SURVIVAL RATES OF INDIAN CARP (*CATLA CATLA*, *LABEO ROHITA*, *CIRRHINA MRIGALA*.) FROM FIRST TO FOURTH WEEK OF LIFE UNDER EXPERIMENTAL TREATMENTS ISOLATING VITAMIN B_{12} FROM VITAMIN B COMPLEX

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SUMMARY. A factorial design was adopted to investigate the effects of two factors, vitamin B_{12}, and vitamin B complex within B_{12}, at four different levels on the survival rate of Indian carp (*Catla catla*, *Labeo rohita*, *Cirrhina mrigala*). The entire design was replicated thrice using three randomized blocks. Analysis of variance on the final proportion surviving showed that main effects of vitamin B_{12} were highly significant, while main effects of vitamin B complex without B_{12} and interaction effects were not significant. Product-moment correlations between initial number and proportion surviving were significant for the first two weeks of life in the control group, for the first week in the lowest level of B_{12}, and were not significant for higher levels of B_{12}. Juvenile life tables were computed for Indian carp under untreated control conditions and for three levels of vitamin B_{12} treatment.

1. Introduction

Previous experiments in this laboratory on the survival rates of Indian carp (*Catla catla*, *Labeo rohita*, *Cirrhina mrigala*) during the initial period of life demonstrated that treatment with vitamin B complex enhanced survival significantly (Das and Krishnamurthy, 1960). The B complex mixture consisted of 5 μg crystalline vitamin B_{12}, 3 mg aneurine hydrochloride, 30 mg nicotinamide, 1 mg riboflavin, 1 mg calcium pantothenate, and 0.5 mg pyridoxine hydrochloride. Effectiveness of the experimental treatment was limited to the period when the death rate was high. That period occurred during the first week, and the first part of the second week, of the life of the fry, during which the rate of growth is also comparatively high. In order to ascertain in more detail what component or components of the B complex were responsible for the experimental result, the present research was undertaken.

The role of vitamin B complex in the survival of fish during the post-embryonic period, particularly the first four weeks of life, has received little direct research attention. For the Indian carp, its role has not been investigated in terms of survival at any period. An indirect approach to this problem is through the determination of nutritional requirements, for which artificial diets composed of chemically pure substances are necessary. Such diets should be able to maintain the fish over long periods of time. In the case of trout, a diet meeting these specifications was developed by Wolf (1951), and it has permitted subsequent determination of vitamin requirements in trout. All of the fat soluble vitamins are assumed to be necessary for trout;

however, neither vitamin A nor vitamin D have been shown to be required conclusively. Ten of the water soluble vitamins have been established as necessary for trout : aneurine hydrochloride, riboflavin, pyridoxine, B_{12}, biotin, choline, folic acid, inositol, niacin, and pantothenic acid. Tentative daily requirements have been established (per kilogram trout weight per day) for aneurine hydrochloride (.150—.186 mg), riboflavin (.44—.68 mg), pyridoxine (.225—.250 mg), biotin (.0433—.0796), folic acid (.00292 mg), niacin (3.0—4.1 mg) and pantothenic acid (.97—1.25 mg). (Phillips and Brockway, 1957).

A direct approach to the problem has been reported by Phillips and Brockway (1957), who attributed high mortalities in trout to deficiencies of aneurine hydrochloride and pyridoxine, and reduction in growth rate to deficiencies of riboflavin and B_{12}.

The present research project was designed to investigate further the role of the B complex in the survival of Indian carp in the post embryonic period. Two considerations were investigated : first, whether B_{12} or some other constituent or constituents of the B complex, was the active component enhancing survival, and second, treating B_{12} as one factor and the rest of the B complex as another factor, which of several dosage levels, taking the two factors singly and in combination, would be most effective in increasing survival.

2. EXPERIMENTAL DESIGN

In order to compare vitamin B_{12} with other components of vitamin B complex, and to investigate which of several dosage levels would have the optimal effect in increasing survival, a factorial design (4^2) was adopted. All possible combinations of the two factors, vitamin B_{12} and vitamin B complex without B_{12}, at four different levels, were studied. The entire design was replicated thrice, using three randomized blocks. Within each block there were sixteen experimental units, and there were a total of 48 experimental units in the entire experiment. For each combination of the two factors, there were three experimental units, one in each block.

