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Seasonal Variation of Length-Weight Relationship of *Mystus vittatus* (Bloch, 1794) in Two Different Aquatic Habitat

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Abstract

In present study length weight relationship is observed in two different seasons in two different aquatic habitat of a total 96 no. of fishes. The experimental fishes were collected from Kangsabati river and a natural pond of Midnapore town during April 2016 – June 2016 (3 months) and July 2016 – September 2016 (3 months) i.e. Summer and Monsoon. Length of experimented fishes ranged from 7.6cm to 22.86cm in pond water, during summer whereas in river varies from 7.0 cm to 14.47cm. Weight of fishes also varies from 4.5gm to 24.09gm in pond water during summer, whereas in the same time in river it's fluctuates from 3.4gm to 13.87gm. In monsoon length of pond fishes ranged from 9cm to 10.25cm, whereas in river length ranged from 9.1cm to 11.43cm. Weight ranged from 4.4gm to 8.98gm in pond fishes and 7.87gm to 11.28gm in river fishes during monsoon. To calculate length weight relationship Le Cren formula is followed, $W = a + L^b$. Length –weight data were transformed into logarithmic form then graphically plotted. In every cases the scatter diagram shows linear relationship in between log length and log weight of the fish. In all cases the relationship of logarithmic values of length and weight was found positive and highly significant justifying a strong relationship in between length and weight. During summer the correlation co-efficient value is significant at 0.01 level (2-tailed) both in case of river and pond collected fishes. During monsoon this values were significant at 0.05 level both in two habitats. R^2 values of riverine fishes are 0.8605 and 0.7215 in case of pond collected during summer and justify the two good fitted models. Whereas R^2 values are 0.3232 and 0.1714 in case of river and pond fishes respectively during monsoon and justify models were not much good fitted. 't-test' calculation has done to compare seasonal variations between two variables (one is length and another is weight) and this result is significant in many cases but insignificant in some cases. Therefore, the results establish that calculated t-values were greater than tabulated t-value both in case of one-tail and two-tail that establish significant difference between two variables in different season, except in case of length of fishes collected from river, that means no seasonal difference found in length between two seasons.

Keywords: *Mystus vittatus*, Length weight relationship, different habitat, seasons, correlation, regression t-test.

INTRODUCTION

Mystus vittatus is an indigenous freshwater fish species with high market demand due to it's nutritive value, easy to digest and ornamental fish status. Length weight relationship are important in fisheries science because it gives biological information, helps in assessing the variations from the expected weight of known length groups, computing the biomass of a sample, mathematical relationship between two variables (length and weight). *Mystus vittatus* is an important fresh water cat fish found in Pakisthan, Bangladesh, India, Mayanmar, Sri Lanka and Nepal (Jayaram,1977; Jhingran,1991; Rahaman *et. al, 2012). It* can survive in tough environmental conditions such as, wide ranges of temperature and low oxygen concentration (Akhteruzzaman *et. al*, 1991). Length weight relationship is important parameter for assessing well being fishes in different seasons, different habitat and in different conditions. In fisheries science length-weight relationship study of fish is prime important work for fish production and biomass estimation (Anderson and Gutreuter,1983 ;Pauly D, 1993; Petrakis and Stergiou,1995 ; Safran,1992 ; Dulcic and Kraljevic, 1996). Length-weight relationship is one of the scientific tool for demonstrating the survival, growth, maturity, reproduction and general well-being of fishes (Le Cren,1951). It has been widely used in fisheries biology with several purposes: to predict weight from known length to calculate standing crop age structure and function of fish population, growth study, to make seasonal differences. It also helps in comparisons between regions (Petrakis and Stergiou, 1995 ; Goncalves *et al*, 1997 ; Haimovici and Velasco, 2000 ; Ozaydin *et. al*, 2007). Thus these parameters are of great importance in fishery assessment, more important for proper exploitation and management of fish population (Haimovici and Velasco, 2000).

