

Determination of the Maximum and Minimum Lethal Temperature for Year 0 and Year 1 Silver Pomfret (*Pampus argenteus* Euphrasen)

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Abstract

This study was conducted to determine the minimum and maximum lethal temperature of two age groups of silver pomfret (*Pampus argenteus* Euphrasen). Year 0 and Year 1 fish, 38.9 and 55.3%, respectively started to lose their equilibrium at 37°C. The rest of the fish lost their equilibrium at 38°C. On the other hand, Year 0 and Year 1 fish, 5.8 and 40% respectively started to lose their equilibrium at 11°C, 55% and 53.3% at 10°C, respectively and the rest lost their equilibrium at 9°C. Fish that lost their equilibrium died within the day. Fish that lost their equilibrium at the upper temperature did not recover when transferred to another tank with cooler water temperature while all fish exposed at 11 and 10°C fully recovered upon gradual increase in water temperature with only 50% recovering when exposed to 9°C. Results indicate that the maximum and minimum temperature of the two age groups of silver pomfret are 37°C and 9°C, respectively.

Introduction

There has been increasing interest in culturing silver pomfret (*Pampus argenteus* Euphrasen) since this fish is one of the highly valued species in China, Southeast Asia, the Indian Continent and the Arabian Gulf. However, very little is known about its culture requirement. Moreover, exploratory trial in culturing this species in ponds have failed due to the absence of natural food which is jellyfish (Salman et al. 1992). Recently, Cruz et al. (2000) revealed encouraging findings stating that this fish when cultured in fiberglass tanks, accept artificially prepared feeds and perform better when fed dry pellets than moist pellets. The acceptance of artificial diets by this species fulfills one of the requirements for a species that has potential for aquaculture.

The optimum temperature requirement for optimum growth is as yet, not known. So far, the only work done in trying to determine its temperature tolerance was reported by Cruz et al. (In press). They reported that silver

pomfret fingerlings (10 to 30 g) lose weight at a minimum temperature of about 15.3°C, require temperature close to 25°C for optimum growth and increasing the temperature to 30°C does not provide any added advantage in terms of promoting growth, feed conversion efficiency and survival.

In subtemperate countries, ambient seawater temperature range varies widely. In Kuwait, the average minimum seawater temperature decreases to below 20°C and may even decrease to 12°C in certain years while the average maximum seawater temperature increases to above 30°C and may still increase to 34°C in certain years. On the other hand, minimum air temperature decreases below 5°C while the maximum air temperature increases beyond 50°C. Consequently, there is a possibility that the minimum and maximum lethal levels may be reached if the fish tanks are exposed to air temperature. Therefore, this study was conducted to determine the minimum and maximum lethal temperature for two age groups (Year 0 and Year 1) of silver pomfret.

Methodology

Rearing facilities

Six circular fiberglass tanks with black inner wall color located indoor were used in rearing two life stages of silver pomfret: Year 0 and Year 1. Three tanks were used per life stage. Each culture tank used for Year 0 and Year 1 fish had a water volume of 100 l and 250 l, respectively. Thermostatically controlled heaters for the maximum lethal temperature trials were installed inside an elevated reservoir and a 2 t water chiller was attached to an elevated reservoir for the minimum lethal temperature trials. Airstones were installed in the reservoirs to aerate the water. The culture tanks received water from the reservoir. Figure 1 shows the schematic diagram of the experimental facilities. Water flow was regulated to maintain the desired water temperature and dissolved oxygen (DO) level.

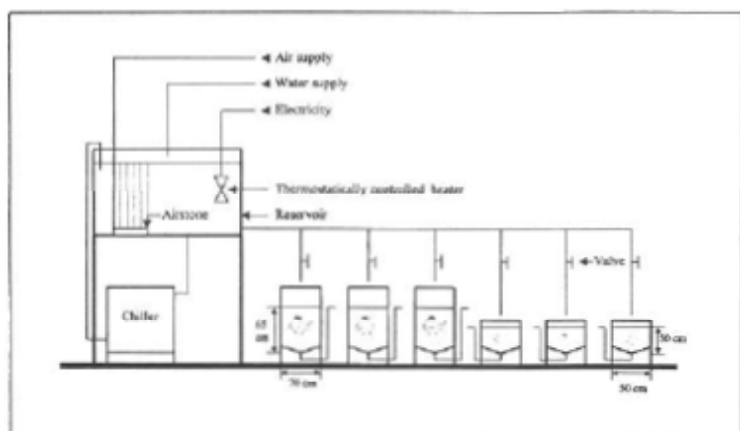


Fig. 1. Schematic diagram of the facilities (Not drawn to scale).

Experimental fish

Fish used came from eggs that were collected from wild broodstock during the 1999 and 2000 spawning seasons. Indoor facilities were used to hatch the eggs and rear the fish.

