Investigation of Ark Clam Culture and Marketability

PROJECT TEAM INVESTIGATORS: Leslie Sturmer, Jose Nunez, LeRoy Creswell, Shirley Baker University of Florida, Institute of Food & Agricultural Sciences Robert Degner, Kimberly Morgan University of Florida, Agricultural Market Research Center Alan Power, Randal Walker University of Georgia, Marine Extension Service John Baldwin, Larry Nissmen Florida Atlantic University, Dept. Biological Sciences FUNDED BY: USDA CSREES and Florida Sea Grant

FLORIDA IFAS









Rationale

- Clam farming in Florida supports small businesses
 - Over 350 growers in 10 coastal counties
 - 1800 acres in leases
 - \$13M in sales value
 - 92 shellfish wholesalers
- However, it is a monoculture industry
- Need for diversification from a single species
 - Augment profit potential
 - Spread production risks



Rationale

- Alternative species for aquaculture consideration
 - Native molluscan species
 - Cultured and marketed similar to hard clam, Mercenaria mercenaria
- Sea Grant-funded research has evaluated the suitability of several mollusk species
 - Angel wing, 1990-2
 - Bay scallop, 1997-9
 - Sunray venus, 2006-8







Rationale

- Ark clams harvested in mid-Atlantic states (VA, NC) in limited quantities
- Development of a major fishery for these species restricted by
 - Dispersed wild populations
 - Minimum understanding of reproduction
 - Small, isolated ethnic markets
- Research efforts in Virginia during 1990s concluded slow growth of arks limit aquaculture potential
- Natural recruitment of arks into newlyplanted clam bags supported hypothesis that arks may have potential for commercial development in Florida



Ponderous ark Noetia ponderosa



Reproductive Patterns

- Determine gametogenic cycles of blood ark off Florida's east coast (2002-3) and ponderous ark off Florida's west coast (2001-3)
 - Histologic analysis of gonadal tissue
 - Monthly gonadal index values
 - Peak spawning periods
 - Sex ratios





Findings published

- Power, A.J., J. Nunez, M. Mitchell, R. Walker and L. Sturmer. 2004. Reproductive pattern of the blood ark, Anadara ovalis, from the northeast coast of Florida. *J. Shellfish Research* 23 (1): 173-178.
- Power, A.J., L. Sturmer, C. Lucas, R.L. Walker and J. Manley.
 2005. Gametogenic cycle of the ponderous ark, *Noetia ponderosa* from Cedar Key, Florida. *J. Shellfish Research* 24 (1): 69-73.

Alan Power, UG

Reproductive Patterns

- Dribble spawning reproductive strategy for both ark clams
- Prolonged spawning over most of year with bimodal peaks





Ark	Sexes	Sex Ratio (M/F)	Reproductive Pattern
Blood	Dioecious, 2% hermaphrodites	2.68 / 1	Major peak during late spring-early summer months (45% ripe in May). No activity in summer. Minor peak during winter (21% ripe in December). Spawning seen in all months.
Ponderous	Dioecious, no hermaphrodites	1.19 / 1	Ripens rapidly during the spring, peaks in summer and fall months. However, spawning noted year round.

Seed Production

 Set-up experimental molluscan shellfish hatchery and nursery at UF Whitney Lab near Saint Augustine





Micah Alo, UF

Jose Nunez, UF

- Conduct spawning, larval rearing and setting trials
- Develop ark seed production techniques
- Compare with standard hard clam protocols

Spawning

- Wild ark clams were sourced from different sites
- Broodstock were conditioned at lab
- Spawning induced by temperature cycling from 20 to 30°C
- Spawning behavior like hard clam
- Serotonin injection not successful





Spawning Trials, 2002-5

Ark	# Trials	% Spawns	Spawns per month (%)	Fecundity (# eggs /)	Fertilization Rates (%)
Blood	29	38	March10 April 36 May 10 June 19 July 10	0.7 – 3.9 million	low – 55%
Ponderous	51	20	August 10 September - 30 October 10 November 10	1.5 – 3.5 million	low – 79%

- Fertilized eggs
 - Color: orange to reddish
 - Size:
 - Blood: 55 μm
 - Ponderous: 65 μm
 - Hard clam: 70 µm



Embryonic Development

Blood Ark



Fertilization 0 minutes



First cleavage 1 hour



Blastula 4-5 hours



Gastrula 7-8 hours

Ponderous Ark



Fertilization 0 minutes



First cleavage 1 hour



Blastula 5 hours



Gastrula 8-9 hours

Documented using light and fluorescence microscopy

Embryonic Development

Blood Ark

Ponderous Ark

D-shape veliger, 19-21 hours



D-shape veliger 21 hours



Hard Clam

D-shape veliger 24 hours

- Differences in timing of development between ark clams were negligible
- Behavior and developmental timeline of ark clams similar to hard clam
- Documentation of protocol and reference for commercial hatchery development

