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EFFECTS OF SALINITY ON GROWTH OF YOUNG MILKFISH, *CHANOS CHANOS**

by

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Abstract

Growth of young milkfish was studied at different levels of salinity over a period 68 days. Results suggested that young milkfish reared in freshwater or less saline sea water grew faster than in sea water. The increase in body weight was neither due to the increase in water content nor increase in feeding rate. The difference in growth rate might be attributed to the deviation from the original acclimating salinity. Mechanisms of the effect of salinity in retarding or accelerating milkfish growth should be investigated in the future.

Introduction

Milkfish culture in Taiwan dates back to the end of Ming dynasty, more than three hundred years ago. Milkfish is one of the most important food fish in Taiwan. According to the Fisheries Yearbook of 1975 published by the Taiwan Fisheries Bureau, the culture area of milkfish is more than 16,000 ha which is about 31.4% of the total area under aquaculture in Taiwan. The estimated annual yield of milkfish in 1974 was 28,900 tons. While extensive work has been done on the various cultural aspects of this economically important species (Chen, 1971), very little information is available on its physiology and ecology (Lin, 1969; Tsai et al., 1970). The present study is one of a series of physiological and ecological experiments carried out on milkfish during 16 September to 23 November 1975, in order to find out the optimum salinity range for the optimum growth of young milkfish.

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Materials and Methods

Milkfish fry, presumably from the same spawning stock, were collected near the shoreline of the Tungkang coastal area with a triangular scoop net in June, 1975. They were brought alive to the laboratory and then acclimatized to a salinity of about 15 $^{o}/oo$ at water temperature ranging from 29 to 30 °C in the outdoor cement tank for about three months. During this period and later experimental period, fish were fed with compound feed. The composition of the compound feed is given in Table 1. The amount of feed given each day was enough for satiation. 300 young milkfish were transferred to indoor plastic tanks (0.5 ton capacity) for the experiments. They were divided into 15 groups of 20 fish each for testing of different salinities ranging from 2.32 to 37.06 $^{o}/oo$. After being weighed, each group was acclimated to the present levels of salinity through intermediate salinities, by adding sea salt to freshwater. Then each group was divided into two subgroups with approximately equal mean body weight. Experiments were carried out in 30 covered gray PVC aquaria (50 cm x 25 cm x 21 cm in deep), each containing 10 fish in 26 liters of water with aeration and filter system. Water temperature, salinity and ration were recorded daily for each group (Fig. 1 and Table 2). Water in the experimental aquaria was renewed partially with prepared water of same salinity whenever needed. Experiments were conducted under natural illumination. Growth data were obtained by weighing all fish from each aquarium periodically. Wet body weight was recorded on a single pan Mettler P 1210 balance. After the final measurement, four to six individuals of different sizes from each group were sacrificed for water content analysis.

Results and Discussion

Mean wet body weight of fish in every group at each weighing is listed in Table 2 and illustrated in Fig. 2. Data obtained are divided into four groups of closer salinity range, i.e., 2.32-9.25, 10.77-18.74, 19.75-29.12 and 30.05-37.06 $^{o}/oo$ and those of the same group are plotted in the same panel. Fig. 2 shows that milkfish reared in low salinity of 2.69 $\pm$ 0.37 $^{o}/oo$ grew faster than those reared in other salinities, the gross general pattern of increase in weight was similar. It was, however, observed that increase in weight somehow slowed down in all groups after the fourth weighing probably owing to the decrease in wate temperature (Fig. 1). To check if the different increase in weight at various levels of salinity

Table 1. The composition of compound feed for young milkfish.

Ingredient	%
White fish meal	18
Shrimp meal	10
Soybean	22
Yeast	20
Flour	15
Wheat germ	10
Soybean oil	4
Vitamin mixture	1
Total	100

Table 11 Water temperature, salinity, ration and summarized growth results.

