

# Indoor Overwintering of Silver Pomfret (*Pampus argenteus* Euphrasen) Fingerlings in Fiberglass Tanks

E.M. CRUZ, S. ALMATAR, K. AL-ABDUL ELAH and A. AL-YAQOUT

*Aquaculture, Fisheries and Marine Environment Department  
Kuwait Institute for Scientific Research  
P.O. Box 1638, 22017 Salmiya,  
Kuwait*

## Abstract

Indoor rearing of silver pomfret (*Pampus argenteus* Euphrasen) fingerlings cultured under three temperature regimes during winter months in Kuwait was evaluated for growth and survival in fiberglass tanks. Thirty fish with mean weights of approximately 10 g were stocked in each fiberglass tank (water volume = 500 L). Three tanks were assigned to each of the three sea water temperature regimes: ambient, 25°C and 30°C. Under controlled water temperature regimes, heat exchangers were installed and set to the desired water temperature of 25°C and 30°C. Water flowed through each tank at the rate of two L/min. The fish were fed at satiation rate five times a day at two hours interval starting at 0800 h, six days a week with turbot pellet (Ecostart 15 by Biomar of France). The experiment was conducted for 154 days. Growth rates of fish under controlled temperature regimes were significantly higher than those under ambient temperature regime ( $P < 0.01$ ). However, growth rates between the controlled temperature regimes did not differ significantly ( $P > 0.05$ ). Survival rate of fish was highest at 25°C (66.7%) followed by fish at 30°C (62.2 %) and the lowest was those at ambient temperature regime (40.0%). Survival rates of fish reared at water temperatures of 25°C and at 30°C did not differ significantly ( $P > 0.05$ ) but were significantly higher than those reared at ambient temperature regime (40.0%). Based on the results of this study, it is apparent that silver pomfret should be cultured in sea water with temperature close to 25°C during winter in Kuwait to obtain better growth and survival.

## Introduction

Silver pomfret (*Pampus argenteus* Euphrasen) is a highly valued marine fish worldwide with wide distribution in East China Sea, Southeast Asian Sea, Indian Ocean and the Arabian Gulf. In Kuwait, the high value and demand for this fish are the reasons for the development of aquaculture technology for this species. Initial experiments conducted at the Aquaculture, Fisheries and Marine Environment Department, Kuwait Institute of Scientific Research show that eggs collected from wild broodstock can be artificially fertilized (Almatar et

al. 2000), hatched, nursed and reared using similar techniques used for other marine species (Al-Abdul-Elah et al. 1999) and that the fingerlings accept dry pelleted feeds (Cruz et al. 2000).

Among the natural food materials of silver pomfret are crustaceans with copepods as the dominant group, tunicates, medusae, jellyfish, and fish larvae, eggs and scales (Suyehiro 1942; Chopra 1960; Kuthalingam 1967; Rao 1967; Pati 1980; Mohamed and Ali 1994; Dadzie et al. 2000). Silver pomfret is slow eater, column feeder, feeds by sight and eats bigger portion of its meal towards the end of the day (Cruz et al. 2000).

The desired market size of this species is  $\geq 300$  g. Age estimation for the desired size of 300 g or more for this fish indicates that they would be at least 2.86 years old (Al-Hossani, et al. 1998). Therefore, to reach market size, the fish will have to go through two winter seasons. During winter in Kuwait, seawater temperature decreases below 20°C and may decrease to below 13°C in certain years. With the brown spotted grouper (*Epinephelus coioides* Hamilton), rearing under ambient water temperature in tanks and cages during winter resulted in low survival rates; 37.2 and 1.3 %, respectively and low daily growth rates; 0.13 and 0.07 g, respectively (Thani A. Ahmad, unpublished data). On the other hand, high winter survival rates of 90.4 to 100% in floating sea cages (Teng et al. 1987) and 98.3 to 100 % in concrete tanks (Ahmad 1987) were obtained for the local silver black sea bream (*Sparidentex hasta* Valenciennes). Likewise Mediterranean seabream, (*Sparus auratus* L.) withstand winter water temperatures in sea cages (pers. comm).