Maximum lethal temperature

On 6 November 2000, Year 0 silver pomfret fingerlings were randomly taken from 1.0 t circular fiberglass tank and transferred to three 100 l tanks at the rate of 12 fish per tank. The mean weight per fish was 8.3 ± 1.9 g (S.D.) and the mean fork length was 66.2 ± 6.2 mm. Rearing temperature before the fish transfer was 25°C. From the initial water temperature of 25°C, the temperature was increased to 31°C by 1°C steps at daily intervals. The temperature was kept at 31°C for 3 days to acclimatize the fish. The temperature of 31°C was chosen because it is the average maximum rearing water temperature during summer in Kuwait without any mortality attributed to this temperature. Thereafter, the water temperature was increased by 1°C step at daily interval until all the fish have lost their equilibrium i.e., when the fish are no longer able to swim, maintain its normal position and lying lethargic at the bottom of the tank but are still alive. Dead fish and those that lost their equilibrium were counted for each increase in temperature. During the experiment, the fish were fed twice a day with paste composed of 50% minced shrimp, 49% encapsulated diet (Lansy A2, INVE Aquaculture N.V., Belgium), 1% fish oil, 20 g mineral premix per kg feed and 100 g vitamin mix per kg feed (Al-Abdul-Elah et al., In press).

The trial using Year 1 fish started on 28 November 2001. Fish reared in 1 t circular fiberglass tanks were randomly transferred to three 250 l fiberglass tanks at the rate of five fish per tank. The mean weight per fish was 48.3 ± 14.9 g and the mean fork length was 114.6 ± 10.6 mm. Rearing temperature before the fish transfer was 25.5°C. Similar temperature procedures indicated for Year 0 fish were followed. Fish were fed twice a day with turbot pellets (Ecostart 15 by Biomar of France) containing 51% crude protein.

Minimum lethal temperature

Trials for Year 0 and Year 1 fish were conducted simultaneously on 16 January 2001. The same tanks and number of fish used in the maximum lethal temperature trials were used in this minimum lethal temperature trial. Initial mean individual weights for Year 0 and Year 1 were 10.3 ± 1.1 g and 65.1 ± 19.0 g, respectively. The mean individual fork lengths for Year 0 and Year 1 were 73.3 ± 4.3 mm and 129.1 ± 12.4 mm, respectively. The water temperatures before fish transfer were 19.0 and 22.5°C, for Year 0 and Year 1, respectively. Temperature of the water was decreased from an initial temperature of 20°C by 1°C steps daily to 15°C (average minimum temperature during winter) and kept at this temperature for 3 days. Thereafter, the water temperature was decreased by 1°C per day until the lethal temperature was reached. Dead

fish and those that lost their equilibrium were counted in each decrease in temperature and recorded. The fish were fed with the same feed as those used in the maximum temperature trials.

In both the maximum and minimum lethal trials, the ultimate lethal temperature is reached when there is total loss of equilibrium for all the fish in the tank. Loss of equilibrium is equivalent to death since under natural conditions in ponds and tanks, the fish that lost equilibrium would not be able to escape attack of other organisms under this condition.

Fish response to changes in temperature was recorded. When the fish lost its equilibrium, attempt to revive them was done by transferring them to separate tanks with water temperature similar to those when the trials started or by gradually increasing the temperature. .

Water temperature was measured every two hours from 0800 hr to 1400 hr. Daily DO was measured using Hanna HI9141 DO meter.

Results and Discussion

Maximum lethal temperature

Fish exposed to high temperature lost appetite at 35°C. At 36°C, fish were swimming restlessly at high speed, staying mostly at the bottom of the tank and attempting to escape through the drainpipe located at the bottom of the tank where the water was cooler since water was supplied from the top or the fish were trying to escape by jumping out of the water. These reactions explain the high decrease in body weight of those exposed to high temperature (Table 1). Similarly, Baras et al. (2001) explained the depressed growth of Nile tilapia at a temperature above optimum growth to the increase of routine metabolism and reduction of the scope of activity.

The rates in which the fish started to lose equilibrium when exposed to high temperature are shown in table 2. Fish of both age groups (Year 0 and Year 1) started to lose equilibrium at 37°C while the rest of the fish lost equilibrium at 38°C. Fish that lost equilibrium at 37°C when transferred to cooler temperature did not recover. All the fish that lost equilibrium eventually died within the day when they remained lying at the bottom of the tank.

Table 1. Mean individual weight and fork length (±S.D.) of silver pomfret exposed to low and high temperatures.

