour (Maguire et al., 1999b,c; Rupp and Parsons, 2004), or the ability to withstand an acute stressor (Artiles et al., 1999, Hernandez et al., 2001; MacNiven and Little, 2001). Such a link can then be used as a predictive indictor of future performance in the culture system. For example, the recessing and righting speed of the juvenile scallop, *Pecten maximus*, is inversely correlated to a desiccation stressor (Maguire et al., 1999c), and byssal attachment is influenced by salinity and temperature stressors (Christophersen and Strand, 2003). Webb and Heasman (2005), also demonstrated that the activity of Greenshell™ seed mussels was affected by stressors, such as desiccation and exposure to ethanol in the laboratory, but did not relate this to retention of seed mussels following seeding onto nursery ropes. Furthermore, their method of assessing stress relied on detailed chemical staining and microscopic techniques which are impractical for application by a commercial farming operation, especially for small seed mussels which are typical for this industry.

The first aim of this study was to identify those stressors that may reduce seed mussel retention following seeding out. We selectively focused on the three stressors most likely to be encountered during seed mussel harvesting, transportation and seeding out process and have the potential to be easily controlled through improved handling procedures, i.e., starvation, rapid temperature fluctuation, and short-term desiccation. The second aim of the study was to establish a link between a behavioural trait and retention properties prior to seeding. To achieve this we focussed on two behaviours that have been previously observed in *P. canaliculus* seed mussels, byssal attachment behaviour and “walking” or crawling movements through repeated extension of the foot (Buchanan, 1994).

2. Materials and methods

2.1. Source of seed mussels and holding protocol

Experiments were performed at the Bream Bay Aquaculture Park in northern-eastern New Zealand and used wild seed mussels attached to drift seaweed that was collected by a commercial mussel seed harvester from nearby Ninety Mile Beach. The seaweed (10 kg), with attached seed mussels, was placed in 100 l conical holding tanks supplied with flow-through filtered (5 μm), seawater at ~4 ml min $^{-1}$ and vigorous aeration. Seed mussels were fed daily a mixture of microalgae (*Isochrysis galbana*, *Pavlova lutheri* and *Chaetoceros* spp.), from a stock algal solution of 3.2–10.1×10^{-5} cells ml^{-1} at the rate of 0.7 l h^{-1}. Three days after collection the seed mussels were removed from the seaweed and passed through a graded series of sieves to obtain seed mussels in the 0.5–2.0 mm size range. Seed mussels were then transferred to large cylindrical sieves that were housed in 100 l cylindrical holding tanks and left undisturbed for at least 3 d before use in experiments.