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Pond Culture of *Penaeus semisulcatus* and *Marsupenaeus japonicus* (Decapoda, Penaeidae) on the West coast of Turkey

Gürel Türkmen[1, *]
[1] Ege University, Faculty of Fisheries, Department of Aquaculture, 35100, Bornova-İzmir, Turkey.

* Corresponding Author: Tel.: +90. 232 3884000-1295; Fax: +90. 232 3883685;
E-mail: gurel.turkmen@ege.edu.tr

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Abstract

Postlarvae of *Penaeus semisulcatus* and *Marsupenaeus japonicus* were grown for 150 days at a stocking density of 15 shrimps/m^2 on the west coast of Turkey. At the end of the culture period, *P. semisulcatus* and *M. japonicus* reached to mean weights of 16.46 g and 7.05 g, respectively. Final yield and survival for *P. semisulcatus* were 1950 kg/ha and 79%, while these figures for *M. japonicus* were 655 kg/ha and 62%. The FCR was 2.42 for *P. semisulcatus* and 3.50 for *M. japonicus*. The result indicated that *P. semisulcatus* had better growth performance, final yields and survival rates.

Key Words: *Penaeus semisulcatus*, *Marsupenaeus japonicus*, grow-out, inland water, fauna, Aegean Sea, Turkey.

Introduction

Shrimp culture in Turkey dates back to the early 1990s on the southern Mediterranean coast of Turkey. Green tiger shrimp (*Penaeus semisulcatus*) was first farmed in 1994 on a trial basis in extensive earthen ponds in the south-eastern Mediterranean region (Adana). Later on, *P. semisulcatus*, Japanese kuruma shrimp (*Marsupenaeus japonicus*) and giant tiger shrimp (*Penaeus monodon*) were farmed at semi-intensive system between 1995-1998 in western Mediterranean region, Antalya (Türkmen, 2001). However, the results of these commercial farms have not been reported anywhere. *M. japonicus* is an important Indo-West Pacific species and it has migrated through the Suez Canal into the Mediterranean Sea and is now caught off southern Turkey (Dore and Frimodt, 1987). *P. semisulcatus* is an Indo-Pacific species distributed along the coast of the eastern Mediterranean and is one of the most important commercial species in this part of the world (Kumlu *et al*., 2003). Whereas shrimp-farming studies on *P. semisulcatus* or *M. japonicus* in the Mediterranean countries mainly in Israel and Italy are well documented (Samocha and Lewinsohn, 1977; Issar *et al*., 1987; Seidman and Issar, 1988; Canese *et al*., 1990; Lumare *et al*., 1999; Lumare *et al*., 2000), only a limited number of studies related to pond culture of these species have been carried out in Turkey (Türkmen, 2000; Kumlu *et al*., 2003; Türkmen, 2005).

Türkmen (2000) reported the growth of *M. japonicus* at different stocking rates in Antalya. The grow-out practise of *P. semisulcatus* was carried out in semi-intensive and intensive condition in 2001 in Adana, and their result was reported by Kumlu *et al*. (2003). In 2002, *P. semisulcatus* and *M. japonicus* were cultured in experimental small size ponds (100 m^2) in İzmir, western part of Turkey (Türkmen, 2005). The purpose of this study was to obtain growth results at a commercial level from *P. semisulcatus* and *M. japonicus* at semi-intensive (15 PL/m^2) stocking densities under climatic conditions of the Aegean Sea region.

Materials and Methods

The study was carried out in 2003 and 2004 in a private marine fish farm (Pınar Sea Products) in İzmir, located on the western coast of Turkey. First trial was carried out with *P. semisulcatus* between June 11 and November 8, 2003, whereas second trial was run with *M. japonicus* between June 13 and November 10, 2004. Brood stocks were obtained from Antalya and transferred to the farm hatchery. They were kept in a 10-t fibreglass tank and spawned in 1-t tanks at salinity of 37 ppt and temperature of 28°C. The larvae were fed on *Isochrysis galbana* and newly hatched *Artemia* nauplii until the early postlarvae (PL) stages. A granulated feed (INVE Aquaculture Nutrition, Belgium) containing 56% protein was given between PL5 and PL25 stages.

