AGE DETERMINATION AND GROWTH STUDIES ON THE *BARBUS BYNNI*, FORSK. OF THE NOZHA HYDRODROME.

By

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ABSTRACT

The ages of *Barbus bynni* in the Nozha hydrodrome were determined and its growth rates were computed from the examination and measurement of scales, collected during two sampling periods (1956—1961 & 1967—1970). It was found that the body length - scale length ratio is not constant throught the life of the fish. For this reason, Vovk's method was used in the study of its growth rates . The growth in length was found to be high during the first and second years,while the growth in weight considerably increases during the third and fourth years of life. The study of the length-weight relationship shows that the value of the exponent «n» increases to a power more than the cube of length which indicates that the body shape changes rapidly as the fish grows in length.

INTRODUCTION

During 1964, the Nozha-hydrodrome was partially drained and extensive fishing operations were carried out in order to minimize the effect of carnivorous fish. Moreover, the common Carp *(Cyprinus carpio)* was introduced into the hydrodrome during 1966, where the fish has well established itself, specially in 1968, when a successful spawning has happened. As a result of all these changes the *B. bynni* in the Nozha hydrodrome is now far less abundant than it was in the early years.

So, the present work on age detemination and growth studies of *B. bynni* in the N. hydrodrome during two sampling periods (1956—1961 & 1967—1970) may add useful information to the proper management of the species in our waters.

MATERIAL AND METHODS

The material used in this study were obtained from the Nozha-hydrodrome during two periods viz. 1956—1961 and 1967—1970. During the first period, 163 fish of *B. bynni* , ranging in total length from 23 to 84 cm were collected. During the second period, 1708 fish ranging between 11 & 80 cm.T.L., were also collected, of which 1219 fih belong to 1968 collection.

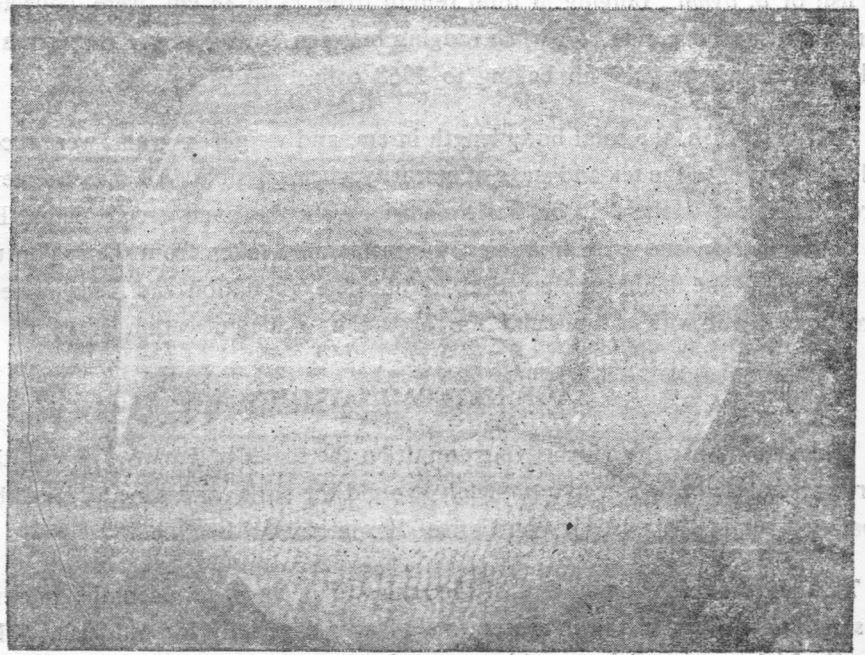
For every fish, the total body length in cm. and weight in gram. were recorded, in addition to the sex and stage of maturity when possible. All measurements were carried out in the field on fresh material from the commercial catch. For age determination and growth studies, the scales were taken from the region under the lateral line behind the pectoral fin. Scale examination and measurements were carried out with a binocular microscope at a magnification of 16 x.

AGE DETERMINATION

The criteria used for identifying annuli on the scales of *Barbus bynni* is that a true annulus can be traced completely around the scale and generally exhibits crossing over in the posterior portion of the lateral fields.