It is apparent that different species respond differently to low water temperature. As no study has been conducted on the tolerance of silver pomfret at low temperature, their growth and survival rates during the winter season are not known. Hence, the objectives of this study are to determine the growth rate, feed conversion and survival rate of silver pomfret reared in indoor fiberglass tanks under ambient seawater temperature and to determine their performance at two controlled temperature regimes. Results obtained in this study can serve as the basis for choosing the appropriate method of culturing this species during winter months.

## Materials and Method

Preparation of the indoor facilities for this experiment started during the first week of October 1999. Three 1-t round fiberglass tanks with an average inside radius of 128 cm and an average water depth of 40 cm with water volume about 500 l with internal gray color and one reservoir were assigned to each of the three temperature regimes: ambient, 25°C and 30°C. Under the controlled water control regimes, heat exchangers were installed at the reservoir tanks and set to the desired water temperature of 25°C and 30°C. Aeration was supplied by an air blower through air stones installed inside the reservoir to avoid adverse effect of the fish gulping the air bubbles as observed by Cruz et al. (2000) if airstones are installed inside the culture tank. Water flow through each culture tank at the rate of 2 l-min. The set up was tested and

declared fit for the experiment when the desired temperature remained constant for a week.

On 31 October 1999, each tank was stocked with 33 hatchery reared silver pomfret to acclimatize and train them to feed entirely on dry pellets. The fish were previously fed with moist paste composed of 50% minced fresh shrimp, 49% encapsulated diet, 1% fish oil, 20 g mineral premix per kg feed and 100 g vitamin mix per kg feed. The paste was gradually replaced with 0.7 to 1.0 mm turbot starter crumbles (Ecostart 15 by Biomar of France), at 25% replacement each week. Based on proximate analysis of the feed, it contained 54.7% crude protein, 10.0% crude lipids, 23.4% nitrogen free extract, 11.5% ash and 0.4% fiber on dry matter basis. The moisture content of the feed is 2.5%. Under the controlled temperature regimes, temperature was increased by 2°C per day from ambient seawater temperature until the desired temperatures, i.e. 25°C and 30°C, were reached. The tanks were illuminated by two 5 ft fluorescent daylight tubes installed 170 cm above the tanks.

On 13 November 1999, the experiment started. The fish were individually weighed and stocking rate was reduced to 30 fish per tank (60 fish·m<sup>-3</sup>). Mean weights of fish at stocking were 9.69, 9.95 and 10.63 g for ambient, 25°C and 30°C sea water temperature regimes, respectively. The fish were fed at satiation rate five times a day at two hours interval starting at 0800 h, six days a week. Feces and uneaten feed were siphoned before the first feeding six days a week. As this species is very sensitive to handling, sampling was done on a monthly basis. During sampling, all the fish in each tank were counted and weighed. Fish were anesthetized with quinaldine at a rate of 2 ppm before weighing.

The minimum and maximum water temperatures during the day were recorded using minimum – maximum thermometer. Surface water temperatures at 0900 h were recorded using an ordinary mercury thermometer. Temperatures were taken at least 6 days a week. Dissolved oxygen concentration was measured twice a week using a YSI DO meter.

This experiment was completed on 16 April 2000 after 154 days. The fish were individually weighed. Coefficient of variation (CV) was computed as:  $CV = 100 (\text{standard deviation} \div \text{mean weight})$ . The specific growth rate (SGR) was calculated as:  $SGR = 100 (\ln \text{ final weight} - \ln \text{ initial weight}) \div \text{culture days}$ . The feed conversion ratio (FCR) was calculated as feed given per kilogram wet weight gain.

Data obtained on the individual final mean weight, daily gain in weight, specific growth rate, feed conversion ratio and survival rate were analyzed statistically using the SPSSPC+ statistical software package (SPSS 1996).

