Chapter III

RESULTS

I Growth of mullet (Mugil dussumieri Val.)

The experiment was conducted for 4 weeks. The growth parameters, i.e., length and weight of mullet at the three levels of temperature were shown in Table 1-3. The relationships between the average length and time, the average weight and time and the average length and avarage weight were shown in Figure 4-6, respectively.

At the beginning of the experiment. The average length and weight of the fish at 23.0°C were 8.24 cm and 6.66 gm. After four weeks of treatment, the increment of the average length and average weight were 0.08 cm and 0.5 gm. The length increment rate was approximately 0.02 cm/week.

At 28.0 ± 0.2°C the fish had an average length of 8.50 cm and the average weight of 7.41 gm. After four weeks of treatment, the average length was 8.70 cm and the average weight was 8.30 gm. The increment of length and weight were 0.20 cm and 0.89 gm. The length increment rate was approximately 0.049 cm/week.

At 33.0 ± 0.2°C, the fish had average length of 8.22 cm and the average weight of 6.59 gm. After four weeks of treatment, the average length was 8.41 cm and the average

weight was 7.59 gm. These results showed that the length and weight increment were 0.19 cm and 1.45 gm and the length increment rate was 0.048 cm/week.

Table 1 Growth of mullet (Mugil dussumieri Val.) at 23.0 C. X = time interval (week), Y = mean length of fish in each aquarium (cm).

Y \ X	1	2	3	4	5
Y1	7.95	8.00	8.05	8.08	8.10
Y2	8.20	8.20	8.24	8.26	8.29
Y3	8.26	8.27	8.27	8.30	8.32
Y4	8.34	8.35	8.36	8.38	8.40
Y5	8.45	8.46	8.47	8.48	8.49
average	8.24	8.26	8.28	8.30	8.32

Table 2 Growth of mllet (Mugil dussumieri Val.) at at 28.0 ± 0.2 C. X = time interval (week), Y = mean length of fish in each aquarium (cm)

Y \ X	1	2	3	4	5
Y1	8.37	8.43	8.48	8.53	8.59
Y2	8.44	8.48	8.52	8.57	8.65
Y3	8.45	8.54	8.59	8.62	8.68
Y4	8.60	8.63	8.68	8.72	8.77
Y5	8.64	8.67	8.73	8.76	8.81
Average	8.50	8.55	8.60	8.64	8.70

Table 3 Growth of mullet (Mugil dussumieri Val.) at 33.0 ± 0.2°C. X = time interval (week), Y = mean length of fish in each aquarium (cm)

Y \ X	1	2	3	4	5
Y1	8.04	8.09	8.14	8.20	8.25
Y2	8.06	8.10	8.16	8.21	8.27
Y3	8.16	8.20	8.24	8.29	8.34
Y4	8.41	8.44	8.49	8.54	8.59
Y5	8.43	8.46	8.52	8.56	8.60
Average	8.22	8.26	8.31	8.36	8.41

The linear regression analysis was used to infer the relationship between length and time at the three temperatures. The result of the analysis (Table 4) showed that there was significantly positive linear regression between length and time at 33.0 ± 0.2°C and 28.0 ± 0.2°C but not for the relationship at 23.0°C. The calculated growth rates of the fish at 28.0 ± 0.2°C and 33.0 ± 0.2°C were 0.049 cm/week and 0.048 cm/week, respectively.

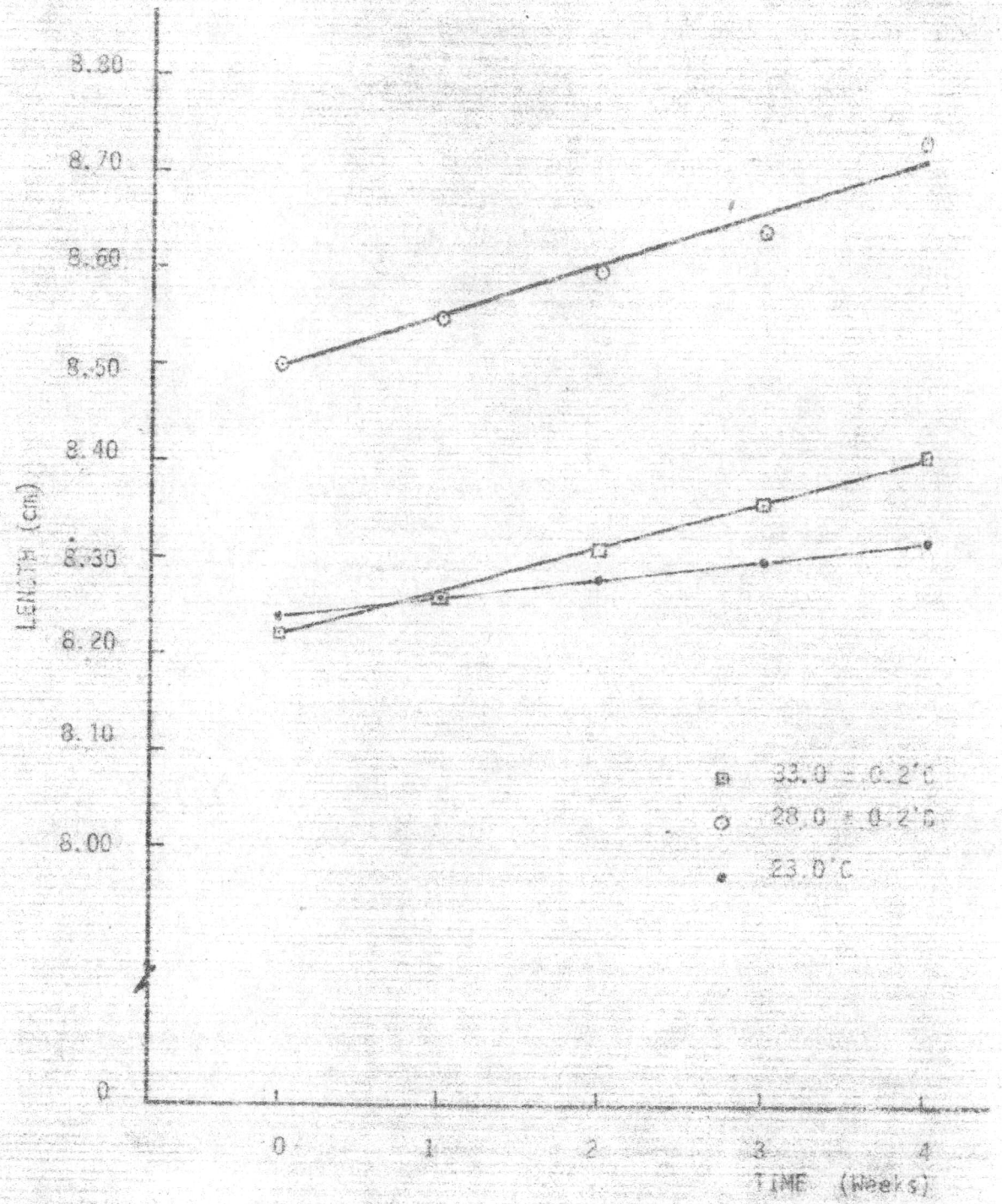

Figure 4 Relationship between length & time of mullet (Mugil dussumieri Val.) at the three temperatures.