Larval Rearing

Species	Day	Stage	Larval Size (µm)	Screen size (μm)	# per ml	Survival %
Hard Clam	1	D-shape	105 x 90	34	6.9	100
	9	Setting	225 x 215	100	2.7	<u>39</u>
Blood Ark	1	D-shape	80 x 65	34	4.3	100
	9	Veliger	115 x 110	54	0.5	12
	17	Setting	275 x 200	110	0.2	5
Ponderous Ark	1 9 21	D-shape Veliger Setting	90 x 70 130 x 100 211 x 155	34 54 110	2.4 1.7 0.6	100 71 25

Setting and Post-set

- Setting was problematic
- No distinct pediveliger stage
- Setting based on behavior (probing the tank bottom) and size (>200 µm)
- Experiments conducted to evaluate cues on settlement
 - Physical (substrates sand, mud; poly strands) cues – 0% set
 - Chemical (H₂O₂, KCl, exudate, norepinepherin) cues – 0% set
 - Biological (algal species) cues
 - T-Iso, Pav, Ch, BG, no food 0% set
 - Benthic algae (<35 µm) 74% set within 7 days</p>



Land-based Rearing

- Post-set rearing in downwellers
 - Tendency to crawl out of tanks
 - Attach to tanks and other arks with byssal threads
 - Growth rates
 - Blood: 6-12 days to 1 mm
 - Ponderous: 49-56 days to 1 mm
- Land-based nursing in downwellers
 - Sieving difficult
 - Growth rates
 - Blood: 3-4 months
 to 14-15 mm SL (3.5-4.3 mm/mo)
 - Ponderous: 6 months to 19 mm SL (3.2 mm/mo)







Blood Ark Culture

- Conduct field nursery and growout rearing trials in St. Augustine (east coast of Florida), 2003-4
- Document growth and survival in soft (polyester) bags and hard (polyethylene) culture bags





Blood Ark Shell Length



- From 14 mm to 34-35 mm (1.4") SL in 11 months (1.9 mm/mo)
- No differences in bag types

Blood Ark Shell Width



- From 7 mm to 22-23 mm (0.9") SW in 11 months (1.4 mm/mo)
- No differences in bag type

Blood Ark Survival



66% survival in nursery (2 months), 80-93% survival in growout (9 months)

Overall survival of 61% in hard bag and 53% in soft bag (11 months)



Ponderous Ark Culture

- Conduct field nursery and growout trials in Cedar Key (west coast of Florida), 2004-6
- Document growth and survival in hard (polyethylene) culture bags





Ponderous Ark Length and Width



From 19 mm to 44 mm (1 ³/₄") SL in 24 months (1 mm/mo)

From 11 mm to 30 mm (1 ¼") SW in 24 months (0.8 mm/mo)

Ponderous Ark Weight



From 2 grams to 31 grams whole weight (14 per pound) in 24 months

Ponderous Ark Survival



• 76% survival in nursery (6 months), 72% survival in growout (18 months)

Overall survival of 62% through Dec 05, or 55% through Jun 06



Shell Length to Width Ratio: 1.5-Blood Ark, 1.4-Ponderous Ark, 1.9-Hard Clam



Ark Clam Marketability

- Assess magnitude of potential domestic market for ark clams, 2003
 - Over 2,100 shellfish wholesalers surveyed nationwide
 - 309 respondents, or 15%
 - Survey results revealed limited trade awareness
 - Over 90% wholesalers unfamiliar with them
 - Only 1% reported selling ark clams in previous year
- Nearly one-third were willing to evaluate product samples of both species

Ark Clam Marketability

- Determine desired product attributes and evaluate sensory attributes, 2003-4
 - 82 interested dealers received live samples and questionnaire
- Evaluate a number of basic product characteristics – appearance, taste, aroma, and textural properties
 - 52 provided useful evaluations, or 63%
- Estimate potential sales through respective firms



Marketability

- Appearance evaluations were mediocre
 - Rating of 5 on 0 to 10 scale
 - Negative comments on black color, "fuzzy and "furry" shell
- Meat Color evaluations fared worse
 - 4.2 rating for blood
 - 3.6 rating for ponderous
 - Negative comments on bloody appearance
- Texture was "slightly" to "much too tough"
- Taste ratings were under
 5 if eaten raw and about
 5 is eaten cooked