Tank number	1,1'	2,2'	3,3'	4,4'	5,5'	6,6'	7,7'	8,8'	9,9'	10,10'	11,11'	12,12'	13,13'	14,14'	15,15'
Temperature (°C) (mean ± S.E.)	27.7 ± 1.6														
Designated salinity (°/oo)	36	34	32	28	24	22	19	17	15	13	11	9	7	5	Fresh-water
Actual salinity (°/oo) (mean ± S.E.)	36.07 ±0.99	33.58 ±0.96	31.31 ±1.16	28.40 ±0.72	25.35 ±1.40	23.29 ±1.21	20.78 ±1.03	17.25 ±1.49	14.90 ±0.73	13.39 ±0.53	11.32 ±0.55	8.61 ±0.64	6.63 ±0.35	4.45 ±0.46	2.69 ±0.37
Initial number of fish	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Initial mean body weight (g)	1.34	1.32	1.55	1.29	1.44	1.38	1.46	1.45	1.46	1.42	1.52	1.43	1.53	1.42	1.48
Daily ration (g) per fish during 1st period	0.34	0.36	0.40	0.36	0.34	0.34	0.34	0.34	0.34	0.34	0.35	0.34	0.34	0.34	0.34
Mean body weight (g) at 2nd weighing	2.22	2.08	2.06	2.08	2.01	1.78	2.08	2.00	1.58	1.92	2.21	1.90	2.34	2.45	3.20
Growth rate (%)* and specific growth rate (x10⁻²)** at 2nd weighing	65.67 3.28	57.58 2.88	32.90 1.65	61.24 3.06	39.58 1.98	28.99 1.45	42.47 2.12	37.93 1.90	8.22 0.41	35.21 1.76	45.39 2.27	32.87 1.64	52.94 2.65	72.54 3.63	116.22 5.81
Daily ration (g) per fish during 2nd period	0.41	0.40	0.56	0.42	0.39	0.38	0.39	0.47	0.39	0.39	0.38	0.39	0.39	0.39	0.40
Mean body weight (g) at 3rd weighing	2.34	2.67	2.51	2.76	2.73	2.37	2.41	2.49	2.29	2.24	2.65	2.95	3.25	3.51	4.32
Growth rate (%)* and specific growth rate (x10⁻²)** at 3rd weighing	5.41 0.34	26.37 1.77	21.84 1.37	32.69 2.04	35.82 2.24	33.15 2.07	15.87 0.99	24.50 1.53	44.94 2.81	16.67 1.04	19.00 1.19	55.26 3.45	38.89 2.43	43.27 2.70	35.00 2.19
Daily ration (g) per fish during 3rd period	0.52	0.42	0.68	0.44	0.39	0.45	0.39	0.54	0.37	0.38	0.41	0.41	0.43	0.44	0.44
Mean body weight (g) at 4th weighing	2.96	3.22	3.44	3.16	3.38	2.78	3.09	3.18	2.59	2.65	3.12	3.72	3.98	4.11	5.11
Growth rate (%)* and specific growth rate (x10⁻²)** at 4th weighing	26.50 1.66	20.60 1.29	37.05 2.32	14.49 0.91	23.81 1.49	17.30 1.08	28.22 1.76	27.71 1.73	13.10 0.82	18.30 1.14	18.63 1.16	26.10 1.63	22.46 1.40	17.09 1.07	18.29 1.14
Daily ration (g) per fish during 4th period	0.50	0.42	0.60	0.40	0.39	0.42	0.41	0.48	0.37	0.40	0.41	0.42	0.44	0.44	0.46
Final mean body weight (g)	3.53	3.58	3.53	3.21	3.42	2.94	3.44	3.64	2.16	3.01	3.04	3.07	4.42	4.22	5.20
Growth rate (%)* and specific growth rate (x10⁻²)** at final weighing	19.26 1.20	11.18 0.70	2.62 0.16	1.58 0.10	1.18 0.07	5.76 0.36	11.33 0.71	14.47 0.90	-16.60 -1.04	13.58 0.85	-2.56 -0.16	4.03 0.25	11.06 0.69	2.68 0.17	1.76 0.11
Averaged growth rate (%)	29.21	29.43	23.60	27.50	25.10	21.30	24.47	26.15	12.42	20.94	20.12	29.57	31.34	33.90	42.82
Averaged feeding rate (%)***	18.07	16.33	22.05	18.22	15.64	18.52	15.51	18.07	20.44	17.16	17.11	14.72	13.45	14.18	12.28
Survival number	14	19	11	18	15	19	19	15	20	20	18	20	20	20	20