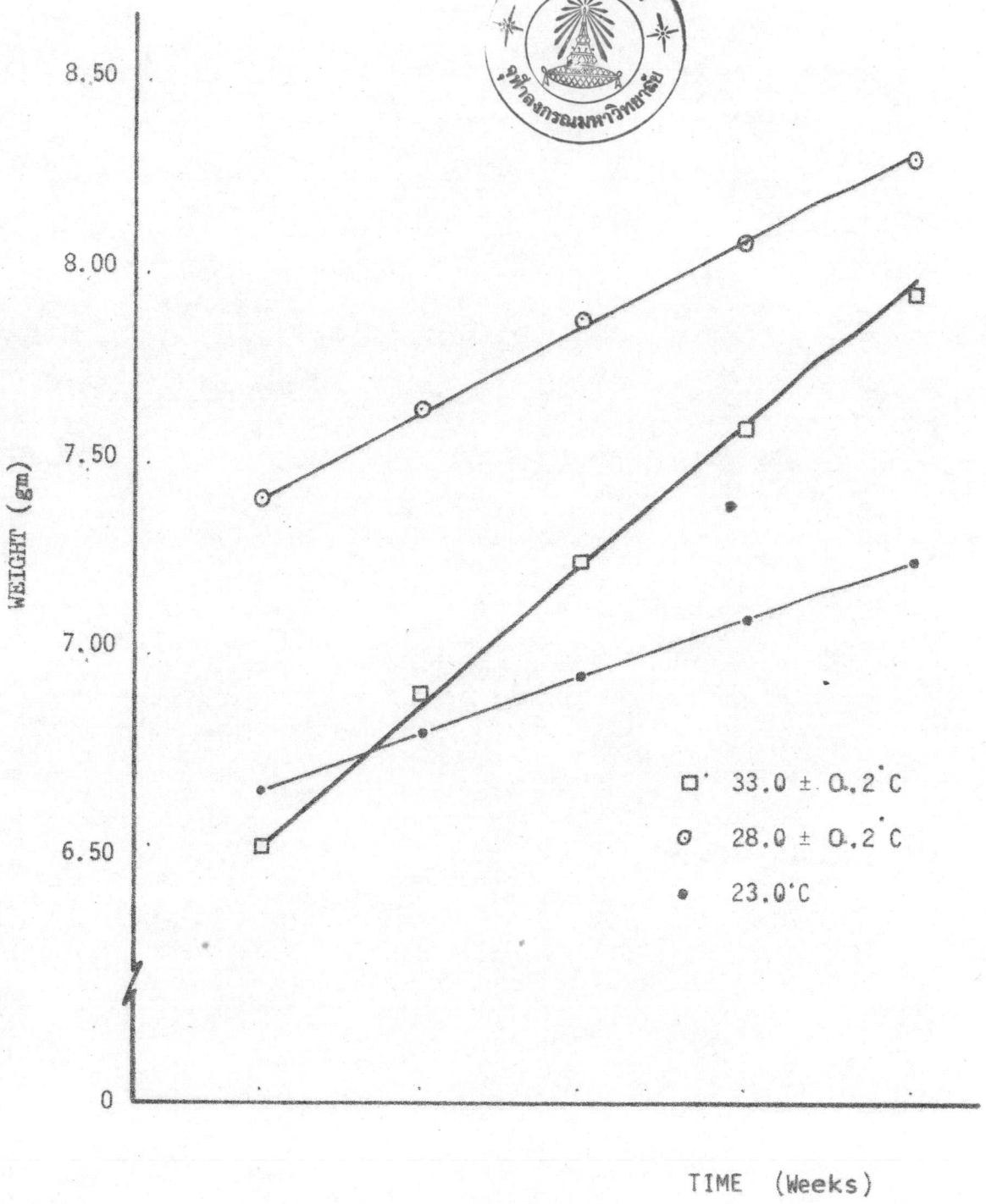

Figure 5 Relationship between weight & time of mullet (Mugil dussumieri Val.) at the three temperatures.