	Low Temperature		High Temperature	
	Year 0	Year 1	Year 0	Year 1
Initial weight, g fish ⁻¹	10.3 ± 1.1	65.1 ± 19.0	8.3 ± 1.9	48.3 ± 14.9
Final weight, g fish ⁻¹	9.3 ± 1.1	59.2 ± 18.6	6.0 ± 1.7	37.9 ± 11.8
Decrease in weight, %	9.7	9.1	27.7	21.5
Initial fork length, mm fish ⁻¹	73.3 ± 4.3	129.1 ± 12.4	66.2 ± 6.2	114.6 ± 10.6
Final fork length, mm fish ⁻¹	72.7 ± 4.3	122.6 ± 11.0	61.1 ± 7.3	107.9 ± 11.8
Decrease in length, %	0.8	5.0	7.7	5.8

The ultimate maximum temperature of 38°C for silver pomfret observed in this study is similar to those observed by Baras, et al. (2001) for the warm water freshwater Nile tilapia *Oreochromis niloticus* L.

Fewer Year 0 fish (38.9 %) lost equilibrium at 37°C than Year 1 fish (55.3%). Apparently, this observation seems to indicate that younger fish have better chances of surviving at higher temperature than older fish. Lowe McCowell (1982) commented that the thermal preference of fish decreases as the fish ages.

The average DO for Year 0 and Year 1 were 4.94 ± 0.23 mg·l and 5.51 ± 0.71 mg·l, respectively while DO ranged from 4.65 to 5.26 mg·l and 4.85 to 6.50 mg·l for Year 0 and Year 1, respectively. The salinity was 40 ppt.

Minimum lethal temperature

Fish exposed to low temperature lost their appetite and stopped eating at 12°C. The fish were sluggish and were barely swimming. The fish stayed most of the time close to the bottom of the tank. This behavior might explain the lesser magnitude in the decrease in fish weight (9.1 to 9.7%) and length (0.8 to 5.0%) of fish exposed to low temperature as compared to the decrease in weight (21.5 to 27.7%) and length (5.8 to 7.7%) of the fish exposed to high temperature (Table 1).

More Year 1 fish (40%) started to lose equilibrium at 11°C while it was only 5.8% for Year 0 (Table 3). The difference in the response between Year 0 and Year 1 may be due to the difference in the pretreatment temperature. The pretreatment temperature in Year 1 was 25°C while that in Year 0 was 20.5°C. Other workers obtained similar results. Dickerson & Vinyard (1999) reported that responses to thermal conditions vary in relation to the thermal history of the individual fish involved. With *Oreochromis aurea* (previously named *Tilapia aurea*), Chervinski and Lahav (1976) observed that fish pre-acclimated at 28°C began to die when temperature reached 11°C while those pre-acclimated at 18°C began to die at 9°C.

Table 2. Loss of equilibrium rates of Year 0 and Year 1 silver pomfret exposed to high temperatures.

Tank No:	Year 0					Year 1				
	1	2	3	Mean	Percent	1	2	3	Mean	Percent
37°C	5	3	6	4.7	38.9	2	3	3	2.7	55.3
38°C	7	9	6	7.3	61.1	3	2	2	2.3	44.7

Table 3. Loss of equilibrium rates of Year 0 and Year 1 silver pomfret exposed to low temperatures.

Tank No:	Year 0					Year 1				
	1	2	3	Mean	Percent	1	2	3	Mean	Percent
11°C	2	0	0	0.7	5.8	3	3	0	2.0	40.0
10°C	4	9	7	6.6	55.0	1	2	5	2.7	53.3
9°C	6	3	5	4.7	39.2	1	0	0	0.3	6.7

Table 3 shows that majority of the fish lost equilibrium at 10°C; 53.3% for Year 1 and 55.5% for Year 0. At 9°C, only 6.7% lost equilibrium for Year 1 and 39.2% for Year 0. Fish that lost equilibrium when left lying at the bottom of the tank eventually died within the day.

All the Year 0 and Year 1 fish that lost equilibrium at 10 and 11°C revived and lived when transferred to a tank with water temperature of 20°C. Similarly, Yashouv (1960) observed that *Oreochromis niloticus* and *Oreochromis galilaeus* that lost their erect position survived when exposed only for a short time at temperature of 6 to 7°C.

When water temperature was gradually increased for Year 0 fish that lost equilibrium at 9°C, the fish slowly started to revive at 12.5°C. However, at 17°C, only 50% of the fish that lost equilibrium were able to survive and the rest died. Although some of the Year 1 fish were able to survive, they eventually died since they were very weak. The only survivor in Year 1 at 9°C eventually died upon transfer to warm water. The fish that survived might have lost its equilibrium only for few hours before being transferred to warmer temperature.

The average DO for Year 0 and Year 1 were 6.54 ± 0.63 mg·l and 6.63 ± 0.86 mg·l, respectively while DO ranged from 5.68 to 7.83 mg·l and 5.30 to 7.52 mg·l for Year 0 and Year 1, respectively. The salinity was 40 ppt.

Conclusion

Based on the results of this study, it is apparent that the ultimate maximum and minimum lethal temperature for both age groups of silver pomfret reared in indoor tanks are 38°C and 9°C, respectively. Hence, for optimum growth and production, silver pomfret should be grown with water temperature within the range of the ultimate maximum and minimum lethal temperatures.

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