MATERIALS AND METHODS

A total no. of 96 fish species belonging to all available sizes of both male and female are observed from Kangsabati river of Midnapore sadar areas and a pond located at Midnapore town. Latitude and longitude of Midnapore town is 22.4257^0 N, 87.3199^0 E. respectively. Specimens were collected at random in two different seasons and from two different aquatic habitat. 24 number of fishes are collected from river and 24 from pond separately during summer. Another way 24 number of fishes collected from river and 24 from pond separately during monsoon. Fishes are c0llected and directly kept in ice bag to die fish directly as well as ice acts as fixative for sometimes and also to avoid decomposing. In the laboratory fishes are blotted and air dried, only to measure actual weight and to remove the mucous from outer surface to handle fish easily. Length is measured by a graduated scale in cm whereas weight is measured by an electric balance in gm, results are recorded in an exercise book. Maximum recorded value of length of this fish is 20.2cm (Shafi and Quddus,2001). But in our experiments the maximum value of length is 22.86 cm which is larger than recorded value. Length weight data are analyzed by Le Cren, 1951 formula. The equation is $W = {}_aL^b$ where W = total weight of fish in gm, L = total length of fish in cm, a = co-efficient related to body form, b = an exponent indicating isometric growth which is equal to 3.0 (Wooton,1990). If the result of $b>3$ means positive allometric growth whereas if $b<3$ means negative allometric growth (Levent et al, 2007). If the equation is expressed in logarithmic forms it will be $\text{Log } W = \text{Loga} + b \text{ Log } L$. Calculated values are graphically plotted which is shown in scattered diagram. To calculate correlation co-efficient, regression statistics, ANOVA, t-test SPSS software and MS EXCEL have used.

RESULTS

During summer two types of experiment were done. One of them was on pond fishes and another one was on river fishes. In case of pond, length of experimented fishes were ranged from 7.6 cm – 22.86 cm and weight ranged from 4.5 gm. – 24.09 gm. In case of river, length of experimented fishes were ranged 7 cm - 14.47 cm and weight ranged from 3.4 gm. - 13.87 gm. All these collected data are converted into logarithmic form by MS- EXCEL to estimate length weight relationship. After that data are graphically plotted which is shown in the form of scattered Diagram. Fig-1 is the scattered diagram of pond fishes in summer and Fig-2 is of river fishes in summer. Both diagrams are showing straight line or linear form. This linear form establish length and weight are related here. That means there is a relationship.

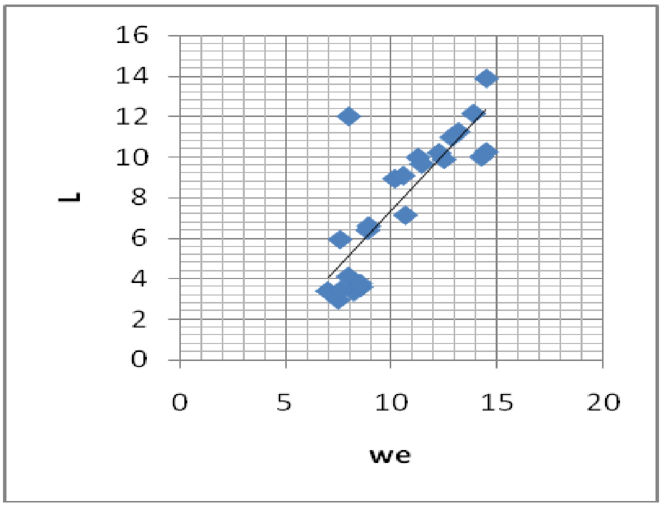

Fig -1: Length-weight relationship of experimental fishes in pond during summer

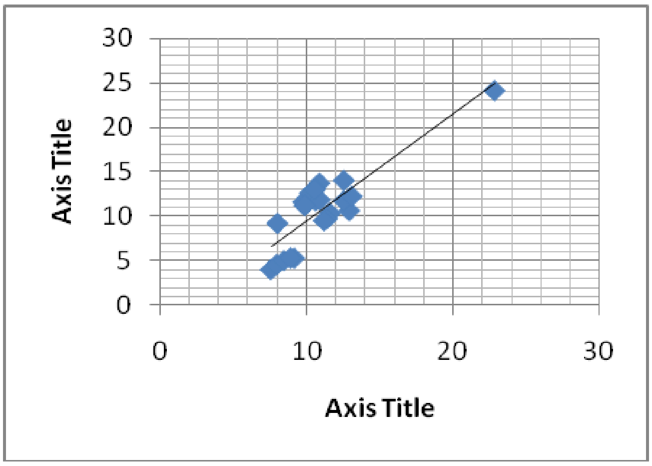

Fig-2: Length-weight relationship of experimental fishes in the river during summer