* Growth rate $= \frac{W_t - W_o}{W_o} \times 100\ \%$

** Specific growth rate $= \frac{W_t - W_o}{W_o \cdot t}$

*** Averaged feeding rate $= \frac{R}{\frac{W_o + W_t}{2}} \times 100\ \%$

W_t : Final mean body weight.

W_o : Initial mean body weight.

t : Period in days.

R : Averaged daily ration.

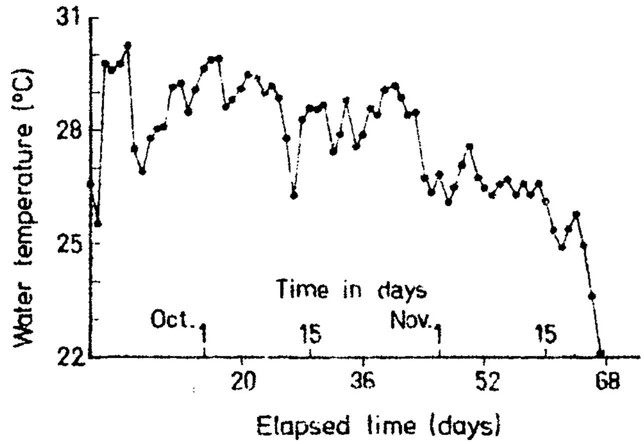

Fig. 1 Fluctuation of water temperature during the experimental period.