## Results and Discussion

The weight, growth rate, feed conversion ratio and survival rate of fingerlings reared under different temperature regimes are shown in table 1. The mean weights per fish at harvest were 19.01, 26.54 and 25.22 g under the ambient, 25°C and 30°C temperature regimes, respectively. The fish under

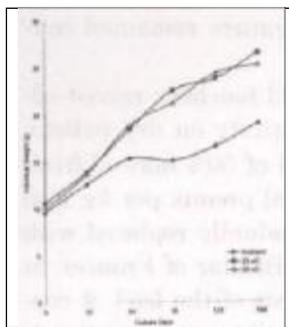


Fig. 1. Growth curve of silver pomfret fingerlings under three temperature regimes

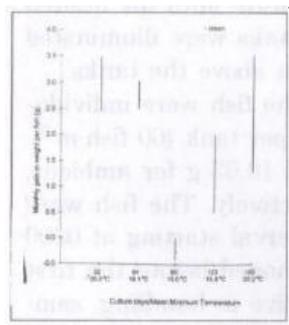


Fig. 2. Monthly gain in weight per fish under ambient temperature

ambient temperature regime were significantly smaller than those under the controlled temperature regimes ( $P < 0.01$ ). Fish mean weights under the controlled temperature regimes did not differ significantly ( $P > 0.05$ ). Individual size variation calculated as CV increased from the initial of 13.91% to 33.54% at harvest in fish under the ambient temperature regime, from 24.48% to 53.97% and from 17.92% to 61.09% under the 25°C and 30°C temperature regimes, respectively.

Daily gains in weight per fish were 0.06, 0.10 and 0.10 g, under ambient, 25°C and 30°C temperature regimes, respectively. The mean daily gains in weight per fish cultured under controlled temperature regimes (25°C and 30°C) were not significantly different ( $P > 0.05$ ). However, the mean daily weight of fingerlings under ambient temperature regime was significantly lower than those under the controlled temperature regimes ( $P < 0.01$ ).

Growth curve of fingerlings during the 154 culture days is shown in figure 1. Reduced growth due to low temperature has been likewise reported in tilapia *Oreochromis niloticus* L. (Caulton 1982; Abdelghany 1996) and in common carp (Goolish and Adelman 1984; Abdelghany 1996). In this study, the monthly growth rate of fish reared under ambient temperature revealed that the fish lost weight when the minimum temperature was about 15.3°C (Fig. 2). The loss in weight was due to the decrease in feeding activity and that a substantial amount of energy intake was used for

Table 1. Growth and survival of zobaidy fingerlings under three temperature regimes.

	Temperature Regimes		
	Ambient	25 °C	30 °C
Mean weight at stocking,			
Individual (g)	9.69	10.63	9.96
Coefficient of variation, %	13.91	24.48	17.92
Total (g tank <sup>-1</sup> )	290.70	318.90	298.80
Mean weight at harvest			
Individual (g tank <sup>-1</sup> )	19.01	26.54	25.22
Coefficient of variation, %	33.54	53.97	61.09
Total (g)	228.12	530.80	471.61
Daily weight gain, g fish <sup>-1</sup>	0.06 <sup>a</sup>	0.10 <sup>b</sup>	0.10 <sup>b</sup>
Specific growth rate, %/d	1.48 <sup>a</sup>	1.75 <sup>b</sup>	1.74 <sup>b</sup>
Initial number	30	30	30
Final number	12	20	18.7
Survival rate, %	40.0 <sup>a</sup>	66.7 <sup>b</sup>	62.3 <sup>b</sup>
Total gain in weight, g tank <sup>-1</sup>	-62.58	211.90	172.81
Feed consumption, g tank <sup>-1</sup>	208.70	725.00	820.00
Feed conversion ratio	-3.33 <sup>a</sup>	3.42 <sup>b</sup>	4.74 <sup>c</sup>

maintaining its body metabolism rather than for growth (Payne et al. 1988). The fish grew when the minimum temperature was about 16.7°C (Fig. 2). During this period, the fish were sluggish and appeared not to be actively feeding. Lin (1969) reported the same observation where milkfish becomes sluggish when water temperature goes below 20°C. It appears that the minimum temperature for silver pomfret to maintain its weight (zero growth) is between 15.3°C and 16.7°C. Due to the long intervals (one month) in which growth was measured, it was however difficult to determine exactly the temperature where no growth occurred.