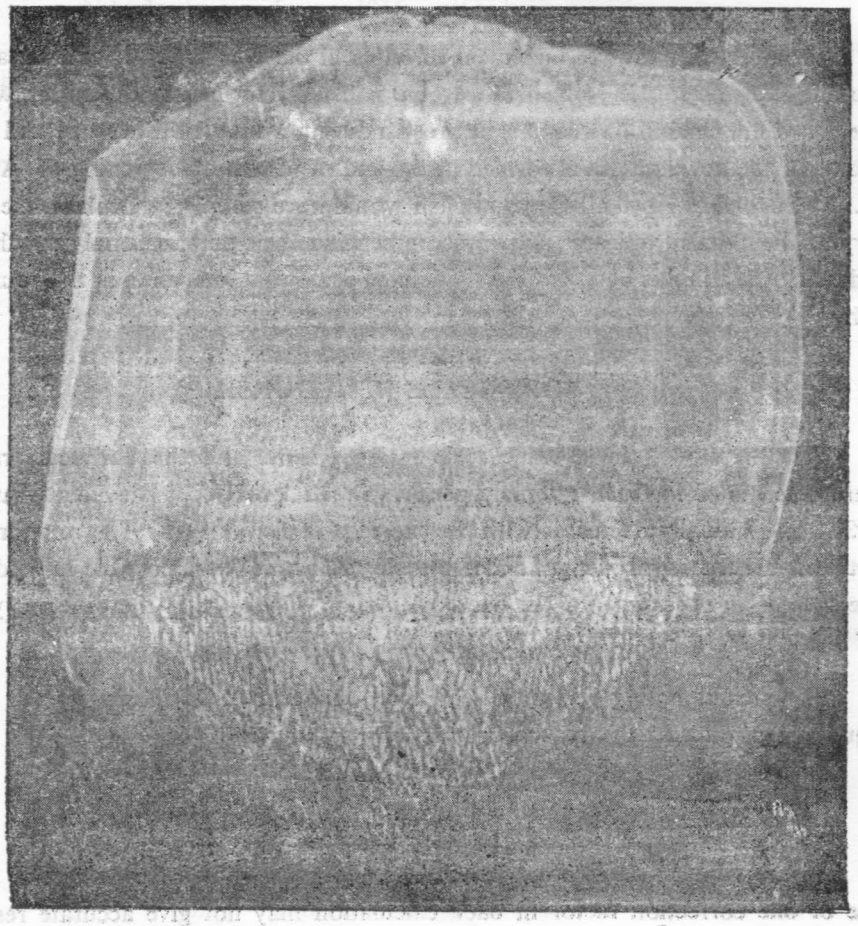
The microscopic examination of the scales of *B. bynni* revealed the presence of some difficulties in the interpretation of ages especially for old fish. Clear annuli which consist of the usual interrupted ridges or circuli followed by widely-spaced circuli, which are led down as growth resumes in spring are only found in the scales of fishes of young ages. Usually, the circuli preceding the annulus are somewhat crowded and the annulus in the anterior field appears as a light, translucent line adjacent to that dark band of the closely laid circuli (Fig. 1).

The problem of identifying the first annulus, as well as the differentiation between crowded annuli on the perifery of the scales of old fish, may be encountered as the main difficulties in determining the age of this species. Because of these difficulties, some differences arise between the present results and those given by Elster (1960) for *B. bynni* in the hydrodrome during 1954—1955, whose estimates can be considered as preliminary.



(A)

Fig. 1. (A) : Scale of *B. bynni* 59 cm.T.L. and 2500 gm· in weight, caught in 30/9-1968, showing three annual rings.



(1)

Fig. 1. (B) : Scale of *B. bynni* 68 cm.T.L. and 5050 gm. in weight, caught in 20/12-1956, showing five annual rings.

TIME OF ANNULUS FORMATION

The analysis of growth increment throughout the year indicates that the annulus of *B. bynni* in the Nozhahydrodrome is usually formed in the spring when the growth resumes following a slow growth during winter. In fishes one and two years old the new annulus is formed at the end of March or beginning of April, i.e., by the ond of April all the young fish would have complete annuli on the perifery of their scales and are actively commencing their new seasonal growth. In older fish,the annulus becomes clearly defined somewhat later than in the younger fish.

BODY-SCALE RELATIONSHIP

For this study, the average scale measurements and the bodyscale ratio, were determined for each sampling period (Tables 1 & 2). It is evident that the L/S ratio gradually decreases with the increase of fish length. The relationship between the total body length and the scale radius makes it possible to find out the correction necessary for the back calculation of lengths at the different years of life.

For each sampling period, a regression equation is calculated by the least square method and the resulting equations are the following :

$L = 6.744 + 6.935\ S$ for 1956—1961,
$L = 7.189 + 0.066\ S$ for 1967—1970.

As the L/S ratio is not constant throughout the whole life of the fish, so the use of one correction factor in back calculation may not give accurate results.

Therefore , to obtain accurate calculations there could be several correction factors corresponding to different length ranges of nearly constant L/S ratio.

Table 1. Total body length and scale radius relationship of *B. bynni* in the N-hydrodrome during 1956—1961.

Length (cm.)	No. of fish	S microm. divisions	L S	Length (cm.)	No. of fish	S microm. divisions	L S
11	1	11.0	1.00	47	1	59.0	0.80
12	1	10.0	1.20	48	3	62.3	0.77
13	—	—	—	49	3	64.0	0.77
14	2	13.0	1.08	50	4	68.5	0.73
15	2	12.5	1.20	51	2	72.5	0.70
16	—	—	—	52	1	78.0	0.67
17	4	14.5	1.17	53	6	72.2	0.73
18	3	14.0	1.29	54	7	75.4	0.72
19	3	15.0	1.27	55	14	75.5	0.73
20	—	—	—	56	5	70.0	0.80
21	2	20.0	1.05	57	5	76.8	0.74
22	3	20.3	1.08	58	11	75.0	0.77
23	4	23.5	0.98	59	8	81.5	0.72
24	1	25.0	0.96	60	9	81.4	0.74
25	3	24.0	1.04	61	4	80.8	0.76
26	3	24.7	1.05	62	6	92.8	0.67
27	4	25.0	1.08	63	5	83.6	0.75
28	2	33.5	0.84	64	4	81.8	0.78
29	2	31.0	0.94	65	8	90.6	0.72
30	3	31.3	0.96	66	6	90.8	0.75
31	1	43.0	0.74	67	4	86.3	0.87
32	1	36.0	0.89	68	3	84.0	0.81
33	2	36.5	0.90	69	7	80.0	0.86
34	1	40.0	0.85	70	5	89.6	0.78
35	2	45.0	0.88	71	3	92.7	0.77
36	2	50.0	0.72	72	10	94.4	0.76
37	2	46.3	0.80	73	3	92.7	0.79
38	5	45.0	0.84	74	1	102.0	0.73
39	3	49.0	0.80	75	3	85.0	0.88
40	6	50.9	0.79	76	2	86.0	0.88
41	5	48.6	0.84	77	7	109.0	0.71
42	3	59.3	0.71	78	2	93.0	0.84
43	6	55.7	0.77	79	1	97.0	0.81
44	1	59.0	0.75	80	1	84.0	0.95
45	4	59.3	0.67	—	—	—	—
46	5	57.3	0.80	84	1	110.0	0.76

