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THE EFFECT OF SALINITY ON SPAWNING FREQUENCY OF *PENAEUS SETIFERUS* IN AQUARIA

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ABSTRACT *Penaeus setiferus* were matured and spawned in a small 120 L tank system in the absence of males. No significant differences in the number of shrimp that spawned or the time required to spawn were detected for shrimp held at salinities of 20, 25 or 30 ppt in either natural or artificial seawater. The earliest that spawning occurred was an average of 17 days past ablation and as late as 28 days past ablation. None of the shrimp held in artificial seawater at 20 and 25 ppt spawned in the same molt cycle in which they were ablated, while one third of the shrimp held in natural seawater did.

Introduction

Interest in culture of marine shrimp has increased dramatically in the last decade. In 1980, 2% of the world's shrimp were farmed in ponds. In 1991, farmed shrimp provided 28% of the world's shrimp supply. The major limiting factor to further development is the hatchery production of postlarvae or seed (Rosenberry 1991). The production of seed by controlled sexual maturation of captive broodstock has been possible for marine shrimp since 1975. Experimental data on penaeid shrimp maturation and reproduction have been reviewed by Muthu and Laxminarayana (1982), Primavera (1985), Chamberlain (1985), Bray and Lawrence (1992), and Browdy (1992). Conditions representing the "industry standard" for maturation of *Penaeus vannamei* from commercial facilities have been documented by Ogle (1991a). It is the general recommendation of those reviews that clear, clean, ocean seawater of 28-32 ppt be utilized for maturation. Few sites can provide these conditions, compelling more than half of the maturation facilities to use some percentage of recirculation (Ogle 1991a). The salinity of the natural seawater available to the Gulf Coast Research Laboratory is generally much lower than the 28-32 ppt recommended for maturation. Therefore, the addition of artificial salts to the natural seawater is often required (Ogle 1992).

In an attempt to experimentally determine the salinity requirements for maturation and spawning of *P. setiferus*, the following study was conducted.

Materials and Methods

A small tank maturation system as described by Ogle (1991b) was utilized. Six systems containing six aquaria each with a volume of 120 L were utilized. Three systems contained natural seawater and three systems contained artificial seawater. Salinities of 20, 25 and 30 ppt were tested with both natural and artificial seawater. Bay water from Davis Bayou in Ocean Springs, Mississippi with a salinity of 25 ppt was heated to 80°C to achieve a 30 ppt salinity through evaporation for use in the three natural seawater systems. This water was then adjusted with well water as required to achieve test salinities. For the artificial seawater systems, Marine Environment (San Francisco, California) artificial sea salt was dissolved in well water and adjusted to the required test salinities.

Female shrimp collected from the wild were held at 30 ppt and 28°C until they had achieved a minimum size of 30 g before being individually placed in an aquarium in one of the six systems. The shrimp placed in the aquaria system had never been matured. Animals were held at 28°C, exposed to a 14L:10D photoperiod and fed a shrimp grower ration (Zeigler, Gardners, Pennsylvania) until they molted.

After molting, the diet was changed to frozen Maine bloodworms, squid and an artificial maturation pellet (Rangen, Buhal, Idaho). Animals were fed three times daily and water temperature and salinity were recorded. Tanks were cleaned daily by siphoning debris from the bottom of the aquaria. Five days after molting, animals were unilaterally ablated by eyestalk enuculation. Egg collectors were placed on tanks containing ablated animals and checked daily. Subsequent molts and time to spawning were recorded. If the animals failed to spawn after four molt cycles, they were discarded. After spawning, animals were replaced with other shrimp from the holding system. As many as 14 shrimp and as few as 7 shrimp were used in the six systems. For each female, the number of days past ablation until the time of spawning was recorded. This data from each system was analyzed using ANOVA. The percent spawning was analyzed using a G-test.

Results

There were no significant differences in the number of animals that spawned or the time required to spawn between *P. setiferus* at each of the salinities 20, 25 or 30 in either the natural or artificial seawater. The fewest spawns were recorded for animals held at 25 ppt, while the most spawns recorded occurred at 20 ppt; both were natural seawaters (Table 1). Highest mortality was recorded for animals held in 20 ppt artificial seawater and least mortality for animals held in 30 ppt natural seawater. The earliest spawning occurred seven days past ablation in 20 ppt natural seawater. The latest spawning occurred 58 days past ablation in artificial seawater of 25 ppt. In two of the systems containing natural seawater at 20 ppt, the average days past ablation was 17, while at 25 ppt the average days past ablation was 28. Even though it appears that best results were obtained for 20 ppt natural and 30 ppt artificial waters, the results were not significantly different. No shrimp in the artificial water with salinities of 20 and 25 ppt spawned during the same molt cycle in which they were ablated. In comparison, 33% and 38% of the shrimp in the natural seawater of 20 and 25 ppt spawned during the same molt cycle in which they were ablated, respectively.

TABLE 1

Effect of Salinity on Maturation and Spawning of *P. setiferus* in Aquaria

Seawater Type	Salinity ppt	Spawn %	No Spawn %	Dead %	SPAWN Number	Molt Cycle % 1st	2nd	3rd	Average Days Past Ablation	SE
	20	46	28	36	11	0	80	20	27	7.2
Artificial	25	64	14	22	14	0	56	44	24	4.26
	30	50	30	20	10	20	60	20	19	3.74
	20	73	9	18	11	38	38	24	17	4.48
Natural	25	43	43	14	7	33	33	33	28	5.70
	30	54	36	10	11	17	50	33	22	4.16

Spawns in the same molt cycle as ablation are 1st molt cycle.