Although the fish grew under the ambient temperature regime, due to high mortality rate, total weight at the end of the experiment was less than their total weight at stocking. Total weights of fish under controlled conditions were more than double than those under ambient condition. The negative total gain in weight of fish under ambient regime resulted to negative FCR. The FCR of fish under 25°C and 30°C temperature regimes were 3.49 and 4.74, respectively. FCR of fingerlings under the controlled temperature regimes were significantly different ( $P < 0.01$ ).

Results of this study indicate that the temperature necessary for optimum growth and feed conversion efficiency of silver pomfret fingerlings under indoor conditions was 25°C. Similar results were obtained by Anderson and Fast (1991) with Chinese catfish and by Jo (1984) with *Clarias batracus* where optimal growth and FCRs were obtained at 25°C.

Results obtained in the study on the SGR is higher (1.75% vs 0.91%) and the FCR is poorer (3.42 vs 1.80) than those obtained by Cruz et al. (2000). The higher stocking density (60 vs 28 fish m<sup>-3</sup>) used in this study might have limited the swimming activities of fish due to crowding. As less energy was spent for swimming, more energy was available for growth, which might explain higher SGR. On the other hand, the blue internal color and deeper depth (56 vs 40 cm) of the tank used by Cruz et al. (2000) might have contributed to the increase visibility and catch ability of the feed by the fish, it being a column feeder. Thus, this could have resulted to less uneaten feeds.

As previously mentioned, the fish were only fed 6 days a week with Friday as rest day. It was observed that on the first feeding day of the week, i.e., Saturday, 50% of the time, the fish ate less, 38.9% of the time the fish ate more and 16.7% of the time the fish ate the same amount of feed. Based on these findings, not feeding the fish for one day resulted in lowering of appetite of about 50% of the fish population. It is therefore recommended that the fish should be fed seven days a week. The daily ration of the fish under ambient temperature during the coldest period of the experiment was from 0.47 to 0.48% and gradually increased to 1.16% as the temperature increased. Based on the results of this study, silver pomfret should be fed at the rate of 0.5% per day during the months of January and February, increasing to 0.65% in March and to 1.1% in April.

Survival rate of fingerlings was highest at 25°C (66.7%) followed by fingerlings at 30°C (62.2%) and the lowest was those under ambient temperature regime (40.0%). The survival rate of fingerlings under controlled temperature regimes (25°C and 30°C) were significantly higher than those under ambient

temperature regime ( $P < 0.02$ ). The difference in the survival rates between the two controlled temperature regimes however, was not significant ( $P > 0.05$ ). Majority of the mortality (23.3% for the ambient, 22.2% for the 30°C and 16.7% for the 25°C) occurred during the first two weeks of the experiment. Mortality during the first two weeks may indicate that the fish needs longer time to acclimate to new environment and feed as most of the dead fish were found to be emaciated. Mortality during the coldest period from 17 January to 15 February 2000 with mean temperature of 15°C were lower than those with higher temperature in 15 December 1999 to 16 January 2000 (16.1°C) and in 16 February to 14 March 2000 (15.8°C) indicating that the minimum sublethal temperature for silver pomfret fingerlings has not been reached. Determining the minimum and maximum sublethal and lethal temperatures are worth exploring in future experiments.

Survival rates (62.2 to 66.7%) obtained under controlled temperature regimes were lower than the 85 to 100% obtained by Cruz et al. (2000) using underground water with temperature ranging from 23.5°C to 26.0°C. The higher survival rates may be due to bigger tank volume (1 m<sup>3</sup>) and lower stocking density (28.5 fish·m<sup>-3</sup>) used by Cruz et al. (2000). This implies that the roles of tank size and stocking density on survival of silver pomfret are worth investigating in the future.

The minimum, maximum and at 0900 h temperatures during the study for ambient, 25°C and 30°C temperature regimes are shown in table 2. Temperature ranges during the experiment were 14.0°C to 24.0°C, 20.3°C to 28.0°C and 23.0°C to 33.0°C for the ambient, 25°C and 30°C temperature regimes. Maximum diel temperature fluctuation for all the temperature regimes was 3°C. Average diel water temperature fluctuated by 1.6, 2.2 and 2.3°C for ambient, 25°C and 30°C temperature regimes, respectively.