The pond (1000 m^2) was filled up with filtered seawater at a salinity of 37 ppt. Seawater was supplied from a shallow seaside well. The inlet and outlet of the pond were screened with 0.5 and 1.0 mm mesh size net, respectively, in order to prevent the entry of predators and the escape of shrimp from the pond. Urea (50 kg/ha) and TSP (Triple Super Phosphate) (5 kg/ha) were applied to stimulate phytoplankton growth and to maintain adequate transparency. Paddlewheel (1 HP) was operated nightly (18:00 – 06:00) to maintain DO levels above 4.0 mg/L. Postlarvae (PL25) were stocked at 15

PL/m^2 in both trials. Prior to stocking, postlarval quality was checked for their morphological appearances. The mean stocking weight (0.02 g and 0.03 g for *M. japonicus* and *P. semisulcatus*, respectively) was determined from three samples of 30 PL weighed in lots. Shrimps were fed with commercial pelleted feeds (sea bream) containing 45% protein (Pınar A.Ş. İzmir, Turkey) at rates ranging from a maximum of 15% of the culture biomass at the beginning and to minimum of 2.5% at the end of culture. And feeding frequency was changed from 4 to 1 times daily. Feeding rate was calculated on theoretically decreasing survival rates. Samples were taken by using a lift-net ('ancho': 1.0 m X 1.0 m square tray, located at the bottom of pond, which could be lifted by rope) every 15 days. To determine mean weight, minimum 30 individuals were weighed to nearest 0.01 by using an electronic balance (SCALTEC, SAS 50 Model). Shrimp were returned to the pond after weighing.

Water quality parameters of pond water, e.g., dissolved oxygen (HANNA, HI 9143) and temperature were recorded twice a day (08:00 h and 16:00 h); pH (HANNA, HI 8314) and turbidity were measured once a day at 16:00 h, and salinity was recorded weekly. With the exception of replenishing water loss through evaporation, there was little discharge or replacement of the pond water during the first month of the cultivating cycle. Water exchange rates were 5-20% daily between second month and fifth month. After 150 days of rearing, shrimp were harvested by total draining and handpicking from the pond bottom. A hundred shrimp were randomly chosen to weight. The rest were counted and weighed in bulk. The weight increase as described as Specific Growth Rate (SGR; Arnesen *et al*., 1994) according to the following equation: $SGR = [(\ln P_2 - \ln P_1) / (t_2 - t_1)] \times 100$ where P_1 and P_2 are shrimp weights at the start and completion of a growth period, respectively; and t_1 and t_2 is the time, in days, between weigthings.

Results

Temperature, dissolved oxygen, salinity, pH and turbidity readings for the same pond, which is used for both trials at succeeding years were almost the same (Table 1). Water quality parameters, excluding salinity, were generally suitable for growth of penaeid shrimps. Salinity increased from 37 ppt to 42 ppt even 43 ppt in the last week of August and thereafter fluctuated between 42 ppt and 40 ppt during September and decreased to 38 ppt during the remaining period.

Penaeus semisulcatus

The culture of *P. semisulcatus* yielded 1950 kg/ha and obtained 79% survival rate. FCR ranged between 0.32 and 4.74 (mean = 2.42) (Table 2). The PLs, with a mean daily growth rate of 0.109 g, grew linearly from 0.03 g to average final weight 16.46 g for the 150-d period (Figure 1). Daily growth rate was low during the first month (0.054-0.060 g day^{-1}), during which water temperature ranged from 24.5 to 26.5°C. Daily growth rate increased thereafter (0.140-0.230 g day^{-1}) when water temperature remained between 27.5 and 30.5°C. SGR was the highest (22.29% day^{-1}) during the first period of 15 days, then dropped dramatically to 4.81% day^{-1} and to the lowest (0.46% day^{-1}) towards the end of the culture period (Figure 1, Table 2).

Marsupenaeus japonicus

Final yield and survival obtained from *M. japonicus* were 655 kg/ha and 62%. FCR ranged between 0.47 and 7.04 (mean = 3.50). Mean weight increased from 0.02 g to 7.05 g at the end the growth trial. Average daily growth rate was calculated as 0.046 g/day. SGR was the highest (20.29% day^{-1}) during the first 15 days and dropped dramatically to 0.46% day^{-1} towards the end of growth period (Figure 2, Table 3).

Discussion

Water quality parameters, except salinity, measured in both trials were adequate for shrimp farming (Stirling and Phillips, 1990). Salinity ranged from 37 ppt to 43 ppt during the present study. For good growth and survival, Lumare (1998) reported 38-41 ppt and 28-32°C for *P. semisulcatus* and 20-35 ppt and 22-30°C for *M. japonicus*. Salinity preference for *P. semisulcatus* was reported to be greater than 40

Table 1. A summary of the water quality parameters in the study

	P. semisulcatus			*M. japonicus*		
	Mean±SD	Min.	Max.	Mean±SD	Min.	Max.
Temperature 08:00 (°C)	25.0±0.22	18.9	28.5	25.1±0.23	18.6	29.0
Temperature 16:00 (°C)	27.9±0.31	20.3	32.5	28.1±0.27	20.4	33.2
Dissolved oxygen 08:00 (mg/L)	5.9±0.09	4.2	7.1	5.6±0.11	3.8	6.3
Dissolved oxygen 16:00 (mg/L)	9.5±0.07	6.8	11.5	8.8±0.13	6.2	11.1
Salinity (ppt)	39.7±0.33	37	42	40.1±0.34	37	43
pH	8.2±0.01	7.7	8.8	8.2±0.01	7.5	8.5
Turbidity (cm)	42.8±1.27	20	90	48.2±1.45	20	90