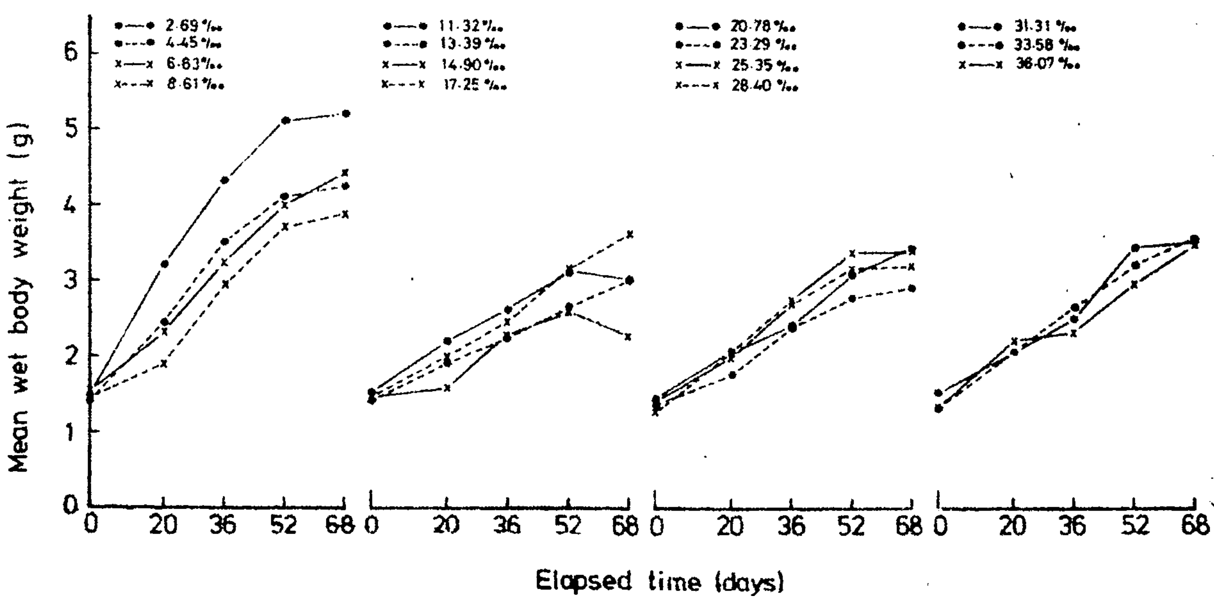

Fig. 2 Mean wet body weight of milkfish reared in different salinities.

was the result of losing or gaining water, water content was analyzed and data are presented in Fig. 3. Although the water content of young milkfish reared in different salinities for 68 days were rather different, no relationship was indicated between the water content and salinity of rearing water. It might be concluded that the increase in weight of young milkfish in lower salinity was not due to the increase in water content but to other components. It implies that growth of milkfish in lower salinity is of practical significance.

The specific growth of young milkfish in different salinities are shown in Fig. 4A. It is clear that the specific growth rate during each period varied a lot and the disparity in specific growth rate atrributed to ration effect was limited, as Fig. 4B was taken into consideration. Fig. 5 shows the average growth rate, average feeding rate and the mean ration per fish over the whole experimental period. It is found that fish in salinity of 14.90 $\pm$ 0.73^{o}/oo grew least, whereas fish in 2.69 $\pm$ 0.37^{o}/oo had the lowest feeding rate and the highest growth rate, almost 3.5 times of the former one. It indicates again that different rations offered in this experiment had a restricted effect on the growth of young milkfish.

The milkfish used in the experiments were reared under similar conditions of water temperature, light, space, and food. Only the ration and salinity levels were different. As mentioned earlier, ration had restricted effect on the growth of fish in the experiments. Fig. 6 shows the total growth increment in young milkfish reared in various salinities as compared to that of salinity 14.90 $\pm$ 0.73 ^{o}/oo. From this, it is clear that change in salinity was good for growth, and that change into lower salinity was better than that of higher salinity. A number of studies have shown that the growth rate of some euryhaline organisms decreases suddenly at salinities other than 5 to 8^{o}/oo, despite the ability of these forms to survive over a long period of time in a wider salinity range (Khlebovich, 1969). Chidambaram and Unny (1946) noticed a remarkable variation in the growth rate of milkfish belonging to the same stock when reared in water of different salinities. The rate of growth was maximum, (61 cm in about one year) in freshwater; whereas it was less in brackishwater and much less in confined seawater. In the present study, an appreciable decrease in the growth rate was observed in salinities above 8^{o}/oo.

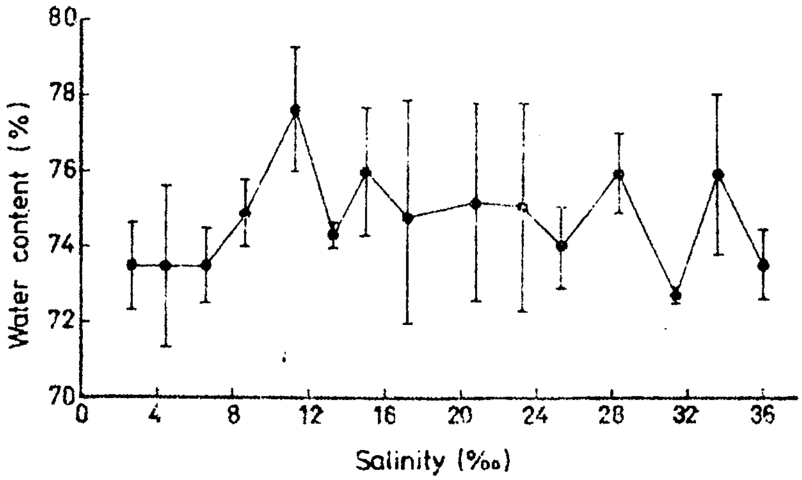

Fig. 3 Water content of young milkfish reared in different salinities.