Table 2. Total body length and scale radius relationship of *B. bynni* in the N-hydrodrome during 1976—1970.

Length (cm)	No.of fish	S radius	$\frac{L}{S}$	Length (cm)	No.of fish	S radius	$\frac{L}{S}$
11	3	8.0	1.38	44	14	53.2	0.83
12	4	8.5	1.41	45	10	51.7	0.87
13	12	8.7	1.49	46	14	56.8	0.81
14	6	10.7	1.31	47	21	60.0	0.78
15	7	11.6	1.29	48	21	64.4	0.75
16	8	14.9	1.07	49	25	65.5	0.75
17	7	16.0	1.06	50	33	69.7	0.72
18	3	15.0	1.20	51	50	69.7	0.73
19	4	16.5	1.15	52	49	69.9	0.74
20	4	20.0	1.00	53	66	72.0	0.74
21	7	19.0	1.11	54	43	75.5	0.72
23	5	19.6	1.13	55	84	75.8	0.75
23	3	73.3	0.99	56	64	76.9	0.73
24	3	25.3	0.95	57	61	80.3	0.71
25	13	27.1	0.92	58	44	78.3	0.74
26	24	28.3	0.92	59	33	80.7	0.75
27	25	28.7	0.94	60	26	82.5	0.73
28	19	30.3	0.92	61	16	83.7	0.73
29	37	31.8	0.91	62	12	84.1	0.76
30	32	33.3	0.90	63	5	86.0	0.73
31	61	34.0	0.91	64	3	89.3	0.72
32	69	36.0	0.89	65	4	94.0	0.69
33	76	36.5	0.90	66	1	91.0	0.73
34	49	37.9	0.90	—	—	—	—
35	88	39.9	0.88	73	1	96.0	0.76
36	76	41.4	0.87	74	1	94.0	0.79
37	64	42.3	0.88	75	1	100.0	0.75
38	68	44.5	0.85	76	—	—	—
39	37	47.1	0.83	77	1	105.0	0.73
40	34	49.6	0.81	78	1	114.0	0.68
41	35	50.3	0.82	79	—	—	—
42	13	52.7	0.80	80	1	104.0	0.77
43	17	52.6	0.82	—	—	—	—

In order to overcome such a difficulty which arises from the non conformity between the speed of growth of the body and the growth of the scales, Vovk's method is used (Chugunova, 1959). In this method, the points in the field of each scatter diagram of L against S were outlined by two smoothed consistent lines (Fig. 2 & 2). Their consistency is verified by a fixed ratio between the scale radius on the lower outline and that on the upper line at any chosen length After achieving full coincidence of the smoothed outlines forming the best fit to the field of points, both outlines are copied onto a millimeter paper and the mean regression curve is formed by bisecting the correlation field horizontally between the outlines. From this curve, a rectilinear monogram with a double scale is constructed in which the measurements of fish scales in ocular micrometer divisions are marked at equal intervals on one side, and the corresponding fish length in a proportional scale are marked on the other side (Fig. 2 & 3).

This method results in the most truely and descriptive curve available, because it is based on a detailed examination of the actual size of the scales at different body lengths with the advantage if elimination of erroneous points. In addition, it involves no assumptions of mathematical relationship, which if used, give only approximate results.