The four levels were defined as follows for the two variables :

level symbol	dosage of vitamin	dosage of vitamin B complex without B_{12}
0	$0\mu g$	0 tablets
1	$8\frac{1}{3}\mu g$	$\frac{1}{2}$ tablet
2	$16\frac{2}{3}\mu g$	1 tablet
3	$25\mu g$	$1\frac{1}{2}$ tablets

Varying the two variables at four levels in all possible ways, sixteen treatments were defined. The treatments are represented by two digits : the tens digit indicates level of B complex without B_{12}; the units digit indicates level of B_{12}. The sixteen treatments and their symbols may be summarized as follows:

symbol	dosage of	
	B complex without B_{12}	B_{12}
00	0 tablets	0μg
01	0 tablets	$8\frac{1}{3}$μg
02	0 tablets	$16\frac{2}{3}$μg
03	0 tablets	25μg
10	$\frac{1}{2}$ tablet	0μg
11	$\frac{1}{2}$ tablet	$8\frac{1}{3}$μg
12	$\frac{1}{2}$ tablet	$16\frac{2}{3}$μg
13	$\frac{1}{2}$ tablet	25μg
20	1 tablet	0μg
21	1 tablet	$8\frac{1}{3}$μg
22	1 tablet	$16\frac{2}{3}$μg
23	1 tablet	25μg
30	$1\frac{1}{2}$ tablets	0μg
31	$1\frac{1}{2}$ tablets	$8\frac{1}{3}$μg
32	$1\frac{1}{2}$ tablets	$16\frac{2}{3}$μg
33	$1\frac{1}{2}$ tablets	25μg

Counts were taken for 18 days. Fluorescent tube lights were arranged to ensure equal lighting throughout the laboratory. Fans were arranged for constant circulation of air and to maintain constant temperature in the laboratory.

3. Materials and methods

One day old Indian carp (*Catla catla*, *Labeo rohita*, *Cirrhina mrigala*) were procured from the same source. In order to assign an equal number of carp to each experimental unit, a sampling procedure of allocation was adopted, as their exact enumeration was not feasible at the initial period due to their minute size. An equal amount of pond water, containing one teaspoon of carp, was assigned randomly to each experimental unit containing 9 litres of water. All experimental units were the same, consisting of an earthen bowl or *gamla*, of 16 inches diameter, filled with pond water from the same source. Throughout the experimental period the water was changed every 24 hours to prevent accumulation of waste products. It has been reported (Kawamoto, 1957) that removal of excretory substances in the water is more important than such factors as oxygen or carbon dioxide for carp culture. Water temperature and pH were recorded daily. Water temperature ranged from 26.5 to 28°C, and pH from 7.3 to 7.6.

Experimental counts were made as follows. Throughout the experimental period, every day, at the same time the dead carp were completely enumerated. At the end of the experiment, the remaining live carp were completely enumerated. The total carp dead and alive reconstructed the initial number. The dead carp were enumerated in the following manner : a water current was induced in the gamla by an artificial centrifugal force, and the dead carp were withdrawn with a glass pipette. For each experimental unit, a separate pipette was assigned. The carp were placed on blotting paper and counted.

The carp were fed live Daphnia, given 10cc by volume each day to each experimental unit. The Daphnia were collected from the same source throughout the experimental period. To determine whether this ration was sufficient, a check was made each day to see if any live Daphnia remained. It was found that there were always some Daphnia remaining.

The B complex factor used tablets of the following composition : 1mg aneurine hydrochloride; 1mg riboflavin; 10mg nicotinamide; 130mg yeast.

At treatment level 0, no tablet was given; at level 1, $\frac{1}{2}$ tablet was given per experimental unit each day; at level 2, 1 tablet was given per experimental unit each day; and at level 3, $1\frac{1}{2}$ tablets were given per experimental unit each day.

A solution of crystalline vitamin B_{12} was prepared so as to obtain $1\frac{2}{3}\ \mu g$ B_{12} per cc. The treatments were given volumetrically as follows : at treatment level 0, no vitamin B_{12} was given; at level 1, 5cc containing $8\frac{1}{3}\ \mu g$ B_{12} were given to each experimental unit each day; at level 2, 10cc containing $16\frac{2}{3}\ \mu g$ B_{12} were given to each experimental unit each day and at level 3, 15cc containing $25\ \mu g$ B_{12} were given to each experimental unit each day. Each experimental unit contained 9 litres of water.

