

JUVENILE PRODUCTION TRIALS 2008:

Effects of diet, density, and substrate

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INTRODUCTION

Newly settled king crabs are too small for any known method of physical tagging used on other species of juvenile crabs (e.g., coded wire tags, elastomer tags, Davis et al. 2004); therefore, further experimentation requires grow-out to a larger size. This study will test the suitability of various diets, stocking densities, and substrates using indoor rearing tanks as nurseries for mass culturing red king crab juveniles.

A major constraint involved in king crab grow out is cannibalism. Juvenile king crabs are highly cannibalistic, which potentially results in high rates of mortality when reared together. To prevent cannibalism, juvenile crabs could be isolated in individual cells to eliminate contact with one another. However, this system presents logistical constraints in a hatchery setting; large numbers of crabs in individual cells require a large amount of space for the holding system and a large amount of labor to feed and clean each cell. The gains made in survival rate may be lost in cost of labor (Zmora et al. 2005, O. Zmora, pers. comm.). Alternatively, complex substrate may be added to reduce encounter rates and reduce cannibalism (Zmora et al. 2005, Epelbaum and Borisov 2007). Red king crab juveniles prefer to settle on complex substrate of bryozoans and hydroids (Armstrong et al. 1985, Stevens 2003). To mimic this substrate in a hatchery situation and allow for ease of handling, we will use equal areas of “artificial seaweed,” biofilter material (Epelbaum pers. comm.), and gill net in each red king crab juvenile tank. Each artificial substrate increases available surface area and provides adequate structure for juveniles to avoid each other. Multiple substrates are being used to test which yields the highest survival of juvenile crab.

Juvenile king crab are benthic scavengers and have well developed feeding appendages adapted for processing both soft and hard food types (Epelbaum et al. 2006). King crabs eat a wide variety of food items including mollusks, crustaceans, fish, and detritus (Jewett and Feder 1982). The following hypotheses will be used to test for effects of stocking density, diet, and substrate:

H_{II0}: There will be no difference in survival of juvenile king crab when reared at a density of 500, 1000, 2000 crabs/m².

H_{IIa}: Survival differs among tanks at different densities.

H_{III0}: There will be no difference in survival of juvenile king crab when fed diets of Cyclopeeze™, frozen enriched Artemia, and commercial shrimp feed.

H_{IIIa}: Survival differs among tanks using different diets.

HIII₀: There will be no difference in survival of juvenile king crab when reared in the presence vs. absence of complex substrate.

HIII_a: Survival is higher in tanks with complex substrates.

METHODS

To determine the optimal conditions for raising juvenile crabs in a mass culture system, recently settled (C1) crabs from the larval density, diet, and production experiments will be collected, mixed randomly, and placed in containers (silos) at different densities. Half of the silos will contain substrate and half will contain no substrate. Each substrate-containing silo will have equal amounts of artificial seaweed, Anna's biofilter, and gill net (Fig. 1). The amount of substrate will be standardized for each silo. At the end of the experiment, numbers of crabs in each substrate type in each replicate will be counted to get an overall census of substrate preference.

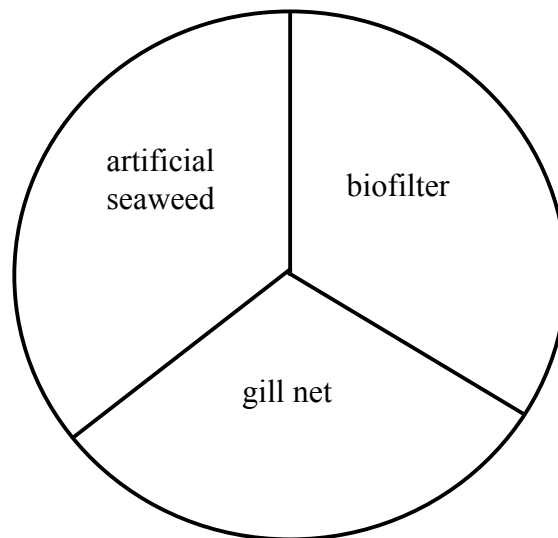


Fig. 1. Silo divided into three equal areas containing artificial seaweed, biofilter, and gill net as substrate.

Crabs will be fed a number of times per week (to be determined) depending on the feed type. The amount of food will be based on observed consumption rates (to be determined). Crabs will be fed to satiation with the goal being to avoid under feeding or over feeding. Crabs will be fed Cyclopeeze™, a commercially available frozen whole adult copepod approximately 800 µm in length reared in arctic lakes. This feed is high in carotenoids and other essential components of a juvenile king crab diet and is used in many aquaculture applications including crustacean larval rearing (Lieberman 2001). Other diets we propose to test include frozen enriched Artemia and commercial shrimp nursery feed (recommended by O. Zmora). Diet may be modified as juveniles grow larger.