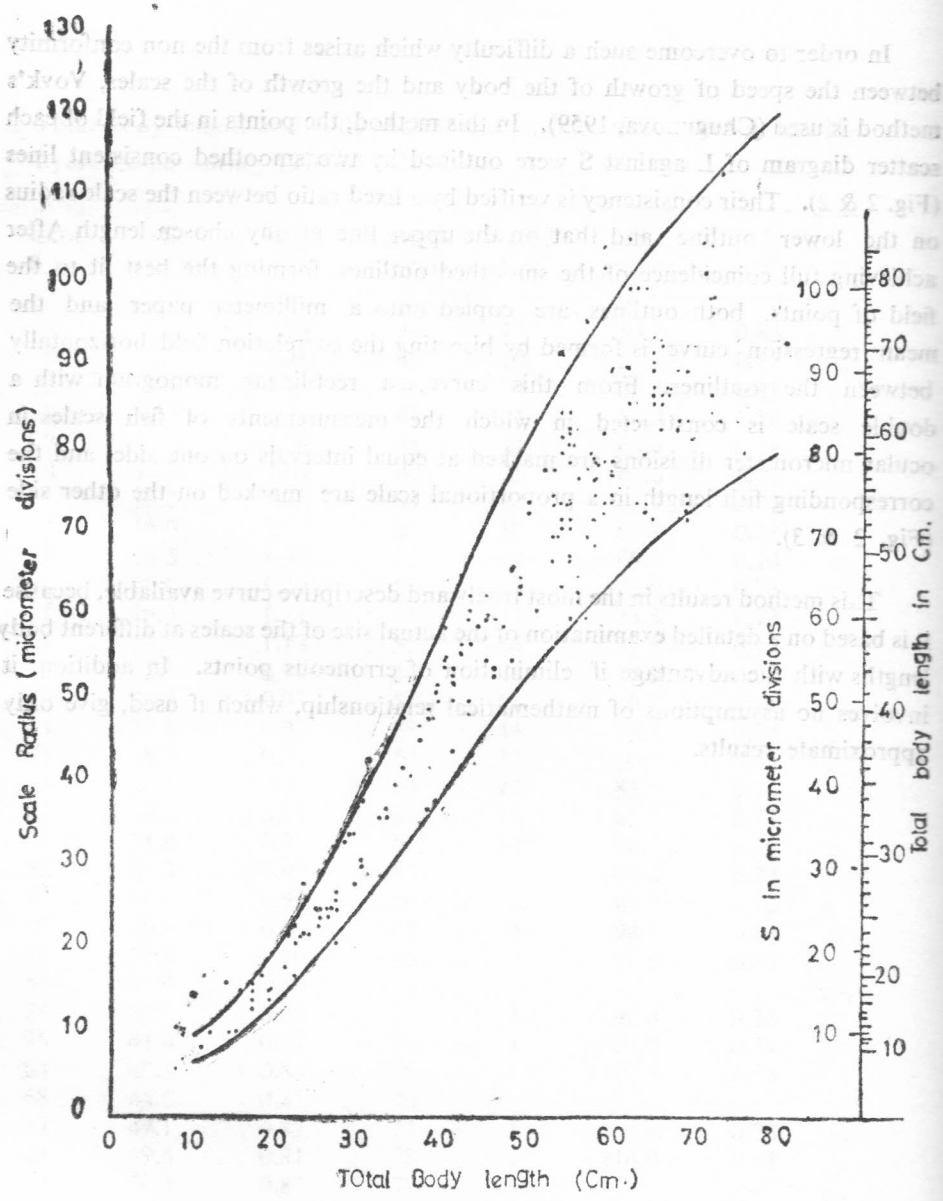


Fig. 2. Scatter diagram of Body-scale relationship, and the monogram of scale measurements with the corresponding fish length, of *B. bynni* of the Nozha-hydrodrome during 1956—1961.