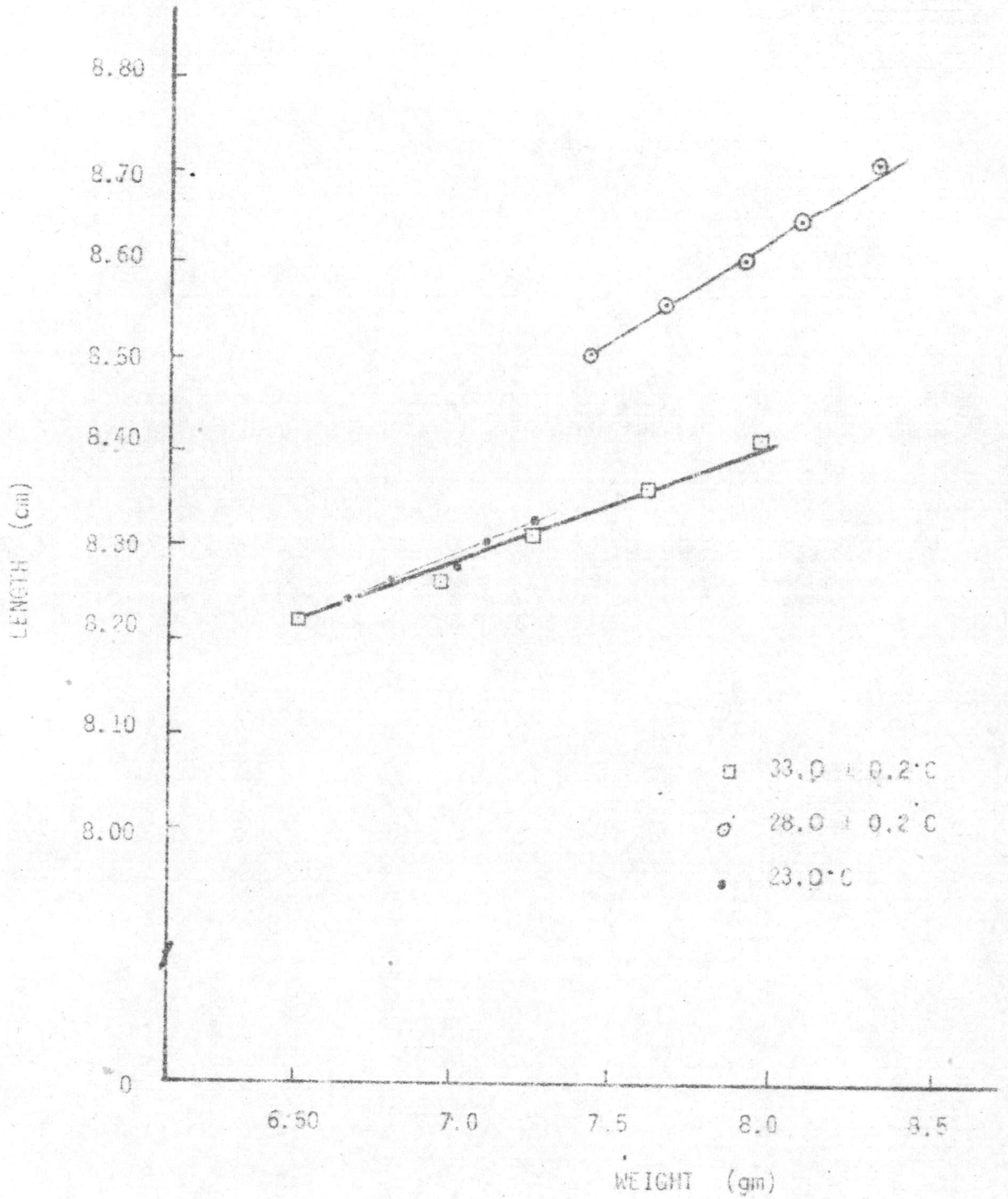

Figure 6 Relationship between length & weight of mullet (Mugil dussumieri Val.) at the three temperatures.

Table 4 Results of the linear regression analysis on growth of mullet (Mugil dussumieri Val.) at three temperatures.

* Significant at 95% level

** Significant at 99% level

Temperature	t calculated	t α .05, t α :01
23.0 C	0.95	2.07, 2.81
28.0 ± 0.2 C	3.73**	
33.0 ± 0.2 C	2.07*	

The covariance analysis was used to infer whether there was any significant different among growth rates at the three temperatures. The result of the analysis showed that there were no significant differences among the three growth rates (Table 5). However, this could not reveal which growth rate were not differed from the others. Therefore furthur covariance analysis by the method of pairing comparision, i.e., 1 & 2, 1 & 3, 2 & 3 had to be used. The result of the analysis (Table 6) showed that the growth rate at 23.0°C did not differ significantly from the growth rate at 33.0 ± 0.2°C and 28.0 ± 0.2°C (Table 7). The growth rate at 28.0 ± 0.2°C did not differed significantly from the growth at 33.0 ± 0.2°C (Table 8).

Therefore, it can be concluded that the growth rate of mullet at 33.0 ± 0.2°C, 28.0 ± 0.2°C and 23.0°C did not statistically differences.

Table 5 Result of the covariance analysis for the relationships among the growth rates of Mugil dussumieri Val. at the three temperatures

S.V.	DF	SS	MS	F value
Due to regression	2	0.026	0.130	0.648
Diviation from regression	69	1.385	0.020	

Table 6 Result of the covariance analysis for the relationships between the growth rates of Mugil dussumieri Val. at 23.0°C and 33.0 ± 0.2°C

S.V.	DF	SS	MS	F value
Due to regression	1	0.021	0.021	0.782
Diviation from regression	46	1.177	0.0	

Table 7 Result of the covariance analysis for the relationship between the growth rates of Mugil dussumieri val. at 23.0°C and 28.0 ± 0.2°C.

S.V.	DF	SS	MS	F value
Due to regression	1	0.02068	0.02068	1.29
Diviation from regression	46	0.736	0.016	

Table 8 Result of the covariance analysis for the relationship between the growth rates of Mugil dussumieri Val. at 28.0 ± 0.2°C and 33.0 ± 0.2°C.

S.V.	DF	SS	MS	F value
Due to regression	1	0.0001	0.0001	0.0056
Diviation from regression	46	0.857	0.0186	

II Growth of seabass (Lates calcarifer [Bloch.])

The experiment was conducted for 8 weeks. The growth parameters, i.e., length and weight of seabass at the three levels of temperature were shown in Table 9-11. The relationships between the average length and time, the average weight and time and the average length and average weight were shown in Figure 7-9, respectively.

At the beginning of the experiment, the average length and weight of fish at 23.0°C were 2.38 cm and 0.20 gm. After eight weeks of treatment, the increment of the average length and average weight were 1.28 cm and 0.55 gm. The length increment rate was approximately 0.163 cm/week.

At 28.0 ± 0.2°C the fish had an average length of 2.18 cm and the average weight of 0.15 gm. After eight weeks of treatment, the average length was 4.51 cm and the average weight was 1.25 gm. The increment of length and weight were 2.33 cm and 1.10 gm. The length increment rate was approximately 0.293 cm/week.

At 33.0 ± 0.2°C, the fish had average length of 2.55 cm and the average weight of 0.25 gm. After eight weeks of treatment, the average length was 4.97 cm and the average weight was 1.25 gm. These results showed that the length and weight increment were 2.42 cm and 1.00 gm. The length increment rate was 0.232 cm/week.

Table 9 The growth of seabass (Lates calcarifer[Bloch.]) at 23.0°C. X = time interval. (week)
Y = mean length of fish in each aquarium. (cm).

Y \ X	0	2	4	6	8
Y1	2.27	2.65	2.96	3.34	3.56
Y2	2.33	2.69	3.02	3.40	3.65
Y3	2.41	2.74	3.06	3.43	3.69
Y4	2.51	2.84	3.16	3.51	3.74
Average	2.38	2.73	3.05	3.42	3.66

Table 10 The growth of seabass (Lates calcarifer [Bloch.]) at 28.0 ± 0.2°C. X = time interval (week), Y = mean length of fish in each aquarium (cm).

Y \ X	0	2	4	6	8
Y1	2.15	2.70	3.29	3.90	4.42
Y2	2.16	2.73	3.33	3.94	4.45
Y3	2.20	2.83	3.42	4.00	4.56
Y4	2.21	2.86	3.48	4.08	4.67
Average	2.18	2.78	3.38	3.98	4.51

Table 11 The growth of seabass (Lates calcarifer [Bloch.]) at 33.0 ± 0.2°C, X = time interval (week), Y = mean length of fish in each aquarium (cm).