The dissolved oxygen concentration for the three temperature regimes are shown in table 3. The minimum dissolved oxygen in all the three temperature regimes were above 3.7 mg·l and the maximum concentration of 8.5 mg·l was recorded in ambient temperature regime. Salinity was 41 ppt.

Based on the findings of this study, the rearing of silver pomfret fingerlings with weights ranging from 15 to 30 g requires water temperature close to 25°C during winter months in Kuwait. Increasing temperature to 30°C which is considered optimum for most warmwater fish (Andrews and Stickney 1972; Villaluz and Unggui 1983; Price et al. 1985; Soderberg 1990; Anderson and Fast 1991) does not provide any added advantage in terms of promoting growth, feed conversion efficiency and survival.

The poor performance of silver pomfret fingerlings under ambient temperature regime in indoor fiberglass during winter in Kuwait clearly indicates the need to increase the temperature of the ambient sea water close to 25°C. The use of underground seawater with temperature range of 23.5 to 26.0°C is sufficient to provide optimum performance during winter. Since the cost of electricity in Kuwait is very cheap, i.e., \$0.006 per kilowatt-hour, an alternative is to heat the water using a water heater.

Results of this study clearly demonstrate that during winter months, silver pomfret can not be cultured in outdoor tanks and more so in sea cages

Table 2. Monthly water temperatures (°C) in tanks and mortality rates (%) of silver pomfret under three temperature regimes.

Culture Days	Inclusive Dates	Mean Temperature			Period Temperature		Mortality %
		Minimum	Maximum	0900 h	Minimum	Maximum	
<b>Ambient</b>							
32	13/11/99 – 14/12/99	20.0	21.5	20.9	18.0	24.0	23.3
64	15/12/99 – 16/01/00	16.1	18.2	17.4	15.0	20.0	13.3
95	17/01/00 – 15/02/00	15.0	16.0	15.5	14.0	18.0	6.7
123	16/02/00 – 14/03/00	15.8	16.5	16.3	14.5	18.0	13.3
155	15/03/00 – 16/04/00	20.2	20.8	20.3	18.5	22.8	3.3
<b>25°C</b>							
32	13/11/99 – 14/12/99	24.4	26.1	25.4	23.0	28.0	15.6
64	15/12/99 – 16/01/00	22.2	26.3	24.9	20.3	28.0	3.3
95	17/01/00 – 15/02/00	23.6	25.9	25.2	20.0	26.5	2.2
123	16/02/00 – 14/03/00	24.7	25.9	25.5	22.5	27.0	6.7
155	15/03/00 – 16/04/00	25.3	25.9	25.4	24.0	27.0	5.6
<b>30°C</b>							
32	13/11/99 – 14/12/99	28.5	31.0	30.6	24.0	33.0	22.2
64	15/12/99 – 16/01/00	28.0	30.6	29.7	23.0	31.0	2.2
95	17/01/00 – 15/02/00	27.3	30.2	29.9	24.0	31.5	6.7
123	16/02/00 – 14/03/00	28.5	30.7	30.1	24.5	32.0	2.2
155	15/03/00 – 16/04/00	30.4	31.2	30.8	26.0	32.0	4.4

Table 3. Dissolved oxygen (mg.l) in silver pomfret tanks under three temperature regimes.

Culture Days	Ambient			25°C			30°C		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean
32	4.4	7.0	5.7	4.2	5.6	4.8	3.8	5.5	4.4
64	7.5	8.0	7.7	5.8	6.0	5.9	4.2	5.8	5.2
95	7.8	8.5	8.1	4.9	6.0	5.7	3.6	5.7	4.6
123	8.0	8.5	8.1	5.5	6.3	5.9	5.2	6.0	5.6
155	7.1	8.5	7.8	5.2	6.1	5.7	4.8	6.0	5.2

since in addition to the low temperature effect, there are other environmental conditions such as current, waves, etc., in open seas that the fish have to overcome in order to survive.

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