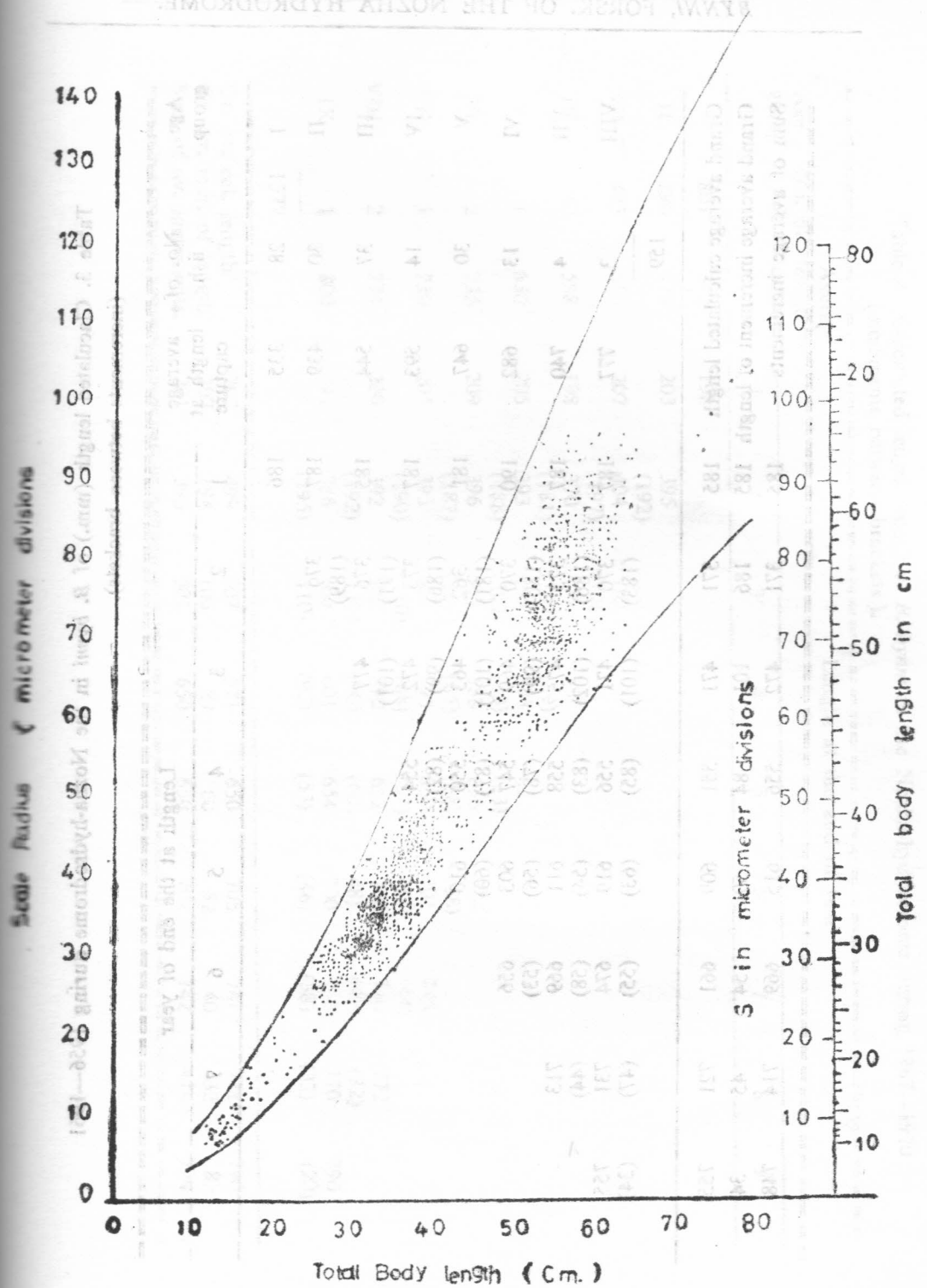


Fig. 3. Scatter diagram of body-scale relationship, and the monogram of scale measurements with the corresponding fish length, of *B. bynni* in the Nozha -hydrodrome during 1967—1970 .

Table 3. Claculated length (mm.) of *B. bynni* in the Nozha-hydrodrome during 1956—1961 (increments between brackets).

Age group	No. of fish	average length at capture	Length at the end of year							
			1	2	3	4	5	6	7	8
I	28	335	186							
II	30	439	187	379 (189)						
III	37	544	185	376 (191)	477 (101)					
IV	14	593	187	373 (186)	472 (99)	554 (82)				
V	30	647	181	362 (181)	463 (101)	550 (87)	610 (60)			
VI	13	682	190	370 (180)	469 (99)	547 (78)	603 (56)	656 (53)		
VII	4	740	187	373 (186)	475 (102)	558 (83)	611 (54)	669 (58)	713 (44)	
VIII	3	777	187	370 (183)	471 (101)	556 (85)	619 (63)	674 (55)	731 (47)	755 (34)
	159									
Grand average calculated length			185	371	471	551	609	661	721	755
Grand average increment of length			185	186	101	84	59	54	45	34
Sum of average increments			185	371	472	556	615	669	714	748

Table 4. Calculated length (mm.) of *B. bynni* in the Nozha-hydrodrome during 1967—1970 (increments between brackets).

Age group	No. of fish	Average length at capture	Length at the and of year							
			1	2	3	4	5	6	7	8	9
I	801	342	198								
II	296	478	203	395 (192)							
III	433	556	207	404 (197)	510 (106)						
IV	40	588	198	370 (181)	479 (109)	568 (89)					
V	1	650	205	393 (188)	495 (102)	578 (83)	631 (53)				
VI	2	735	209	396 (187)	503 (107)	588 (85)	656 (68)	714 (58)			
VII	1	750	205	395 (190)	505 (110)	593 (88)	650 (57)	701 (51)	745 (44)		
VIII	2	778	200	392 (192)	502 (110)	592 (90)	652 (60)	700 48)	740 (40)	772 (32)	
IX	1	800	191	386 (195)	506 (110)	601 (95)	654 (53)	700 (46)	738 (38)	770 (32)	790 (20)
	1577										
Gr. av. cal. length			207	499	507	571	650	705	741	771	790
Gr. av. incr. of length			207	194	106	89	60	52	40	32	20
Sum of av. increments.			201	395	501	650	650	702	742	474	794

GROWTH IN LENGTH

The growth rate of *B. bynni* in the Nozha hydrodrome during each of the two sampling periods (1956—1961 & 1967—1970), is calculted according to Vovk's method. It is evident that during the first period the growth is high in the first and second years of life. The annual increment of growth in the third year is markedly decreased and then it gradually decreases with further increase in age (Table 3).

During the second period (Table 4), most of the collected data are of young age groups (I, II & III), while older ages are rare. It is also clear that the growth is high during the first and second years of life, then a marked decrease in growth is observed in the third year, after which the annual increment gradually decreases with the increase in age.

To give a clear picture of the growth rate of *B. bynni* in the Nozha hydrodrome during the two sampling periods, the changes in the annual increments of length are represented in percentages to the total sum of increments during the whole life of the fish (Table 5).

It is clear that, in both periods, *B. bynni* makes their best growth in length during the first and second years of life, then the growth rate sharply decreases in the third year. This is mostly due to the start of sexual maturation. From the fourth through the eightth years of life, the growth increment decreases with the increase in age, but the decrease during the fourth and fifth years of life are higher than that of the last years.

Also, it has to be mentioned that the noticed high increments of the first three years of life during 1967—1970, compared with those of 1956—1961 may be explained by the high growth rate of the young aged *B. bynni* in the hydrodrome in a period of less competition following the overfishing period in 1964, and before the well establishemt of *Cyprinus carpio* in 1968 (Hashem, 1977). This is shown from the calculated lengths at the end of the first three years of life which are higher in 1967 than in 1968, and 1969—1970 (Table 6).

Table 5. Annual increment in length (mm. & %) of *B. bynni* in the hydrodrome in two sampling periods.