Y \ X	0	2	4	6	8
Y1	2.35	2.90	3.80	4.35	4.78
Y2	2.50	3.06	3.97	4.50	4.99
Y3	2.54	3.17	3.99	4.52	5.01
Y4	2.81	3.35	4.04	4.55	5.10
Average	2.55	3.12	3.95	4.48	4.97

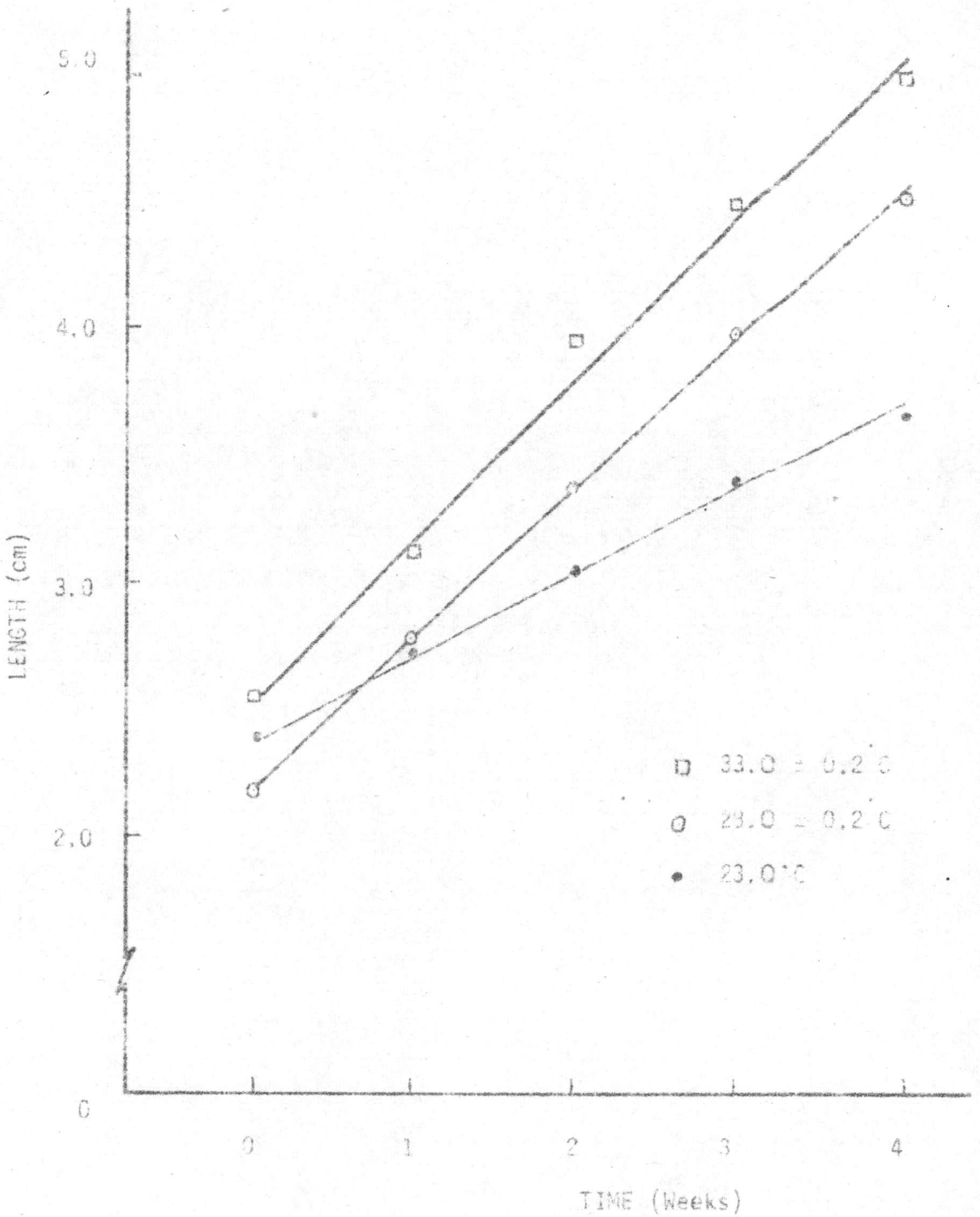

Figure 7 Relationship between length & time of seabass (Lates calcarifer (Bloch.)) at the three temperature.

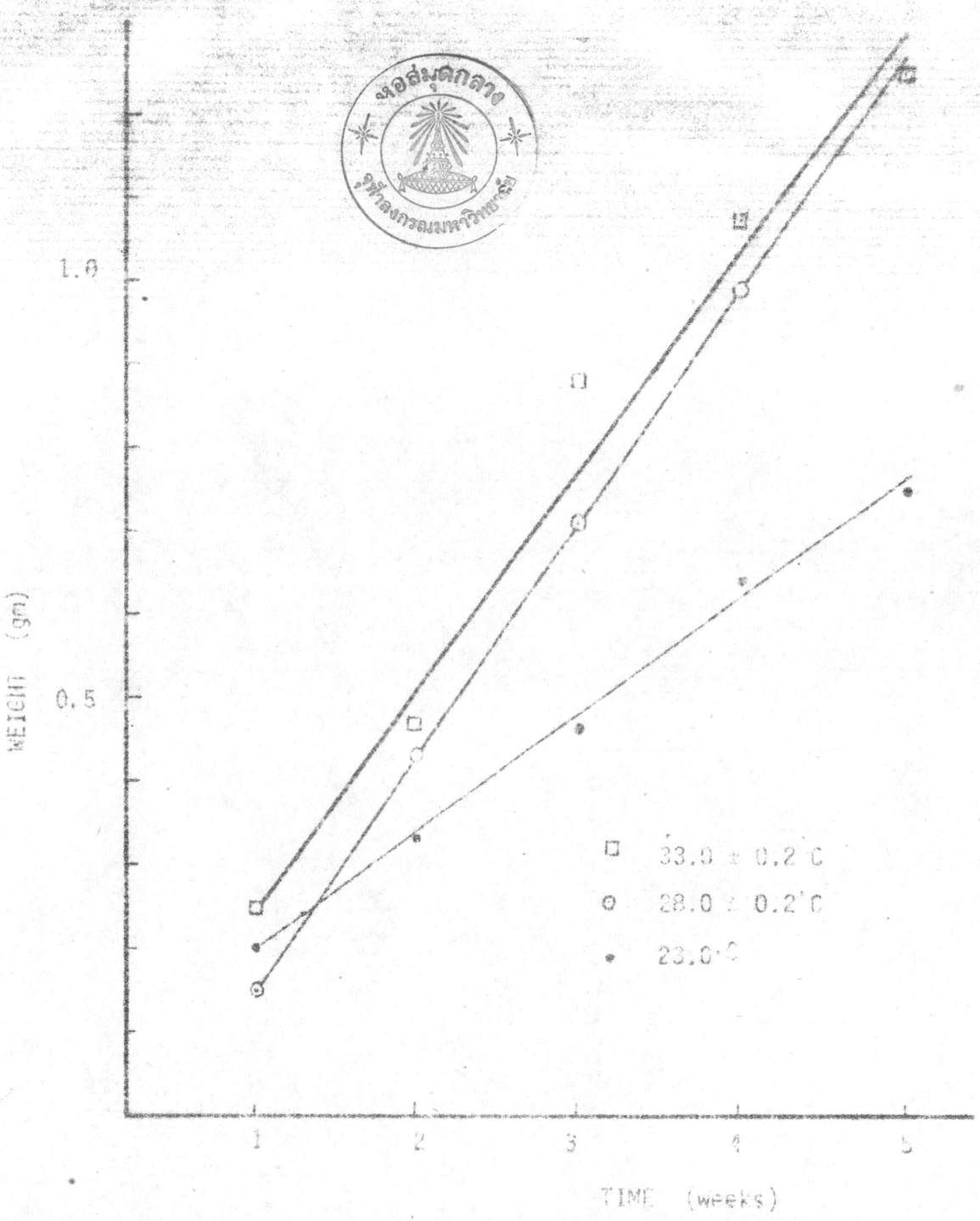

Figure 8 Relationship between weight & time of seabass (Lates calcarifer (Bloch.)) at the three temperatures.