Ark Clam Marketability

- Sales projections for arks
 - 50-60% of respondents could not sell
 - 20% did not know if they could
 - 11 firms, or 21%, estimated sales of 30 to 170,00 blood arks per week
 - 8 firms, or 14%, estimated sales of 30 to 120,000 ponderous arks per week
- Wholesale prices ranged from \$0.18-0.25 per ark clam
- Preferable sizes ranged from 1-1.25" shell width
- Current sellers noted inadequate supplies appear to limit market growth
- Current market is limited
- Widespread lack of familiarity



Blood Ark – 99% survival in refrigerated storage after 9 days, 88% after 15 days
Ponderous Ark – 99% survival in refrigerated storage after 23 days

Ark Clam Nutritional Composition

- Nutritional facts and labeling for cultured ark clams were determined for serving size of 100 grams of edible portion
 - Low in calories, fat, cholesterol
 - No carbohydrate
 - High in protein
 - High in sodium
 - High in iron (50-70% of daily value)

In comparison, hard clams

- Higher in calories
- Similar in fats, cholesterol, and carbohydrate
- Less sodium
- 1/2 to 1/3 daily values for iron

Nutri	tion	Fa	cts		N
Serving Size	1	Servir			
Servings Per Container					Servi
Amount Per S	Serving			!	lmou
Calories 3	5 Cali	ories fr	om Fat 5		Calo
		🖌 Dail	y Value*		
Total Fat O	.5g		1%	1	Fota
Saturated F	at Og		0 %		Sat
Cholestera	l 35mg		12 %	Ī	Chol
Sodium 74	Omg		J1 %		Sodi
Total Carb	o hyd rat	t e Og	0 %	ī	lota
Dietary Fib	er less th	an 1 g	ram 4 %		Die
Sugars Og					Sug
Protein /g				I	Prot
Vitamin A 6%		Vitarr	nin C 2%		vitam
Calcium 6%	•	Iron 7	70%	Ī	Calci
Percent Dally ∨ calorie diet. Your or lower dependir	álues are b r daily ivalu ng on your (ased on : es may b calorie ne	a 2,000 be higher seds:		'Percei xalorie or lowe
	Calories:	2,000	2,500		Frend F
Saturated Fat	Less than	60g 20a	80g 26a		iotal Fi Satura
Cholesterol	Less than	300mg	20g 300mg		Choles
Sodium	Less than	2,400mg	2,400mg	1	Sodium
Total Carbohydra Dietary Fiber	ste	000g 26g	075g 30g	I	fotal C Dietar
Calories per gran Fal 9 • Ca	n: arbohydrate	4 • Pro	tein 4	Ī	Calorie F

Nutrition Facts

Berving Size (100g) Servings Per Container

nt Per Serving ries 50 -Calories from Fat 5 % Daily Value* i**l Fat** 1d 1% urated Fat Og 0% esterol 55mg 18% **um** 480mg 20 % 0% **i Carbohydrate** 1g tary Fiber less than 1 gram 4 % gars Do ein 11g nin A 6%. Vitamin C 4% um 10% Iron 50% ٠ nt Daily Values are based on a 2,000 diet. Your daily values may be higher er depending on your calorie needs: Calories: 2.000 2.500 Less than 65a 8Ûa ated Fat Less than 20g 25a Less than 300mg = 300mg Less than 2,400mg 2,400mg arbohydrate 300g 375g ry Fiber 26g 3Ug s per gram: at 9 • Carbolnydrate 4 • Protein 4

Blood Ark

Ponderous Ark

Ark Clam Market Information

Complete Market Report can be found on the UF/IFAS Florida Agricultural Market Research Center's website:

http://www.agmarketing.ifas.ufl.edu,

first click on "Publications," then click on "Marketing Research Publications 2000+"







Summaries of Phase I, II, III of the marketing assessment can be found at the UF/IFAS Electronic Data Information Source (EDIS) website: <u>http://edis.ifas.ufl.edu</u>, click on EDIS pub FE478 and FE568.



Ark Clam Summary

- Seed can be produced using standard hard clam techniques
- Most likely higher seed costs
 - Lower larval survival
 - Longer larval period
 - Blood 17 days
 - Ponderous 21 days
 - Hard clam 9 to 12 days
 - Need to optimize survival at settlement



Ark Clam Summary

- Land-based nursing, field nursing and growout can be conducted using equipment and methods for hard clams
 - Survival commercially acceptable in field
 - Blood 57%
 - Ponderous 62%
 - Hard Clam 56 to 64%





- Crop period from 1 mm SL to 25 mm SW ("littleneck"-size)
 - Blood 16 mo
 - Ponderous 24 mo
 - Hard Clam 18 to 24 mo



Ark Clam Summary

- Unlikely to be a widespread, mainstream demand for ark clams
- Market development proponents should recognize importance of ethnic markets in target locations on East and West coasts
- Targeting seafood dealers with large Asian ("akagai") and Hispanic ("pata de mula") populations could result in profitable niche markets