Table 2. Results of *P. semisulcatus* grown in earthen grow-out pond in İzmir, Turkey

Days	Feeding Rate (%)	Weight (g)	Estimated Survival Rate (%)	Growth Rate (g day^{-1})	Food Consumption (kg)	FCR	SGR (% day^{-1})
0	15	0.03	97	0.054	3.780	0.32	22.29
15	10	0.85	94	0.060	16.130	1.27	4.81
30	8	1.75	91	0.066	23.480	1.73	3.01
45	6	2.75	89	0.140	39.880	1.42	3.78
60	5.8	4.85	87	0.158	63.240	2.04	2.65
75	5.4	7.22	85	0.150	73.220	2.55	1.81
90	5	9.48	83	0.230	93.560	2.17	2.07
105	4	12.94	81	0.089	71.120	4.38	0.65
120	3.5	14.28	79	0.069	58.320	4.74	0.46
135	3	15.32	77	0.076	47.400	3.59	0.47
150	2.5	16.46	75	-	-	-	-
Mean				0.109		2.42	4.20

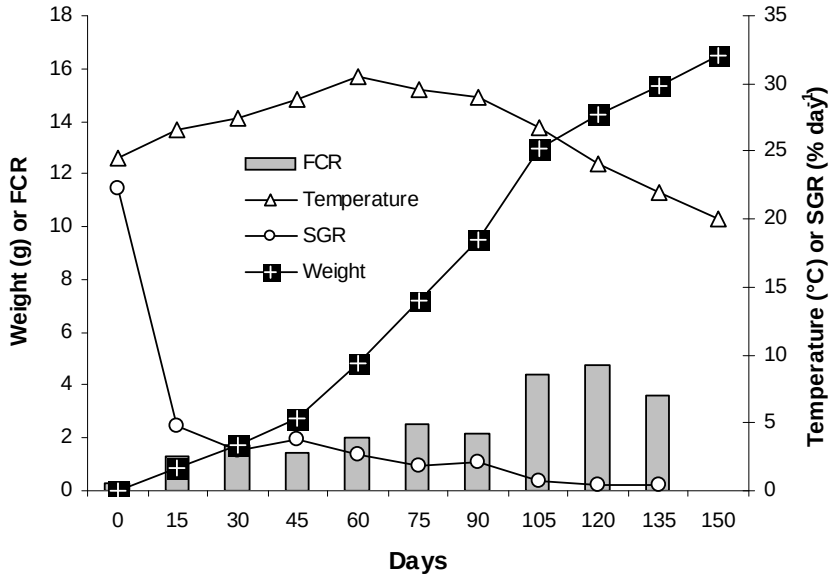

Figure 1. Water temperature, growth, food conversion ratio (FCR) and specific growth rate (SGR) of *P. semisulcatus* grown in pond at a stocking density of 15 individual/m^2 for 150 days.

Table 3. Results of *M. japonicus* grown in earthen grow-out pond in İzmir, Turkey

Days	Feeding Rate (%)	Weight (g)	Estimated Survival Rate (%)	Growth Rate (g day^{-1})	Food Consumption (kg)	FCR	SGR (% day^{-1})
0	15	0.02	97	0.026	2.720	0.47	20.29
15	13	0.42	94	0.017	10.120	2.81	3.21
30	11	0.68	91	0.016	13.860	4.23	2.01
45	9	0.92	89	0.030	16.580	2.76	1.59
60	8	1.38	87	0.104	32.680	1.60	5.04
75	6	2.94	85	0.072	36.650	2.66	2.08
90	5.5	4.02	83	0.122	48.880	2.14	2.50
105	5	5.85	81	0.031	38.120	6.74	0.51
120	4.8	6.32	79	0.017	21.280	7.04	0.26
135	4.7	6.58	77	0.031	24.620	4.58	0.46
150	4.5	7.05	75	-	-	-	-
Mean				0.046		3.50	3.79