The combinations of treatments at the various levels have been described in the previous section on Experimental Design.

4. RESULTS

Tabular summaries of the data and statistical tests of significance are presented in Tables 1 to 7, accompanied by Figures 1 and 2. Table 1 gives, for each of the 16 treatments, the number alive on each day, pooled over three replications, and the corresponding cumulative survival rate. The survival rate was obtained by dividing the pooled number alive on any one day by the pooled initial number. Table 2 gives the final proportion surviving for increasing levels of B_{12} and B complex summed over three replications. The analysis of variance summary table for the factorial design is given in Table 3. Table 4 gives the initial number and final proportion surviving for all 48 replications. To examine the proportion surviving in relation to initial number for successive periods throughout the experiment, the proportions surviving were computed for the initial, middle, and final periods of the experiment with initial number of the particular period as the base. The data and proportions are presented in Tables 5a, 5b and 5c for the three periods respectively. Product moment correlations were computed for the data of Tables 4, 5a, 5b and 5c, between initial number and final proportion surviving. Each correlation is based on the data for 12 experimental units receiving the same B_{12} treatment (B complex treatments were ignored). The correlation coefficients are given in Table 6. A juvenile life table for carp, for the first 18 days of post-embryonic life, is presented for the different levels of B_{12} treatment (ignoring B complex) in Table 7. Figure 1 presents the forces of mortality, or cumulative survival curves, as given by Table 7. Figure 2 compares the cumulative survival curves of the 0,0 (control) and the 1,3 (level 1 B complex, level 3 B_{12}) treatments.

5. DISCUSSION

The present experiment was undertaken to investigate whether the effect of B complex on survival rate, reported previously, was due to vitamin B_{12} or to some other component or components of the B complex. Two factors were therefore used : vitamin B_{12} alone, and vitamin B complex without B_{12}. In addition, the experiment was designed to investigate which of several dosage levels, singly and in combination, of the two factors would be most effective in increasing survival. Four dosage levels were adopted for this purpose, and all possible combinations of the two factors at the four levels were examined.

To examine the significance of the different treatments, an analysis of variance for the factorial design was applied to the final proportion surviving. Several questions may be asked of the analysis of variance summary table. First, did vitamin B_{12} increase survival? Table 3 shows that the main effect of B_{12} was highly significant. According to the critical difference between two levels of a factor, 1.2763, levels 1, 2, and 3 of B_{12} are found to be significantly higher than level 0, but not to differ significantly among themselves (see Table 2). The cumulative survival curves for the 4 levels of B_{12}, given in Table 7, illustrate these differences. Second, did B complex without B_{12} increase survival? Table 3 shows that, in this experiment, the main effect of B complex was not significant.

While interaction, as a source of variation, was not shown to be significant, it should be noted that in the most effective treatment, 1,3, 73 percent of the carp survived as compared to 12 percent in the control (see Table 1 and Figure 2). It may be added here that although it was expected that *Labeo rohita*, *Catla catla*, and *Cirrhina mrigala* would be equally represented in the experiment it was found that the greatest proportion were *Labeo rohita*. As *Labeo rohita*, *Catla catla* and *Cirrhina mrigala* are different species, it would not be unexpected if their survival were affected differently by vitamin treatments. Further experiments will be undertaken along these lines varying the species composition of the carp studied.

In previous experiments on the survival rate of Indian carp (Das and Krishnamurthy, 1960), it was found by statistical analysis that survival rate was inversely related to the initial number; however, this relationship was shown in the first two weeks but not in third week of life. To examine whether this effect was operating in the present data, the first step was to correlate initial number and final proportion surviving for the experimental period as a whole. The coefficients for the different levels of B_{12} are given in Table 6 and show that final proportion surviving was negatively correlated ($P < .01$) with initial number for the 0 and 1 levels of B_{12}, but was independent for the 2nd and 3rd levels of B_{12}. The supporting data are given in Table 4. To determine whether this relationship was consistent throughout the experiment, or limited to a particular period, the second step was to divide the experimental period up into three periods of six days each. The data for these three periods are presented in Tables 5a, 5b and 5c, and the corresponding correlation coefficients are presented in Table 6. The relationship between initial number and final proportion surviving occurs for levels 0 and 1 of B_{12} during the first six days; it holds only for the 0 level during the second six days; and is not found for any of the levels during the last six days. It may be suggested that both B_{12} and age play a role in these results. After a certain age, initial number apparently did not influence final proportion surviving. Within the period in which initial number may have an effect, B_{12} may have modified the effect in proportion to the concentration or level employed. The age effect is in agreement with the results of earlier research (Das and Krishnumurthy, 1960), while the B_{12} effect is not unexpected if B_{12} is the active factor in the results reported with B complex, including B_{12}, in the earlier experiment. Before conclusions may be drawn, however, it should be noted that if the range of initial number were extended beyond that of the present experiments, different results might be obtained.