DISCUSSION

P. setiferus are thought to spawn in 60 feet of water offshore in Louisiana during May and June when salinities are 34-36 ppt (Lindner and Anderson 1956). Joyce and Eldred (1966) reported the spawning of *P. setiferus* inshore at or near inlets. Bray, *et al.* (1982) caught large numbers of mated *P. setiferus* off Port Aransas, Texas at a salinity of 34 ppt. Marifarms operated with mated females fished from Apalachicola Bay, Florida, but no salinities were reported. Continental Sea Farms, a maturation facility in Florida, utilized water collected at 22-28 ppt and adjusted to 28 ppt salinity. Other reported salinities for maturation of *P. setiferus* are 30.5 to 37.1 ppt, Johnson and Fielding (1956); 44 ppt, Conte, *et al.* (1977); 22 to 30 ppt, Brown, *et al.* (1979); 24 to 29 ppt, Lawrence *et al.* (1980); 30 to 36 ppt, Chamberlain (1988); and 25 to 32 ppt with an average of 26.9 ppt, Browdy and Sandifer (1991).

The results reported here are encouraging and demonstrate that *P. setiferus* can be artificially induced to mature and spawn in lower salinity and artificial seawaters. This may allow production of *P. setiferus* in areas of low salinity and will provide a savings for those facilities utilizing artificial seawater. Further research should be conducted to determine the discrete effects of salinity on mating and egg viability.

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LITERATURE CITED

Bray, W.A., G.W. Chamberlain and A.L. Lawrence. 1982. Increased larval production of *Penaeus setiferus* by artificial insemination during sourcing cruises. *J. World Maricul. Soc.* 13:123-133.

Bray, W.A. and A.L. Lawrence. 1992. Reproduction of *Penaeus* species in captivity. Chapter 5, pp. 93-169. In: A. Fast and L.J. Lester (eds.). *Marine Shrimp Culture: Principles and Practices*. Elsevier. 1992.

Browdy, C. 1992. A review of the reproductive biology of *Penaeus* species: Perspectives on controlled shrimp maturation systems for high quality nauplii production. Pp. 22-51. In: J. Wyban (ed.). *Proc. Special Session on Shrimp Farming*. World Aquacul. Soc., Baton Rouge, Louisiana. 301 pp.

Browdy, C.L. and P.A. Sandifer. 1991. Individual institutional progress reports - Waddell Mariculture Center. U.S. Marine Shrimp Farming Program Progress Report, Vol. 1. CSRS U.S. Dept. Agriculture. pp. 34-57.

Brown, Jr., A., J. McVey, B.S. Middleditch and A.L. Lawrence. 1979. Maturation of white shrimp (*Penaeus setiferus*) in captivity. *Proc. World Maricul. Soc.*10:435-444.

Chamberlain, G.W. 1985. Biology and control of shrimp reproduction. In: G.W. Chamberlain, M.G. Haby and R.J. Miget (eds.). *Texas Shrimp Farming Manual*. Texas Agricultural Extension Service publication of invited papers presented at the Texas Shrimp Farming Workshop. 19-20 Nov. 1985, Corpus Christi, Texas, III1-III41.

Chamberlain, G.W. 1988. Stepwise investigation of environmental and nutritional requirements for reproduction of penaeid shrimp. Ph.D. dissertation. Texas A&M Univ. 210 pp.

Conte, F.S., M.J. Duronslet, W.H. Clark and J.C. Parker. 1977. Maturation of *Penaeus stylirostris* (Stempson) and *Penaeus setiferus* (Linn.) in hypersaline water near Corpus Christi, Texas. *Proc. World Maricul. Soc.* 8:327-334.

Johnson, M.C. and J.R. Fielding. 1956. Propagation of the white shrimp (*Penaeus setiferus*) in captivity. *Tulane Studies in Zool.* 4:175-190.

Joyce, Jr., E.A. and B. Eldred. 1966. The Florida shrimping industry. Florida Bd. Conserv., Educ. Ser. No. 15. 47 pp.

Lawrence, A.L.; Y. Akamine; B.S. Middleditch; G. Chamberlain and D. Hutchins. 1980. Maturation and reproduction of Penaeus setiferus in captivity. *Proc. World Maricul. Soc.* 11:481-487.

Lindner, M.J. and W.W. Anderson. 1956. Growth, migrations, spawning and size distribution of shrimp *Penaeus setiferus*. Fish. Bull. 106 from Fish. Bull., U.S. Fish and Wildlife Service, vol. 56, 645 pp.

Muthu, M.S. and A. Laxminarayana. 1982. Induced maturation of penaeid prawns - a review. *Proc. Symp. Coastal Aquacul.* Part 1, Prawn Culture. Mar. Biol. Assn. India, pp. 16-27.

Ogle, J.T. 1991a. Maturation of *Penaeus vannamei* based upon a survey. *Gulf Res. Rept.* 8(3):295-297.

Ogle, J.T. 1991b. Design and operation of a small tank system for ovarian maturation and spawning of *Penaeus vannamei*. *Gulf Res. Rept.* 8(3):285-289.

Ogle, 1992. Design and operation of the Gulf Coast Research Laboratory penaeid shrimp maturation facility I. *Penaeus vannamei*. Gulf Coast Res. Lab. Tech. Rept. No. 4. 41 pp.

Primavera, J.H. 1985. A review of maturation and reproduction in closed thelycum penaeids. In: Y. Taki, J.H. Primavera and J.A. Llobrera (eds.). *Proc. 1st Internat. Conf. on the Culture of Penaeid Prawns/Shrimps*. SEAFDEC, Iloilo City, Philippines, pp. 47-64.

Rosenberry, B. 1991. World Shrimp Farming 1991. Aquaculture Digest. 9434 Kearny Mesa Road, San Diego, California.