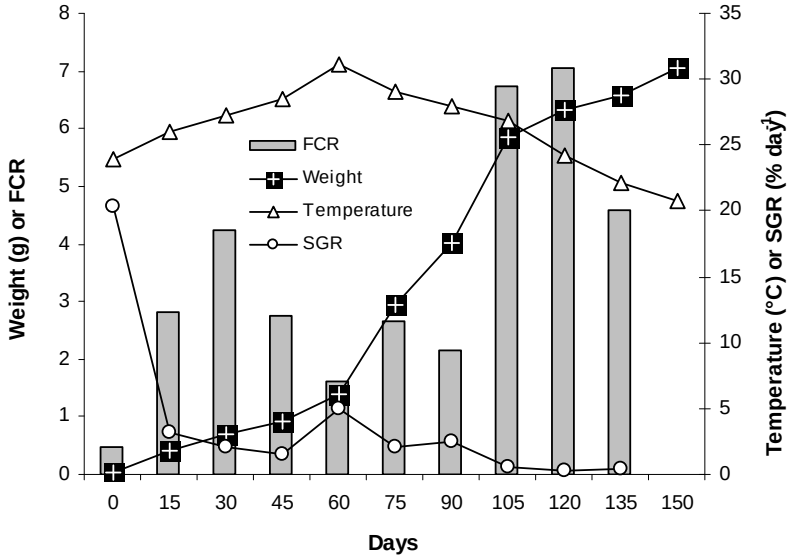

Figure 2. Water temperature, growth, food conversion ratio (FCR) and specific growth rate (SGR) of *M. japonicus* grown in pond at a stocking density of 15 individual/m^2 for 150 days.

ppt (Browdy *et al*., 1986). In view of these results, high salinity might have negative effects on *M. japonicus*. It is well know that response to these environmental parameters is species-specific and salinity and temperature may also interact to influence growth and survival in penaeid shrimps (Staples and Heales, 1991; O'Brien, 1994).

The grow-out of *P. semisulcatus* and of *M. japonicus* yielded 1950 kg/ha and 79% survival, and 655 kg/ha and 62% survival, respectively. The low survival displayed by *M. japonicus* in our study, which carried out in earthen pond, may be partly explained by the fact that in nature this species is a sandy bottom dweller. Liao and Chien (1990) pointed out that sandy bed is important in rearing *M. japonicus*. In the present study, *P. semisulcatus* grew to 16.46 g while *M. japonicus* attained much lower average weight of 7.05 g under similar culture conditions. These findings are similar to those reported in Italy by Lumare *et al*., (1999) who obtained average final weight of 21.6 g for *P. semisulcatus* and 13.1 g for *M. japonicus* in the same culture conditions. Issar *et al*. (1987) reported that final weight of 21 g could be achieved with *P. semisulcatus* at stocking densities of 8 pieces per m^2 in 162 days. Canese *et al*. (1990) reported that *M. japonicus* had yield of 1761 kg/ha and an average survival rate of 72.7%. Body weight of 19.4 g can be obtained in 143 days, cultured period with stocking density of 4.14 shrimp/m^2. In Turkey, Kumlu *et al*. (2003) obtained similar average final weight (17.3 g) at 10 shrimps per m^2 during grow-out of *P. semisulcatus* in south-eastern coast of Turkey in 180 days.

It is well known that shrimps are slow feeders and that their feeds must remain stable in water for at least 2 h (Kumlu *et al*., 2003). Nevertheless the omnivorous *P. semisulcatus*, which has lower protein requirement (Liao and Chao, 1983; Liao and Murai, 1985; Lumare *et al*., 1986), reached a higher final size than the carnivorous *M. japonicus*. In another study, Türkmen (2000) reported that 1863 kg/ha yield and 16.11 g final weight can be achieved with *M. japonicus* at the same stocking density and same rearing period using extruder feed (50% protein, from Taiwan).

In *P. semisulcatus*, daily growth rate was low during the first month (0.054-0.060 g day^{-1}) at water temperatures (08.00 h-16.00 h) of about 24-27°C, but increased thereafter (0.140-0.230 g day^{-1}) when water temperature remained between 28-30.5°C. Daily growth rate at 29°C (0.230 g day^{-1}) was more than 4 times higher than at 24°C (0.054 g day^{-1}). However, growth rate (0.104-0.122 g day^{-1}) of *M. japonicus* even at 28-31°C was about half of that of *P. semisulcatus*. Kumlu *et al*. (2003) reported mean growth rate of 0.11 g day^{-1} for density of 10 ind./m^2 and 0.08 g day^{-1} at 30 ind./m^2 for *P. semisulcatus* under similar culture conditions. We obtained an average weight gain of 0.109 g day^{-1} at 15 ind./m^2. Issar *et al*. (1987) reported that *P. semisulcatus* grew 0.124 g day^{-1} at a stocking density of 8 shrimp/m^2 in Israel.

When growth rate, weight gain, survival rate and FCR are taken into account, *P. semisulcatus* appears to have a good prospect for farming in the Aegean region.

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