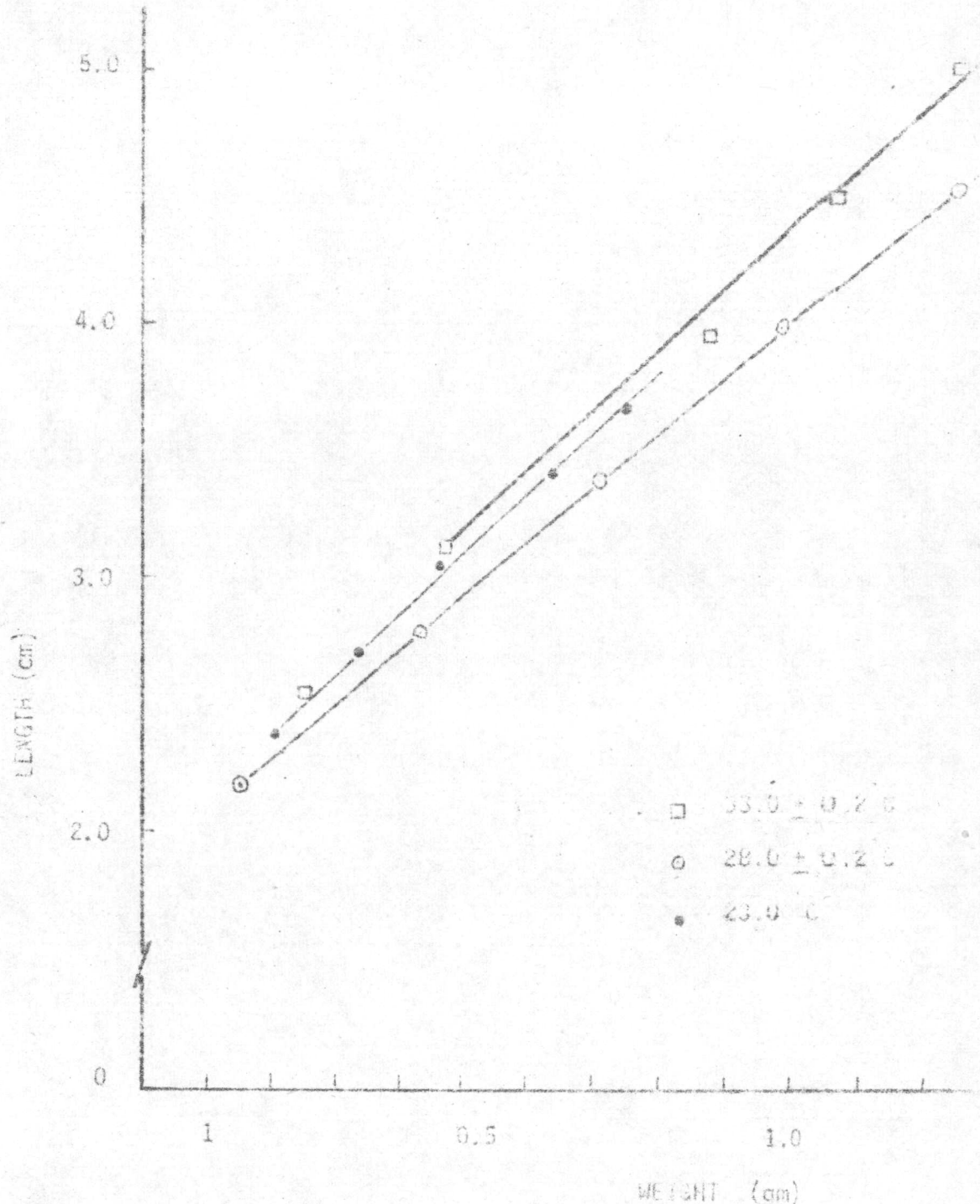

Figure 9 Relationship between length & weight of seabass (Lates calcarifer (Bloch.)) at the three temperatures

The linear regression analysis was used to infer the relationship between length and time at the three temperatures. The result of the analysis (Table 12) showed that there were significantly positive linear regression between length and time at 23.0°C, 28.0 ± 0.2°C and 33.0 ± 0.2°C. The calculated growth rates of the fish at 23.0°C, 28.0 ± 0.2°C and 33.0 ± 0.2°C were 0.163 cm/weeks, 0.293 cm/weeks and 0.232 cm/weeks, respectively.

Table 12 Results of the linear regression analysis on growth of seabass (Lates calcarifer [Bloch.]) at three temperatures.

** Significant at 95% and 99% level

Temperature	t calculated	t α .05, t α .01
23.0°C	24.93**	2.10, 2.88
28.0 ± 0.2°C	51.55**	
33.0 ± 0.2°C	24.42**	

The covariance analysis was used to infer whether there was any significant difference among growth rates at the three temperatures. The result of the analysis showed that there were significant differences among the three growth rates (Table 13). However, this could not reveal which growth

rate differed from the others. Therefore, further covariance analysis by the method of paring comparison, i.e., 1 & 2, 1 & 3, 2 & 3 had to be used. The result of the analysis (Table 14) showed that the growth rate at 23°C differed significantly from the growth rate at 33.0 ± 0.2°C and 28.0 ± 0.2°C Table 15). The growth rate at 28.0 ± 0.2°C did not differ from the growth at 33.0 ± 0.2°C (Table 16). Therefore, it can be concluded that the growth rate of seabass at 28.0 ± 0.2°C was statistically the same as the growth rate at 33.0 ± 0.2°C and the growth rate at 23.0°C was the lowest.