Results of the present experiment suggest that for commercial cultivation of Indian carp during the post-embryonic period, vitamin treatment may be of economic value. Figure 2 shows the cumulative survival rate of the most effective treatment, (level 1 of B complex and level 3 of B_{12}) and of the control, 0, 0. Whereas the final percent surviving is 73 percent for the former, it is 12 percent for the latter. It can also be seen from Figure 2 that this saving is due largely to a sharp reduction in mortality during the early period of the experiment. A short term treatment during this period, resulting in a saving of 61 percent over the untreated condition, may be economically feasible, especially if cheaper sources of vitamin B_{12} can be found. Research on such possible cheaper sources is already in progress in this laboratory and will be reported later.

A final note may be made of the patterns of cumulative survival, or forces of mortality, observed in this experiment. The cumulative survival rates for the different levels of B_{12} are given in Table 7 and are presented graphically in Figure 1. The pattern of survival is in agreement with that reported earlier (Das and Krishnamurthy, 1960). As in the earlier research, it was also found that the experimental treatments enhanced survival during the early period of post-embryonic life, and that, without treatment, mortality was highest during this period.

6. Conclusions

1. Indian carp (*Catla catla*, *Labeo rohita*, *Cirrhina mrigala*) were treated with vitamin B_{12} and vitamin B complex, without B_{12}, from the first to fourth week of post-embryonic life. The results showed that, at the experimental dosage levels investigated, B_{12} significantly enhanced survival, while B complex without B_{12} did not have a significant effect.

2. Final proportion surviving was independent of initial number for levels 2 and 3 of B_{12}. It was not independent for 0 level during the first 12 days of the experiment, nor for level 1 during the first 6 days of the experiment. During the last 6 days, no relation between initial number and proportion surviving was observed for any of the treatments, including the untreated control.

3. The most effective treatment in this experiment, 1, 3, combined B_{12} with B complex and resulted in 73 percent survival, as compared with 12 percent survival in the untreated control. This saving was observed to occur during a very short period marked by high mortality in the untreated control condition. It is suggested that vitamin treatment during this period may have economic implications for commercial cultivators of Indian carp.

TABLE 1. NUMBER OF CARP ALIVE AND SURVIVAL RATE FOR ALL EXPERIMENTAL TREATMENTS BY DAYS

	treatment															
	(00)		(01)		(02)		(03)		(10)		(11)		(12)		(13)	
day	alive	rate	alive	rate	alive	rate	alive	rate	alive	rate	alive	rate	alive	rate	alive	rate
0	220	1.000	436	1.000	755	1.000	546	1.000	466	1.000	405	1.000	726	1.000	381	1.000
1	193	.877	414	.949	723	.958	542	.993	445	.951	380	.938	706	.972	370	.971
2	167	.759	399	.915	696	.922	510	.934	412	.884	361	.891	669	.921	352	.924
3	151	.686	354	.812	625	.828	465	.852	317	.680	313	.773	675	.702	317	.832
4	126	.573	282	.647	525	.696	382	.700	163	.350	247	.610	451	.621	307	.806
5	87	.395	240	.550	481	.637	331	.606	61	.131	216	.533	411	.566	297	.780
6	66	.300	221	.508	449	.608	318	.583	54	.116	204	.504	401	.552	297	.780
7	56	.254	202	.463	436	.578	312	.572	44	.094	192	.474	390	.537	295	.774
8	43	.195	189	.433	422	.559	309	.566	38	.082	184	.454	384	.529	293	.769
9	37	.168	178	.408	408	.541	290	.531	34	.073	181	.447	357	.492	287	.753
10	33	.150	174	.399	405	.537	289	.529	31	.067	176	.431	356	.490	2876	.751
11	31	.141	170	.390	403	.534	288	.527	30	.064	171	.422	355	.489	286	.751
12	29	.132	170	.390	402	.533	287	.526	29	.062	167	.412	354	.487	283	.743
13	29	.132	170	.390	400	.530	287	.526	29	.062	165	.407	352	.485	283	.743
14	28	.127	168	.385	398	.527	284	.520	28	.060	163	.402	352	.485	282	.740
15	28	.127	166	.381	398	.527	284	.520	28	.060	157	.388	352	.485	282	.740
16	28	.127	166	.381	396	.525	282	.517	28	.060	155	.383	346	.476	282	.740
17	28	.127	164	.376	396	.525	281	.515	28	.060	154	.380	345	.475	280	.735
18	27	.123	164	.376	396	.525	279	.511	26	.056	154	.380	345	.475	278	.730