Age Group	1956—1961				1967—1970			
	No. of fish	calc. length	increment mm	%	No. of fish	calc. length	increment mm	%
I	28	185	185	25	801	200	200	25
II	30	371	186	25	296	391	191	25
III	37	472	101	14	433	505	114	15
IV	14	556	84	11	40	584	89	11
V	30	615	59	8	1	654	60	8
VI	13	669	54	7	2	796	52	7
VII	4	714	45	6	1	746	40	5
VIII	3	748	34	4	2	778	32	4

Table 6. Calculated growth of length for the young age groups of *B. bynni* in the N-hydrodrome during 1967,1968 & 1969—1970.

Age group	1967			1968			1969—1970		
	No. of fish	grand av.length	increment (mm)	No. of fish	grand av.length	increment (mm)	No. of fish	grand av.length	increment (mm)
I	11	228	225	612	203	203	178	190	190
II	78	419	191	117	402	199	101	372	182
III	2	512	93	360	510	108	71	468	96
IV	—	—	—	29	604	94	11	541	73
V	—	—	—	—	—	—	1	594	53

Regarding the sex differences in growth rate of *B. bynni* in the Nozha - hydrodrome, the data available during 1968/1969 indicate that the females grow at a slightly higher rate than the males (Table 7).

Table 7. Calculated length (mm) of Males and Females of *B. bynni* of the Nozha hydrodrome during 1968/69.

Age group	Males			Females		
	No. of fish	Length	Increment	No. of fish	Length	Increment
I	26	228	228	42	237	237
II	27	415	187	15	428	191
III	50	505	90	73	526	98
IV	5	573	68	8	605	79
V	—	627	54	—	671	66
VI	1	670	43	1	718	47
VII	1	704	34	—	—	—

LENGTH — WEIGHT RELATIONSHIP

The well established power equation ($W = C L^n$) is usually the more suitable formula for studying the length—weight relationship of fishes, where W = fish weight in grams, L = Fish length in mm., c & n are constants, whose values are calculated from the logarithms of the total lengths and actual weights. Many workers have shown that this relationship is best achieved when based on data for all fishes, regardless time of capture, sex and state of maturity (Beckman, 1948 ; El-Zarka, 1959 ; 1964, . . . etc.).

Using the grouped lengths in millimetres and the corresponding weights in grams of 163 fish, ranging in length from 230 to 840 mm total length, collected during the first sampling period (1956—1961), gives the equation :

$$\log W = -5.7732 + 3.3236 \log L$$

The use of the same procedure for 1708 fish, ranging in length from 110 to 800 mm total length, collected during the second sampling period (1967 — 1970), gives the equation :

$$\log W = -5.6572 + 3.2655 \log L$$

These two equations satisfactorily fit the agreement between the empirical and calculated weights of *B. bynni* in the hydrodrome during the two sampling periods (Table 8). In both equations the value of the exponent «n» increases to a power moe than the cube of length, and this indicates that the body shape changes rapidly as the fish grows in length.

Carefull inspection of the observed data in the two periods shows that fishes of the first sampling period are heavier than those of the second period, resulting in a higher value of «n». This may be due to the small number of fishes collected and also to the good living conditions for the fish in the hydrodrome before the introduction of the common carp.

The examination of data obtained for the males and females of *B. bynni* during 1968/1969 shows that females are somewhat heavier than males of the same length (Table 9). The grouped lengths and corresponding weights of 87 males and 103 females ranging in total length between 310 and 610 mm, give the following equations :

$$\log W = -6.4872 + 3.5765 \log L \quad \text{for males,}$$

$$\log W = -6.3457 + 3.5328 \log L \quad \text{for females.}$$

CONDITION FACTOR «K»

For the purpose of comparing the condition of a fish species, the cube relationship of length to weight ($k = W \times 100/L$) is usually used. Actually, in nature, the value of «k» for a fish species or population is subjected to wide variations. So, the values of «k» can be used as a measure for individual or average seasonal and regional differences in the condition or «degree of well-being» of fishes.

Comparison of the condition factor «k» of *B. bynni* in the Nozha hydrodrome during the different seasons of 1968, and according to various length intervals (Table 10) shows that the values of «k» in the different seasons increase with the increase of fish length. The data also indicate that for fishes of the same length group, the value of «k» is generally higher in spring and summer than in autumn and winter, especially for adult fishes. This is mostly due to the increase in wieght of the reproductive organs of the fish during that period.

Moreover, and in accordance with what has been previosly mentioned in the length-weight relationship , the condition factor for the females is higher than for males. (Table. 11).

Table 11. Average condition factor «k» of males and females of *Barbus bynni* in the Nozha-hydrodrome at various length intervals during 1968.

Length interval (mm)	Males		Females		Total	
	No.	«k»	No.	«k»	No.	«k»
300—349	3	0.909	8	1.025	11	0.993
350—399	10	1.002	13	1.005	23	1.004
400—449	3	1.047	9	1.108	12	1.093
450—499	12	1.227	8	1.231	20	1.229
500—549	38	1.249	16	1.264	54	1.253
555—599	22	1.287	38	1.279	60	1.289
600—649	2	1.279	19	1.293	21	1.274
650—699	—	—	1	1.340	1	1.340
700—749	1	1.258	1	1.360	2	1.310
750—799	1	1.327	—	—	1	1.327

GROWTH IN WEIGHT

The calculated weights for each year of life are computed for the two sampling periods from the corresponding general length-weight equation (Table 12). It is clear that, in both periods, the growth increment in weight at the end of the first year is very small, and sharply increases during the second year. Then the growth increment shows a further increase in weight during the third and fourth years of life, after which a slight decrease is observed in both periods during the fifth year. This may be explained by the high sexual activity of the species at this age. From the sixth through the 8th year of life the annual increment in weight begins to decrease with the increase in age.