In case of Monsoon two types of experiment were done. One of them was on pond fishes and another one was on river fishes. In case of pond, length of experimented fishes were ranged from 9 cm – 10.25 cm and weight ranged from 4.4 gm. – 8.98 gm. In case of river, length of experimented fishes were ranged 9.1 cm-11.43 cm and weight ranged from 7.87 gm- 11.28 gm. All these collected data are converted into logarithmic form to estimate length weight relationship. After that data are graphically plotted which is shown in the form of scattered Diagram. Fig-3 is of Monsoon pond fishes and Fig-4 is of Monsoon river fishes. Both diagrams are showing almost straight line or linear form. Whereas in Fig-4 plotted data are slightly scatter. This linear form establish length and weight are related here. That means there is a relationship.

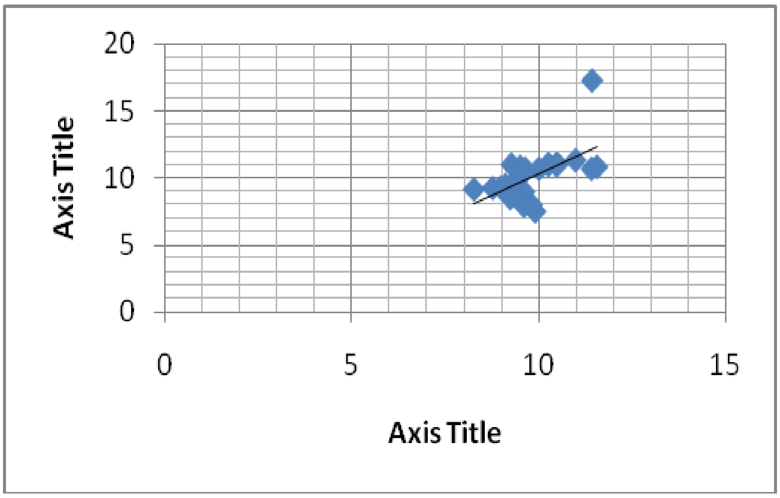

Fig- 3: Length-weight relationship of experimental fishes in pond during monsoon period

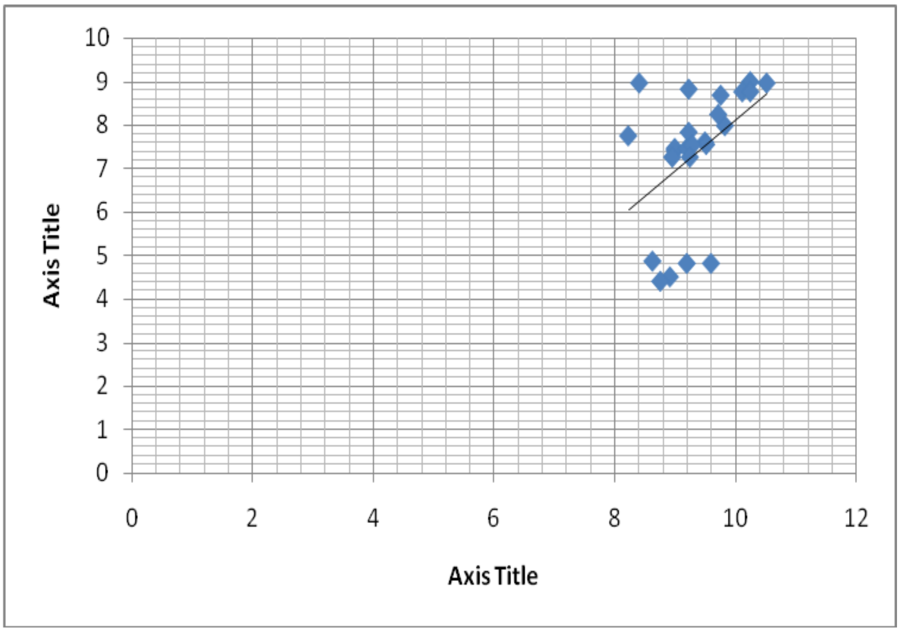

Fig-4: Length-weight relationship of experimental fishes in the river during monsoon period