	treatment															
	(20)		(21)		(22)		(23)		(30)		(31)		(32)		(33)	
day	alive	rate	alive	rate	alive	rate	alive	rate	alive	rate	alive	rate	alive	rate	alive	rate
0	298	1.000	342	1.000	494	1.000	630	1.000	353	1.000	419	1.000	686	1.000	400	1.000
1	272	.913	339	.911	477	.965	587	.932	341	.966	397	.947	639	.931	373	.933
2	255	.856	323	.944	456	.923	551	.875	309	.875	379	.905	597	.870	377	.843
3	217	.728	292	.854	406	.822	440	.698	254	.720	355	.800	502	.732	274	.685
4	135	.453	239	.699	355	.719	352	.559	165	.467	275	.656	396	.577	218	.545
5	85	.285	213	.623	333	.674	331	.525	143	.405	249	.594	364	.531	193	.483
6	70	.235	199	.582	321	.650	307	.487	111	.315	225	.537	341	.497	188	.470
7	58	.195	194	.567	319	.646	290	.460	98	.278	220	.525	339	.494	183	.458
8	51	.171	186	.544	312	.631	286	.454	89	.252	209	.499	322	.469	182	.455
9	45	.151	183	.535	305	.617	281	.446	76	.215	195	.465	303	.442	182	.455
10	44	.148	174	.509	300	.670	281	.446	55	.156	185	.442	298	.434	179	.448
11	42	.141	172	.503	297	.601	280	.444	52	.150	174	.415	296	.431	179	.448
12	42	.141	169	.494	296	.599	280	.444	49	.139	172	.410	294	.429	176	.440
13	42	.141	169	.494	296	.599	280	.444	45	.125	171	.408	292	.426	175	.438
14	39	.131	168	.491	292	.591	278	.441	41	.116	168	.401	299	.424	175	.438
15	38	.128	168	.491	290	.587	277	.440	35	.099	168	.401	289	.421	175	.438
16	36	.121	168	.491	289	.585	277	.440	33	.093	166	.396	289	.421	175	.438
17	36	.121	168	.491	289	.585	276	.438	33	.093	165	.394	289	.421	174	.435
18	36	.121	168	.491	289	.585	276	.435	33	.093	163	.389	286	.417	174	.435

TABLE 2. SUM OF FINAL PROPORTION SURVIVING OVER THREE REPLICATIONS*

		level of B_{12}				
		0	1	2	3	row totals
level of B complex	0	.3625	1.2050	1.5838	1.4524	4.6037
	1	.2780	1.2082	1.4360	2.1329	5.0551
	2	.4823	1.6729	1.7342	1.2643	5.1537
	3	.3662	1.4559	1.2884	1.4953	4.6058
column totals		1.4890	5.5420	6.0424	6.3449	19.4183

* Critical difference for comparing two levels of a factor = 1.2763
Critical difference for comparing two treatments = .6381

TABLE 3. ANALYSIS OF VARIANCE SUMMARY TABLE TESTING MAIN EFFECTS, INTERACTION, AND TREATMENT AND BLOCK DIFFERENCES

source	*d.f.*	*s. s.*	*m. s.*	*F*	tabulated *F* at 5% level	tabulated *F* at 1% level
main effect of B-complex	3	.02121	.00707	.4441	2.92	4.51
main effect of B	3	1.28600	.42866	26.9259	2.92	4.51
interaction	9	.21601	.02400	1.5075	2.21	3.06
treatment	15	1.52319	.10155	6.3788	2.04	2.74
block	2	.14558	.07280	4.5729	3.32	5.39
error	30	.47774	.01592			
total	47	2.14651				