Table 13 Result of the covariance analysis for the relationships among the growth rates of Lates calcalifer [Bloch.]) at the three temperatures

** Significant at 95% and 99% level.

S.V.	DF	SS	MS	F value
Due to regression	2	2.526	1.263	282.87**
Diviation from regression	54	0.241	0.0045	

Table 14 Result of the covariance analysis for the relationships between the growth rates of Lates calcarifer [Bloch.] at 23.0°C and 33.0 ± 0.2°C

** Significant at 95% and 99% level

S.V.	DF	SS	MS	F value
Due to regression	1	1.7433	1.7433	107.06**
Diviation from regression	36	0.5862	0.0163	

Table 15 Result of the covariance analysis for the relationships between the growth rates of Lates calcarifer [Bloch.]) at 23.0°C and 28.0 ± 0.2°C.

** Significant at 95% and 99% level

S.V.	DF	SS	MS	F vale
Due to regression	1	1.3662	1.3662	228.38**
Diviation from regression	36	0.2154	0.00598	

Table 16 Result of the covariance analysis for the relationships between the growth rate of Lates calcarifer (Bloch.) at 28.0 ± 0.2 C and 33.0 ± 0.2 C

S.V.	DF	SS	MS	F value
Due to regression	1	0.0244	0.0244	1.58
Diviation from regression	36	0.5569	0.0155	

III Growth of spinefoot (Siganus virgatus Cuv. & Val.)

The experiment was conducted for 4 weeks. The growth parameters, i.e., length and weight of spinefoot at the three levels of temperature were shown in Table 17-19. The relationships between the average length and time, the average weight and time and the average length and average weight were shown in Figure 10-12, respectively.

At the beginning of the experiment. The average length and weight of the fish at 23.0°C were 3.13 cm and 0.24 gm. After three weeks of treatment, the increment of the average length and average weight were 0.77 cm and 0.69 gm. The length increment rate was approximately 0.258 cm/week.

At 28.0 ± 0.2°C, the fish had an average length of 2.98 cm and the average weight of 0.25 gm. After three weeks of treatment, the average length was 3.99 cm and the average weight was 1.18 gm. The increment of length and weight were 1.01 cm and 0.93 gm, the length increment rate was approximately 0.248 cm/week.

At 33.0 ± 0.2°C, the fish had average length of 2.88 cm and the average weight of 0.24 gm. After three weeks of treatment, the average length was 4.30 cm and the average weight was 1.60 gm. These results showed that the length and weight increment were 1.42 cm and 1.36 gm and the length increment rate was 0.473 cm/week. The thermostat of the treatment at 33.0 ± 0.2°C was out of order during the forth week of the experiment so that data was collected only during the first three weeks.

Table 17 Growth of spinefoot (Siganus virgatus Cuv.& Val.) at 230°C, X = time interval (week), Y = mean length of fish in each aquarium (cm).

Y \ X	1	2	3	4
Y1	3.08	3.34	3.60	3.81
Y2	3.09	3.39	3.61	3.83
Y3	3.16	3.40	3.70	3.93
Y4	3.20	3.43	3.72	4.04
Average	3.13	3.39	3.66	3.90

Table 18 Growth of spinefoot (Siganus virgatus Cuv. & Val.) at 28.0 ± 0.2°C, X = time interval (week), Y = mean length of fish in each aquarium (cm).

Y \ X	1	2	3	4
Y1	2.85	3.14	3.37	3.62
Y2	2.88	3.22	3.41	3.66
Y3	3.04	3.30	3.57	3.74
Y4	3.10	3.36	3.59	3.85
Average	2.98	3.26	3.49	3.99

Table 19 Growth of spinefoot (Siganus virgatus Cuv. & Val.) at 33.0 ± 0.02°C. X = time interval (Week), Y - mean length of fish in each aquarium (cm).

Y \ X	1	2	3	4
Y1	2.83	3.30	3.75	4.22
Y2	2.87	3.35	3.76	4.29
Y3	2.91	3.37	3.78	4.34
Y4	2.92	3.39	3.96	4.37
Average	2.88	3.35	3.81	4.30

The linear regression was used to infer the relationship between length and time at the three temperatures. The result of the analysis (Table 20) showed that there were significant positive linear regression between length and time at 23.0°C, 28.0 ± 0.2°C and 33.0 ± 0.2°C. The calculated growth rates of the fish at 23.0°C, 28.0 ± 0.2°C and 33.0 ± 0.2°C were 0.258 cm/week, 0.248 cm/week and 0.473 cm/week, respectively.