Axis Title-:X-axis represents weight and Y-axis represents length in Fig-1, to Fig-4

Calculation of co-efficient of correlation presented in table no. 1, 2, 3, 4. Result of correlation is significant at 0.01 level (2-tailed) during summer both in pond and river system. On the other hand result of correlation is significant at 0.05 level (2-tailed) during monsoon both in pond and river system. These correlation results justify that there is a strong relationship in between length and weight of fish.

Table 1: Correlation result of experimental fishes during summer in river

Correlations	Correlations				
		Length	Weight		
Length	Pearson Correlation	1	.823**		
Weight	Pearson Correlation	.823**	1		
**. Correlation is significant at the 0.01 level (2-tailed)					

Table-2: Correlation result of experimental fishes during summer in pond

Correlations	Correlations				
		Length	Weight		
Length	Pearson Correlation	1	.848**		
Weight	Pearson Correlation	.848**	1		
**. Correlation is significant at the 0.01 level (2-tailed).					

Table-3: Correlation result of experimental fishes during monsoon in river

Correlations	Correlations	Length	Weight
Length	Pearson Correlation	1	0.585
Weight	Pearson Correlation	0.585**	1
*. Correlation is significant at the 0.05 level (2-tailed).			

Tablee4: Correlation result of experimental fishes during monsoon in pond

Correlations	Correlations	Length	Weight
Length	Pearson Correlation	1	.449
Weight	Pearson Correlation	.449*	1
*. Correlation is significant at the 0.05 level (2-tailed).			

SPSS output for estimation and testing the significance of regression (ANOVA) is presented in Table No 5,6,7,8. The significance of calculated regression is tested through ANOVA. The functional form of relationship in between length and weight is tested through the formula $W = {}_{a}L^{b}$ (log W = log a + blog L). During summer, riverine fishes, the result of ‘a’ is -4.9831 and ‘b’ is 1.2074, but in pond fishes result of ‘a’ is -1.3605 and ‘b’ is 1.1280. During monsoon, riverine fishes, the result of ‘a’ is -0.2325 and ‘b’ is 1.110, but in pond fishes result of ‘a’ is -1.523 and ‘b’ is 1.5646. In regression statistics the R^2 value of riverine fishes during summer is 0.8605 but in pond fishes the value of R^2 is 0.7347. The value of R^2 in riverine fishes during monsoon is 0.3232 but in pond fishes R^2 is 0.1714.

Table-5: Regression Result of experimental fishes in riverine system during summer period

Regression Statistics	
Multiple R	0.927671232
R Square	0.860573914
Adjusted R Square	0.85360261
Standard Error	1.266088689
Observations	24

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	197.8802	197.8802	123.44518	5.23478E-10
Residual	20	32.05961	1.602981		
Total	21	229.9398			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-4.983124668	1.187671	-4.19571	0.000	-7.460563943	-2.50569	-7.46056	-2.50569
LR	1.207486194	0.108679	11.11059	0.000	0.980786049	1.434186	0.980786	1.434186

LR- Length of river fish

Table 6: Regression Result of experimental fishes in pond culture system during summer period

Regression Statistics	
Multiple R	0.857199561
R Square	0.734791087
Adjusted R Square	0.721530641
Standard Error	2.118087924
Observations	24

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	248.5958	248.5958	55.412247	3.48273E-07
Residual	20	89.72593	4.486296		
Total	21	338.3217			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-1.360519632	1.742896	-0.78061	0.44417	-4.996137934	2.275099	-4.99614	2.275099
LP	1.128038921	0.151538	7.44394	0.00000	0.811936445	1.444141	0.811936	1.444141