TABLE 4. FINAL PROPORTION SURVIVING IN RELATION TO INITIAL NUMBER

treatment*	block 1		block 2		block 3	
	initial number	proportion surviving	initial number	proportion surviving	initial number	proportion surviving
00	48	.1250	104	.1346	68	.1029
10	174	.0690	52	.1923	240	.0167
20	137	.1168	26	.2692	135	.0063
30	221	.0568	61	.1967	71	.1127
01	170	.3073	101	.5644	156	.3333
11	169	.2367	183	.4809	53	.4006
21	177	.3729	60	.7667	105	.5333
31	235	.3617	51	.8235	133	.2707
02	231	.5281	168	.5417	306	.5140
12	253	.3676	239	.4017	234	.6667
22	147	.4558	171	.6023	176	.6761
32	377	.3793	144	.3333	165	.5758
03	177	.5281	114	.3596	255	.5647
13	146	.7329	85	.6000	150	.8000
23	142	.3234	306	.4739	182	.4670
33	215	.2884	89	.5506	96	.6563

* Tens digit indicates level of B Complex.
Units digit indicates level of B_{12}.

TABLE 5A. PROPORTION SURVIVING IN RELATION TO INITIAL NUMBER: FIRST SIX DAYS

level of B_{12}	initial number	proportion surviving on 6th day	level of B_{12}	initial number	proportion surviving on 6th day
	26	.5000		144	.3681
	48	.2083		147	.5034
	52	.4038		165	.6545
	61	.5738		168	.5536
	68	.5147		171	.6667
	71	.6197		176	.7557
0	104	.2212	2	231	.5758
	135	.2000		234	.7009
	137	.2190		239	.5607
	174	.1322		253	.4071
	221	.1448		356	.5983
	240	.0417		377	.4774
	51	.9216		85	.6588
	53	.6038		89	.5843
	60	.9333		96	.7188
	101	.6436		114	.4211
	105	.5905		142	.3944
	153	.3910		146	.7534
1	156	.5192	3	150	.8733
	169	.3887		177	.6667
	177	.4576		182	.5220
	179	.4286		215	.3116
	183	.5902		255	.5961
	235	.5362		306	.5098

TABLE 5B. PROPORTION SURVIVING IN RELATION TO INITIAL NUMBER: SECOND SIX DAYS

level of B_{12}	initial number	proportion surviving on 12th day	level of B_{12}	initial number	proportion surviving on 12th day
	10	.7000		53	.9245
	10	.6000		74	.9054
	13	.8462		93	.9892
	21	.4762		103	.9223
	23	.6087		108	.8796
	23	.5652		114	.9035
0	27	.4815	2	133	.9248
	30	.6000		133	.9474
	32	.5000		134	.7239
	35	.2286		164	.9878
	35	.5143		180	.8333
	44	.3409		213	.8310
	32	.8438		48	.8958
	47	.9149		52	.9808
	52	.7500		56	.9286
	56	.8214		56	.8571
	62	.9032		64	.9254
	64	.7156		69	.9275
1	65	.8769	3	95	.8947
	75	.7600		110	1.0000
	81	.6014		118	.8220
	81	.8271		131	.9237
	108	.8426		152	.9671
	126	.7143		156	.0423

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TABLE 5C. PROPORTION SURVIVING IN RELATION TO INITIAL NUMBER : THIRD SIX DAYS

level of B_{12}	number surviving on the 12th day	final proportion surviving	level of B_{12}	number surviving on the 12th day	final proportion surviving
	6	.6667		49	.9796
	7	.8571		67	1.0000
	7	.6364		92	.9891
	8	.8750		95	.9789
	10	1.0000		95	1.0000
	13	.9231		97	.9897
0	13	1.0000	2	103	1.0000
	14	1.0000		123	.9919
	15	.5333		126	.9444
	16	.8889		150	.9533
	16	.8125		162	.9630
	18	.6667		172	.9774
	27	.9630		43	.9535
	39	.9231		48	.9583
	43	.9767		51	.9608
	46	1.0000		52	.9808
	49	.8163		62	1.0000
	56	.9286		64	.9844
1	56	1.0000	3	85	1.0000
	57	1.0000		97	.9691
	57	.9649		110	.9727
	67	.9851		121	.9917
	90	.9444		147	.9796
	91	.9670		147	.9864