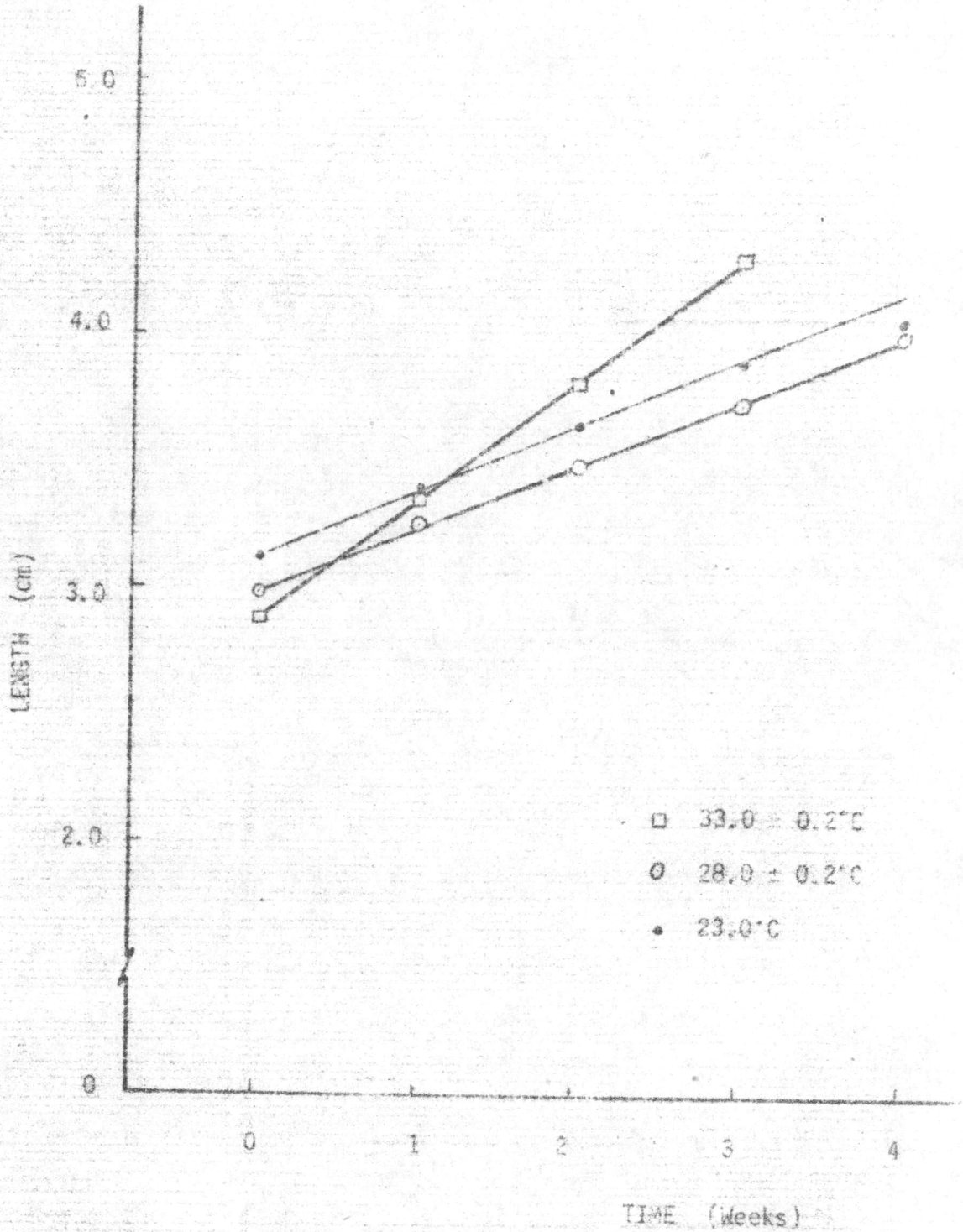

Figure 10 Relationship between length & time of spinefoot (Siganus virgatus Cuv. & Val.) at the three temperatures.

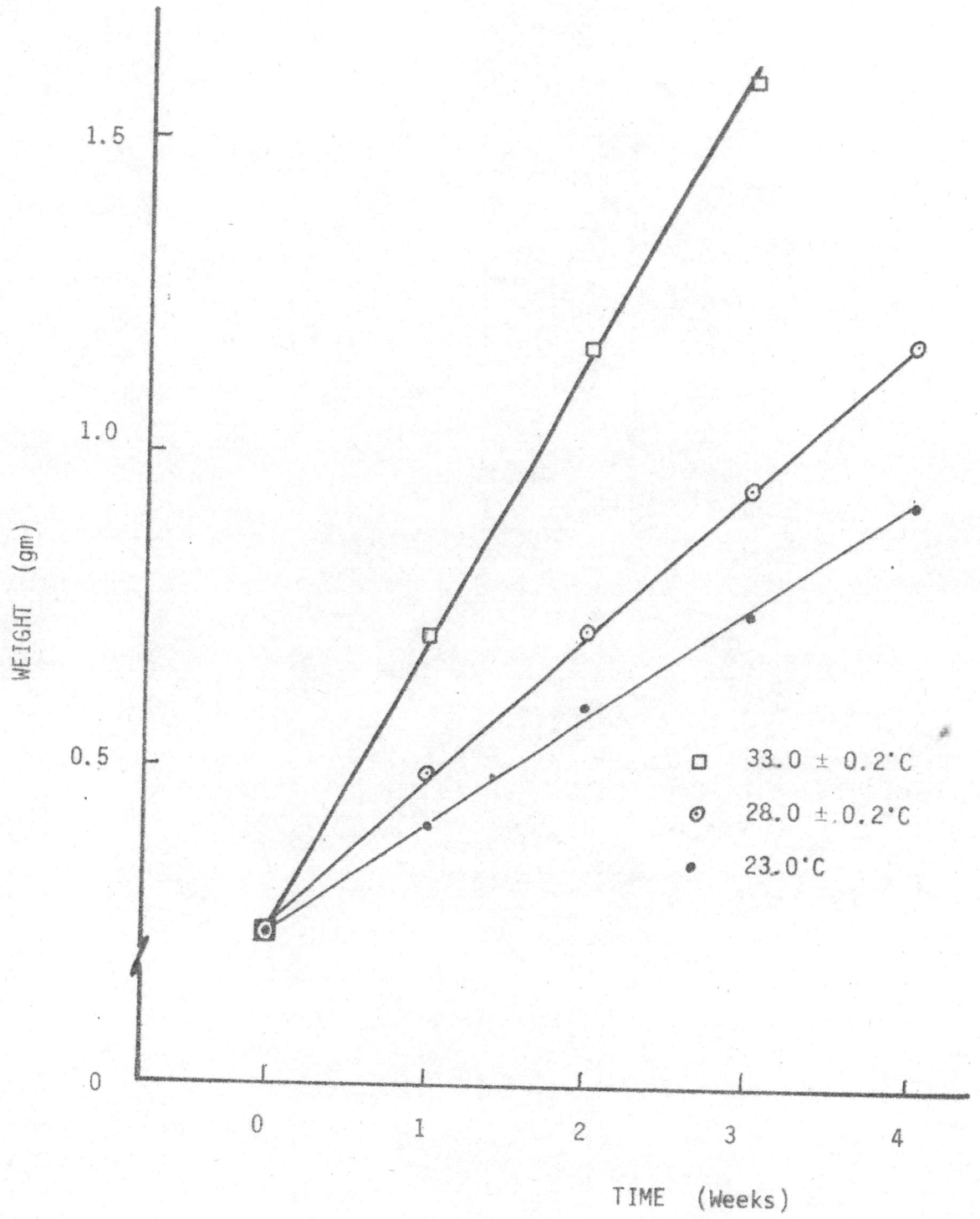

Figure 11 Relationship between weight & time of spinefoot (Siganus virgatus Cuv. & Val.) at the three temperatures