LP- Length of pond fish

Table 7: Regression Result of experimental fishes in riverine system during Monsoon period

Regression Statistics								
Multiple R	0.568543							
R Square	0.323241							
Adjusted R Square	0.29248							
Standard Error	0.141617							
Observations	24							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	0.210740779	0.210741	10.5079	0.003745872			
Residual	22	0.441220138	0.020055					
Total	23	0.651960917						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.23525	0.783678781	-0.30018	0.766856	-1.860496884	1.390004	-1.860497	1.39
LRiver	1.110966	0.342722795	3.241589	0.003746	0.400202917	1.82173	0.4002029	1.82173

LRiver- Length of river fish

Table 8: Regression Result of experimental fishes in Pond culture system during Monsoon period

Regression Statistics								
Multiple R	0.41407							
R Square	0.171454							
Adjusted R Square	0.133793							
Standard Error	0.220271							
Observations	24							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	0.220885	0.220885	4.552536	0.044267			
Residual	22	1.067421	0.048519					
Total	23	1.288306						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-1.52398	1.638437	-0.93014	0.36239	-4.92189	1.873932	-4.92189	1.873932
LPond	1.564678	0.733328	2.133667	0.04427	0.043849	3.085508	0.043849	3.085508

LPond- Length of pond fish

t-test has done to compare seasonal variation of length and weight of fishes in two different habitat which are presented in Table no 9,10,11,12.

Table-9: t-test result of length of fishes collected from river between summer and monsoon

t-Test: Two-Sample Assuming Unequal Variances		
	LRS	*LRM*
Mean	10.44458	9.861667
Variance	6.355713	0.741136
Observations	24	24
Hypothesized Mean Difference	0	
df	28	
t Stat	1.071962	
P(T<=t) one-tail	0.146445	
t Critical one-tail	1.701131	
P(T<=t) two-tail	0.29289	
t Critical two-tail	2.048407	
	insigni	

LRS- Length of river fishes in summer

LRM- Length of river fishes in monsoon

Table-10: t-test result of weight of fishes collected from river between summer and monsoon

	WRS	*WRM*
Mean	7.868333	10.15333
Variance	11.47343	3.60198
Observati	24	24
Hypothesi	0	
df	36	
t Stat	-2.88308	
P(T<=t) on	0.003303	
t Critical o	1.688298	
P(T<=t) tw	0.006605	
t Critical t	2.028094	

WRS -Weight of river fishes in summer

WRM- Weight of river fishes in monsoon

Significant result

Table-11: t-test result of length of fishes collected from pond between summer and monsoon

	LPS	*LPM*
Mean	10.93917	9.349167
Variance	8.825121	0.343695
Observati	24	24
Hypothesi	0	
df	25	
t Stat	2.572445	
P(T<=t) on	0.008212	
t Critical o	1.708141	
P(T<=t) tw	0.016424	
t Critical tv	2.059539	

LPS- Length of pond fishes in summer
LPM- Length of pond fishes in monsoon

Significant result

Table-12: t-test result of weight of fishes collected from pond between summer and monsoon

	WPS	*WPM*
Mean	10.67625	7.352917
Variance	17.51308	2.31323
Observati	24	24
Hypothesi	0	
df	29	
t Stat	3.656441	
P(T<=t) on	0.000504	
t Critical o	1.699127	
P(T<=t) tw	0.001008	
t Critical tv	2.04523	