Therefore, on the basis of the increase in weight, it would be economically important to protect the *B. bynni* of the Nozha-hydrodrome from capture till their fourth year of life, after they have reached a total body length of about 55 cm., and a total body weight of about 2 kg., which is a good marketable size. This is in accordance with the results obtained from sexual maturation and the recommendation of establishing a size limit (55 cm.T.L.) for fishing of *B. bynni* in the N. hydrodrome (Hashem, 1977).

Table 12. Calculated weights and annual increment in weight (in gm. & %) of *B. bynni* of the Nozha-hydrodrome during the two sampling periods.

Age group	1956—1961				1967—1970			
	calc. length (mm)	Calc. wt. (gm)	Increment of wt. gm	%	calc. length (mm)	calc. wt. (gm)	increment of wt. gm	%
I	185	58	58	1.0	201	72	72	1.2
II	371	584	526	8.8	395	661	589	9.9
III	472	1299	715	11.9	501	1439	778	13.0
IV	556	2241	942	15.7	590	2460	1021	17.1
V	615	3133	892	14.9	650	3375	915	15.3
VI	669	4143	1010	16.8	702	4342	967	16.2
VII	714	5745	1002	16.7	742	5207	865	14.5
VIII	748	6005	860	14.3	774	5977	770	12.9
IX	—	—	—	—	794	6500	523	8.0

SUMMARY

The criteria used for age determination of *B. bynni* is that a true annulus can be traced completely around the scale and generally exhibits crossing over in the posterior portion of the lateral fields. Clear annuli are usually found in young ages, while in old ages, some difficulties are encountered in identifying the first annulus and in differentiating between crowded annuli on the perifery of the scales.

The body-scale ratio is not constant throughout the whol elife of the fish and so, there should be several correction factors corresponding to different length ranges of nearly constant L/S ratio. To overcome such difficulty, Vovk's method was used in the back calculation of the lengths at different years of life.

The growth rate of *B. bynni* in the Nozha-hydrodrome during the two sampling periods was generally high during the first and second years of life, then a marked decrease was observed in the third year. This is mostly due to the start of sexual maturation. From the fourth through the 8th year, the growth increment in length decreases with the increase in age.

Table 9. Average empirical and calculated weights of males and females of *Barbus bynni* in the Nozha hydrodrome during 1968—1969.

Length group. (mm)	Length midpoint (mm)	Males			Females		
		No. of fish	Av. wt. (gm)	Calc.wt. (gm)	No. of fish	Av. wt. (gm)	calc. wt. (gm)
310	315	1	290	281	1	300	302
320	325	—	—	314	1	350	338
330	335	1	330	349	3	400	376
340	345	1	370	388	1	420	417
350	355	4	435	430	—	—	461
360	365	2	450	475	2	483	509
370	375	2	570	523	—	—	560
380	385	1	590	575	7	600	613
390	395	1	610	630	3	625	673
400	405	—	—	690	1	700	735
410	415	1	710	752	1	800	800
420	425	1	780	819	3	855	871
430	435	1	860	890	3	880	946
440	445	—	—	966	—	—	1025
450	455	1	950	1045	2	1100	1109
460	465	2	1225	1130	1	1350	1197
470	475	4	1350	1219	2	1400	1290
480	485	3	1490	1313	2	1505	1388
490	495	2	1610	1413	1	1650	1495
500	505	6	1625	1517	—	—	1603
510	515	5	1675	1628	3	1850	1716
520	525	10	1810	1744	2	1900	1838
530	535	9	1840	1866	6	2000	1964
540	545	4	1970	1993	7	2120	2096
550	555	6	2115	2126	12	2210	2237
560	565	3	2185	2267	8	2275	2381
570	475	8	2375	2414	6	2450	2534
580	585	2	2510	2568	8	2610	2695
590	595	5	2600	2728	7	2720	2859
600	605	—	—	2897	7	3800	3033
610	615	1	2650	3071	3	2990	3214

Table 10. Seasonal variation of the condition factor at (5 cm.) length intervals of *B. bynni* in the Nozha hydrodrome during 1968.

Length interval (mm)	January-March		April-June		July-September		October-December		Total	
	No.	«k»	No.	«k»	No.	«k»	No.	«k»	No.	«k»
110-149	1	0.692	—	—	—	—	19	0.781	20	0·777
150-190	3	0.849	—	—	—	0.898	11	0.827	17	0.843
200-249	2	1.197	—	—	—	—	5	0.885	7	0.974
250-299	5	1.143	45	1.139	16	1.152	21	0.922	87	1.089
300-349	4	1.236	21	1.086	14	1.077	190	0.911	229	0.943
350-399	1	1.279	5	1.230	22	1.060	230	0.936	158	0.954
400-449	1	1.278	2	1.195	6	1.155	64	0.933	75	0.972
450-499	25	1.219	13	1.245	4	1.147	14	1.012	56	1.163
500-549	54	1.282	42	1.293	50	1.243	38	1·154	184	1.247
550-599	5	1.217	31	1.291	103	1.296	73	1.167	212	1.249
600-649	1	1.288	6	1.336	18	1.333	29	1.270	54	1.299
650-699					1	1.372	2	1.281	3	1.311
700-749					—	—	1	1.258	1	1.258
750-799					2	1.381	1	1.327	3	1.363
800 mm					1	1.384	—	—	1	1.384

Table 8. Empirical and calculated weights of *B. bynni* in the Nozha-hydrodrome during the two sampling periods.