TABLE 6. PRODUCT MOMENT CORRELATIONS BETWEEN INITIAL NUMBER AND FINAL PROPORTION SURVIVING FOR SUCCESSIVE SIX DAY PERIODS

(12 exprimental units in each cell)

period	level of B_{12}			
	0	1	2	3
(1)	(2)	(3)	(4)	(5)
first six days	−.7779**	−.6944**	−.1088	−.2724
second six days	−.7570**	−.3971	−.3389	.1569
third six days	.0251	.0928	−.5304	−.3788
total period	−.8351**	−.7399**	−.2463	−.2380

** $P < .01$

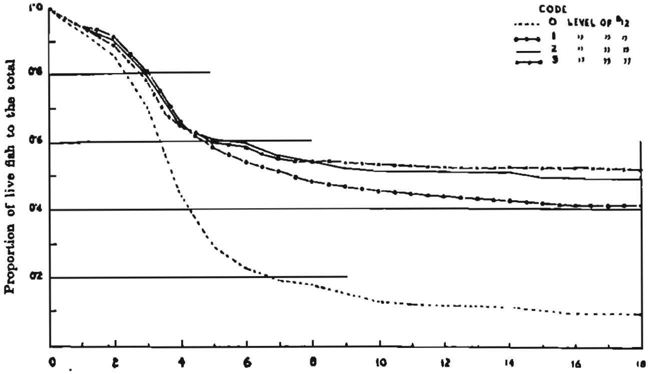

Figure 1. Cumulative survival rate of carp for different levels of vitamin B_{12} treatment.

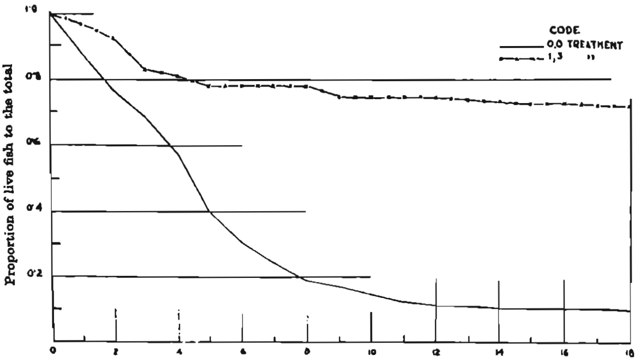

Figure 2. Cumulative survival rate of carp under no treatment control 0,0) condition versus treatment with vitamin B_{12} and B complex (1,3)

TABLE 7. JUVENILE LIFE TABLE FOR INDIAN CARP (*CATLA CATLA, LABEO ROHITA, CIRRHINA MRIGALA*) FOR DIFFERENT LEVELS OF VITAMIN B_{12} TREATMENT

level of B_{12}	0		1		2		3	
day	alive	rate	alive	rate	alive	rate	alive	rate
0	1337	1.0000	1602	1.0000	2662	1.0000	1957	1.0000
1	1251	.9357	1530	.9551	2545	.9564	1872	.9566
2	1143	.8549	1462	.9126	2418	.9087	1750	.8942
3	939	.7023	1294	.8077	2108	.7921	1496	.7644
4	589	.4409	1043	.6511	1727	.6490	1259	.6433
5	376	.2812	918	.5730	1589	.5971	1152	.5887
6	303	.1266	849	.5300	1512	.5682	1110	.5672
7	254	.1900	808	.5044	1476	.5547	1080	.5519
8	221	.1653	768	.4794	1440	.5412	1070	.5468
9	192	.1436	737	.4600	1373	.5160	1040	.5314
10	163	.1219	709	.4426	1359	.5107	1035	.5289
11	155	.1159	687	.4288	1354	.5088	1033	.5279
12	149	.1114	678	.4232	1346	.5058	1026	.5243
13	145	.1085	675	.4213	1340	.5038	1025	.5238
14	136	.1017	667	.4164	1333	.5009	1019	.5207
15	129	.0965	659	.4114	1329	.4994	1018	.5202
16	125	.0935	655	.4088	1320	.4961	1016	.5192
17	125	.0935	651	.4064	1319	.4951	1011	.5166
18	122	.0912	649	.4051	1316	.4946	1007	.5146

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