The duration of the experiment will be 6 weeks (or determined otherwise) to determine overall survival of early juveniles for practical enhancement purposes. Survival and growth of juveniles will be assessed by counting and weighing (wet vs. dry: to be determined) the crabs at the start and end of the experiment. Difference in survival of juveniles between density treatments will be determined by ANOVA after 6 weeks (or to be determined).

Experimental containers: 60 silos (broodstock hatching bins) in 6 SS units (10 silos each)

Each silo is a cylindrical container with a mesh screen bottom with surface area of approximately 0.25 m^2 . When immersed in the SS tanks, each silo can be operated at a depth of up to about 20 cm, yielding a seawater volume of approximately 50 L per silo.

Each silo will have a small size mesh (100-300 μm) on bottom to allow water exchange but retain food. Silos are a reasonable container to deal with in terms of cleaning and managing crabs.

Once per week the crabs and substrate will be placed in a drop screen with larger mesh size (800-1000 μm) and rinsed with seawater with a cushion of water to get rid of old food and waste. Crabs and substrate will then be replaced in clean silos and fed.

3 components being tested: diet, density, substrate

Diets: frozen Cyclopeeze, frozen enriched Artemia, shrimp nursery feed

Density: $500/\text{m}^2$, $1000/\text{m}^2$, $2000/\text{m}^2$

Substrate: artificial seaweed, Anna's biofilter, gill net, no substrate

Units 1 and 2 are allocated for testing effects of Cyclopeeze as a diet. Units 3 and 4 are allocated for testing effects of shrimp feed as a diet. Units 5 and 6 are allocated for testing effects of frozen enriched Artemia as a diet. Diets must remain the same in each SS unit as water is shared from silo to silo within the SS unit. However, density and substrate treatments will be randomly assigned within the SS units to minimize pseudo-replication. Each treatment combination will have three replicates. Total C1s needed: 15,750.

Table 1. 18 treatment combinations using three diets (Cyclopeeze, shrimp feed, Artemia), three densities (500, 1000, 2000 /m²), and two substrates.

Treatment	Diet	Density #/m²	Substrate
1	Cyclopeeze	500	yes
2	Cyclopeeze	1000	yes
3	Cyclopeeze	2000	yes
4	Cyclopeeze	500	no
5	Cyclopeeze	1000	no
6	Cyclopeeze	2000	no
7	shrimp feed	500	yes
8	shrimp feed	1000	yes
9	shrimp feed	2000	yes
10	shrimp feed	500	no
11	shrimp feed	1000	no
12	shrimp feed	2000	no
13	Artemia	500	yes
14	Artemia	1000	yes
15	Artemia	2000	yes
16	Artemia	500	no
17	Artemia	1000	no
18	Artemia	2000	no

Unit 1

5		2	Diet: Cyclopeeze Density: 500, 1000, 2000/m ² Substrate: seaweed, biofilter, and gill net combined or none
2		6	
6		1	
4			
1		5	

Unit 2

3		6	Diet: Cyclopeeze Density: 500, 1000, 2000/m ² Substrate: seaweed, biofilter, and gill net combined or none
1		4	
4		5	
2		3	
3			

Unit 3

11		8	Diet: shrimp nursery feed Density: 500, 1000, 2000/m ² Substrate: seaweed, biofilter, and gill net combined or none
8		7	
12		9	
10		12	
7			

Unit 4

		9	Diet: shrimp nursery feed Density: 500, 1000, 2000/m ² Substrate: seaweed, biofilter, and gill net combined or none
9		10	
7		8	
10		11	
12		11	

Unit 5

14		14	Diet: Artemia Density: 500, 1000, 2000/m ² Substrate: seaweed, biofilter, and gill net combined or none
16		18	
17		15	
17			
16		18	

Unit 6

15		18	Diet: Artemia Density: 500, 1000, 2000/m ² Substrate: seaweed, biofilter, and gill net combined or none
15		17	
13		16	
14		13	
		13	

Fig. 2. Experimental SS units. Units 1 and 2 are allocated for testing effects of Cyclopeeze, 3 and 4 are allocated for shrimp feed, and 5 and 6 are allocated for frozen enriched Artemia as a diet. Density and substrate treatments are randomly assigned within the SS units. Numbers indicate treatments (see Table 1).

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