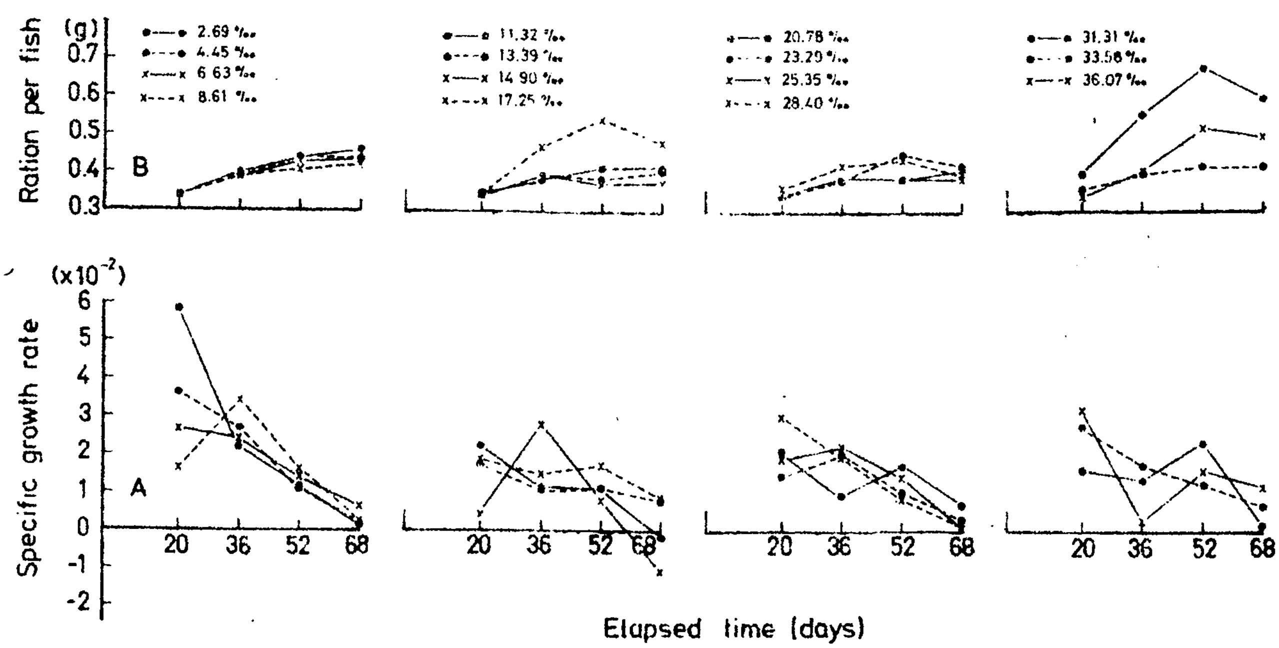

Fig. 4A Specific growth rate of young milkfish reared in different salinity.
B Ration per fish in different salinities.