WRS -Weight of pond fishes in summer

WRM- Weight of pond fishes in monsoon

Significant result

DISCUSSION

Length-weight relationship is done by the formula proposed by Le cren, it is $W = aL^b$ which is previously mentioned. Here, two variables are present. One is 'Length' and other is 'Weight'. 'Length is independent variable whereas 'Weight' is dependent variable. Length-weight data are transformed into logarithmic form. 'b' (regression co-efficient) is an exponent and in all observed cases value of 'b' is less than 3 ($b<3$) , it proves that it is negative allometric growth pattern not isometric as 'b' value below 3. It means that they are favour to increase in length than in mass in environmental conditions. Earlier study reported on length-weight relationship on catfish performed by Paiboon Panase and Kriangsak Mengumphan, 2015 and showed negative growth pattern where b values were 2.63 and 2.03. In all cases scattered diagrams show almost linear relationship. Awasthi et al, 2015 estimated length-weight relationship on *Trichogaster lalius* from different pond ecosystem of eastern and central regions of India. The study shows negative allometric growth. Correlation results in summer are highly significant in both river and pond fishes, as it is significant at 0.01 level but in monsoon it is significant at 0.05 level both in river and pond fishes. In comparison between two seasons the result of significance of correlation is higher in summer than monsoon. It means the relationship of length-weight in summer is more significant than monsoon. It may be due to some water parameters or their physiological factors are responsible for it. Pal et. al, 2013 reported length-weight relationship on *Puntius sophore* , where the result of correlation was found to be 0.934 showed a strong correlation. SPSS software is used to estimate regression. ANOVA is estimated to prove whether the data are statistically significant or not. In regression statistics the R^2 value of riverine fishes during summer is 0.8605 but in pond fishes the value of R^2 is 0.7347. These two values are significant and establish a strong relationship between length and weight in summer season both in river and pond water. The value of R^2 in riverine fishes during monsoon is 0.3232 but in pond fishes R^2 is 0.1714. These two values are less significant than summer values as found in correlation. Pal et. al, 2013 reported length-weight relationship on *Puntius sophore* , where the result of R^2 was 0.871 which is highly significant as we found 0.8605 in our experiment. Regression statistic is also proves that the relationship between two variables is highly significant in summer than in monsoon. Result of river fishes, establish much significant relationship (0.8605) than pond fishes (0.7347) in summer. On the other hand the relationship between two variables in monsoon is less significant than summer. Moreover, monsoon pond fishes establish very less significant result (0.1714) than monsoon river fishes (0.3232). It may be due to changes in water parameters, as heavy rainfall occur, some pesticides can mix with water bodies, as cultivated fields are flooded and drain into the water bodies etc. So growth rate may be hampered. T-test statistics estimate the differences between two variables season wise and habitat wise. Mean value shows the difference two variables but t-test establish whether the value is significantly different or not. Here, in river water length of fishes between summer and monsoon are showing insignificant result, because calculated t value is 1.071, which is less than tabulated t value, 1.701 in one-tail and 2.048 in two-tail. It means there is no significant difference in length of fishes in river both in summer and monsoon. Therefore, Null hypothesis is accepted here. But in river water weight of fishes between summer and monsoon are showing significant result, because calculated t value is 2.883, which is higher than tabulated t value, 1.688 in one-tail and 2.028 in two-tail. It means there is significant difference in weight of fishes in river both in summer and monsoon. Therefore, Null hypothesis is rejected here and Alternative hypothesis accepted here. Again, in case of pond water, length of fishes between summer and monsoon are showing significant result, because calculated t value is 2.572, which is higher than tabulated t value, 1.708 in one-tail and 2.059 in two-tail. It means there is significant difference in length of fishes in pond both in summer and monsoon. Therefore, Null hypothesis is also rejected here and alternative hypothesis is accepted here. Again in pond water, weight of fishes between summer and monsoon are showing significant result, because calculated t value is 3.656, which is higher than tabulated t value, 1.699 in one-tail and 2.045 in two-tail. It means there is significant difference in weight of fishes in pond both in summer and monsoon. Therefore, Null hypothesis is rejected here and Alternative hypothesis accepted here. Overall t-test result establish that length of river fishes almost remain same in both summer and monsoon but does not. In pond water system both length and weight do not remain same in two different seasons. Pal *et. al*, 2013 reported length-weight relationship on *Puntius sophore* , where t value was 57.099 which also establish a significant relationship between length weight.

CONCLUSION

The final result of length-weight relationship and seasonal variation of *Mystus vittatus* in two different aquatic habitat are showing positive and in few cases negative allometric growth pattern depend on the availability of food sources and climatic factors also. This result can be useful to fishery management practices.

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