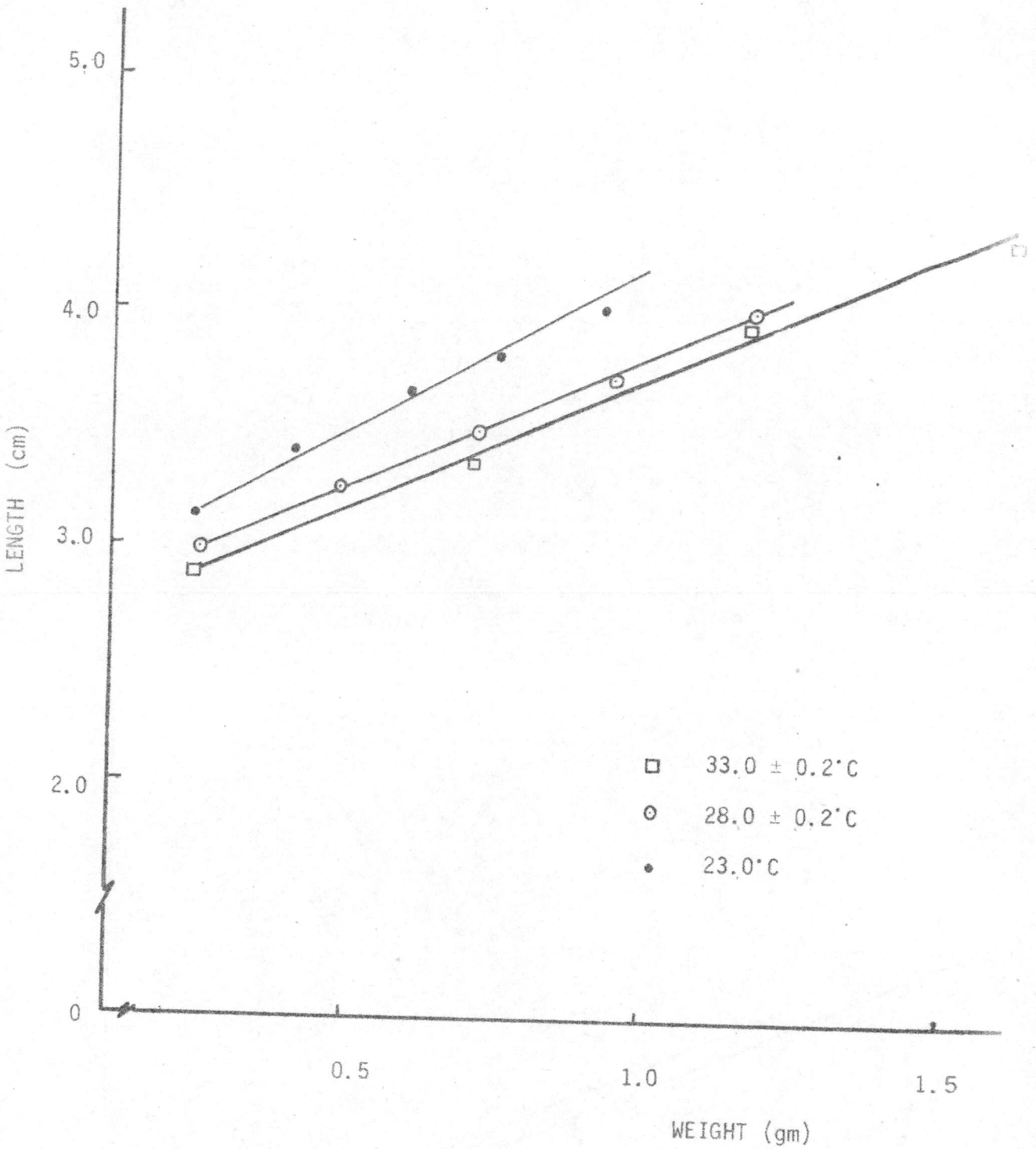

Figure 12 Relationship between length & weight of spinefoot (Siganus virgatus Cuv. & Val.) at the three temperatures.

Table 20 Results of the linear regression analysis on growth of spinefoot (Siganus virgatus Cuv. Val.) at three temperatures.

** Significant at 95% and 99% level

Temperature	t calculated	t α .05, t α .01
23.0 C	17.42**	2.14, 2.98
28.0 ± 0.2°C	11.07**	
33.0 ± 0.2°C		

The covariance analysis was used to infer whether there was any significant difference among growth rates at the three temperatures. The result of the analysis showed that there were significant differences among the three growth rates (Table 21). However, this could not reveal which growth rate differed from the others. Therefore, further covariance analysis by the method of pairing comparison, i.e., 1 & 2, 1 & 3, 2 & 3 had to be used. The result of the analysis (Table 22) showed that the growth rate at 23.0°C differed significantly from the growth rate at 33.0 ± 0.2°C but not for the growth rate at 28.0 ± 0.2°C (Table 23). The growth rate at 28.0 ± 0.2°C differed significant from the growth at 33.0 ± 0.2°C (Table 24). Therefore, it can be concluded that

the growth rate of spinefoot at 33.0 ± 0.2°C was the highest and followed by the growth rate of 23.0°C.

Table 21 Result of the covariance analysis for the relationship among the growth rates of Siganus virgatus Cuv. & Val. at the three temperatures.

** Significant at 95% and 99% level.

S.V.	DF	SS	MS	F value
Due to regression	2	0.6464	0.3232	53.51**
Diviation from regression	42	0.2536	0.00604	

Table 22 Result of the covariance analysis for the relationship between the growth rates of Siganus virgatus Cuv. & Val. at 23.0°C and 33.0 ± 0.2°C

** Significant at 95% and 99% level.

S.V.	DF	SS	MS	F value
Due to regression	1	0.4627	0.4627	113.94**
Diviation from regression	28	0.1137	0.00406	

Table 23 Result of the covariance analysis for the relationship between the growth rates of Siganus virgatus Cuv. & Val. at 23.0°C and 28.0 ± 0.2°C.

S.V.	DF	SS	MS	F value
Due to regression	1	0.00104	0.00104	0.15
Diviation from regression	28	0.1986	0.00709	

Table 24 Result of the covariance analysis for the relationship between the growth rates of Siganus virgatus Cuv. & Val. at 28.0 ± 0.2°C and 33.0 ± 0.2°C.

** Significant at 95% and 99% level

S.V.	DF	SS	MS	F value
Due to regression	1	0.50669	0.50669	72.79**
Diviation from regression	28	0.1949	0.00696	

Mortality

I Mortality of Mullet (Mugil dussumieri Val.)

The mortality of mullet was observed during the course of experiment. The specimens had the highest mortality at 33.0 ± 0.2°C and the lowest mortality at 23.0°C (Table 25).

Table 25 Mortality of mullet (Mugil dussumieri Val.) at the three temperatures.

Temperature °C \ day	0	7	14	21	28	Total
23.0 C	0	3	4	6	2	15
28.0 ± 0.2 C	0	5	7	9	2	23
33.0 ± 0.2 C	0	9	5	16	2	32

II Mortality of seabass (Lates calcarifer Bloch.)

Table 26 showed the mortality of seabass. The fish began to die at 15 days after the beginning of the experiment. The mortality was less at the lower temperature.

Table 26 Mortality of Seabass (Lates calcarifer Bloch.) at the three temperature.

Temperature \ day	0	14	28	42	56	Total
23.0 C	0	0	5	3	2	10
28.0 ± 0.2 C	0	0	7	18	2	27
33.0 ± 0.2 C	0	0	9	17	9	35

III Mortality of spinefoot (Siganus virgatus Cuv. & Val.)

The mortality of spinefoot in the laboratory condition was less when compared with those of mullet and seabass. There was no testing fish death occurring at 23.0°C and only 4 specimens died at 28.0 ± 0.2°C on the last week of the experiment. (Table 27). The thermostat of the treatment at 33.0 ± 0.2°C was out of order during the forth week of the experiment and all specimens died.

Table 27 Mortality of spinefoot (Siganus virgatus Cuv. & Val.) at the three temperatures during the 28 days of treatment.

* Thermostat was out of order and all specimens died.

Temperature°C \ day	0	7	14	21	28	Total
23.0°C	0	0	0	0	0	0
28.0 ± 0.2°C	0	0	0	0	4	4
33.0 ± 0.2°C	0	0	0	7	*	