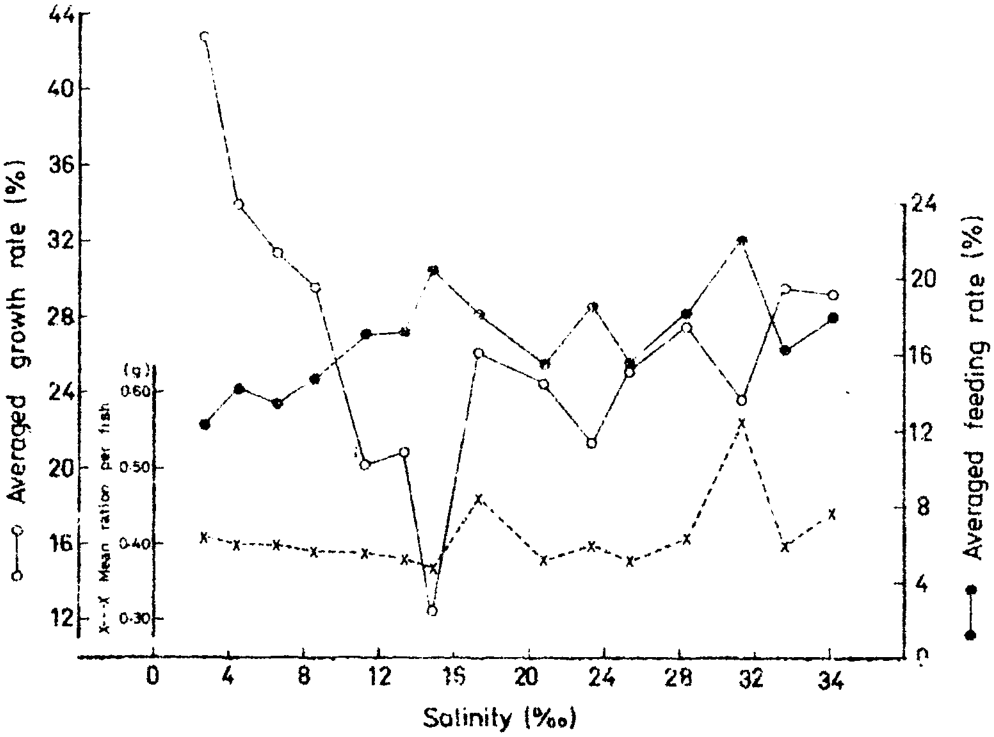

Fig. 5 Averaged growth rate and averaged feeding rate of young milkfish reared in different salinities. Mean ration per fish was presented as a reference.

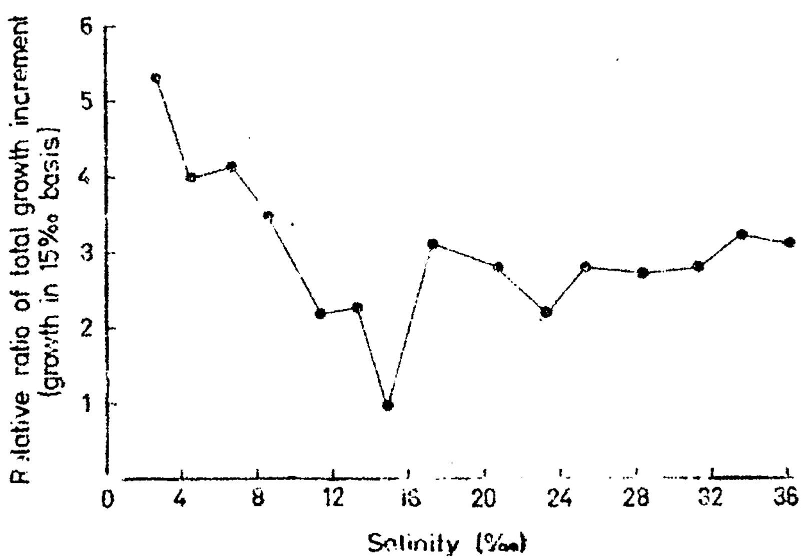

Fig. 6 Total growth increment obtained from young milkfish reared in various salinities as compared with that obtained in 14.90 $\pm$ 0.73 o/oo.

In Taiwan, the traditional milkfish farming faces a serious problem since it is no longer possible to increase the production. Modification or improvement in culture techniques is urgently needed. Determining the optimum salinity range for each growth stage could conceivably be of more value and large scale trials are necessary for confirming the present finding. Thus knowledge gained from these physiological and ecological studies, no doubt, would help increasing the production in milkfish farming.

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