Length group (mm)	Length mid-points (mm)	1956—1961			1967—1970		
		N.o of fish	av. wt. (gm)	Calc. wt. (gm)	No. of fish	av. wt. (gm)	Calc. wt. (gm)
110—119	115				3	12	11.8
120—	125				4	14	15.5
130—	135				11	19	19.9
140—	145				6	26	25.2
150—	155				7	29	31.3
160—	165				8	38	38.4
170—	175				7	46	46.5
180—	185				3	58	55.8
190—	195				4	65	66.2
200—	205				4	94	78.0
210—	215				8	104	91.1
220—	225				5	118	105.6
230—	235	1	122	11.87	3	133	121.8
240—	245	1	154	137.0	3	150	139.4
250—	255	1	148	156.7	12	184	159.0
260—	265	2	188	179.2	26	200	180.2
270—	275	1	200	203.3	26	229	203.3
280—	285	2	233	229.8	21	250	228.5
290—	295	2	234	258.6	40	251	255.8
300—	305	2	323	289.9	38	263	285.3
310—	315	1	410	323.8	67	299	317.0
320—	326	1	373	360.4	75	315	351.8
330—	335	2	407	399.7	75	345	387.5
340—	345	—	—	—	54	384	426.6
350—	355	1	565	487.6	92	419	468.2
360—	365	1	575	536.3	84	454	512.9
370—	375	2	612	588.3	73	503	560.1
380—	385	4	681	644.2	73	541	610.7
390—	395	4	765	703.1	39	595	663.7
400—	405	7	836	765.8	37	663	720.4
410—	415	4	865	833.2	33	681	779.6
420—	425	3	937	903.5	16	838	842.9
430—	435	6	1013	978.3	17	827	909.5
440—	445	1	1000	1058.0	14	927	980.0

Table (8)— Continued.

450—	455	4	1113	1140	11	923	1053
460—	465	2	1250	1229	14	1174	1131
470—	475	1	1250	1322	23	1235	1213
480—	485	1	1250	1419	28	1348	1297
490—	495	3	1550	1523	27	1425	1378
500—	505	3	1824	1629	41	1556	1480
510—	515	—	—	—	53	1720	1579
520—	525	1	1750	1863	49	1739	1681
530—	535	6	2113	1988	72	1856	1788
540—	545	6	2037	2117	47	1959	1899
550—	555	13	2250	2252	79	2109	2015
560—	565	3	3163	2395	65	2141	2135
570—	575	4	2625	2543	52	2313	2262
580—	585	8	2531	2698	46	2448	2394
590—	595	7	2957	2857	35	2654	2528
600—	605	8	2975	3002	26	2717	2672
610—	615	3	3417	3201	16	2855	2818
620—	625	5	3920	3383	12	3197	2970
630—	635	3	3917	3572	6	3742	3129
640—	645	2	3625	3768	6	3456	3293
650—	655	4	4262	3969	4	3903	3460
660—	665	3	4225	4181	1	3400	3637
670—	675	3	4337	4401	—	—	—
680—	685	1	5050	6629	1	4000	4006
690—	695	4	4525	4865	—	—	—
700—	705	1	4000	5109	—	—	—
710—	715	—	—	—	—	—	—
720—	725	4	5912	5619	—	—	—
730—	735	2	5825	5892	1	5300	5024
740—	745	1	5500	6173	1	5100	5272
750—	755	2	6250	6457	1	5600	5503
760—	765	1	6000	6759	—	—	—
770—	775	1	6200	7063	1	6500	5995
780—	785	1	6500	7382	1	6600	6253
790—	795	1	7500	7709	—	—	—
800—	805	1	6500	8044	1	7600	6785
——	——	—	——	——	—	—	—
840—	845	1	8750	9501	—	—	—

The differences in growth rates during the two sampling periods may be explained by the high growth rates of the young aged fish in the hydrodrome in a period of less competition following the overfishing period (1964/1965) and before the well establishment of the common carp in 1968.

The mathematical study of the length-weight relationship of *B. bynni* in the Nozha-hydrodrome during the two sampling periods , gives the following equations, which satisfactorily fit the agreement between the empirical and calculated weights :

$$\log W = -5.773 + 3.323 \log L \text{ (for 1956—1961)},$$

$$\log W = -5.683 + 3.274 \log L \text{ (for 1967—1970)}.$$

It is evident that in both periods the value of the exponent (n) increases to a power more than the cube of length and this indicates that the body shape changes rapidly as the fish grows in length. Also, it was found that the females are somewhat heavier than the males of the same length.

As regards the condition factor of *B. bynni* in the N-hydrodrome during 1968, the data show that the values of «k» generally increases with the increase of fish length and for the same length groups the values of «k» are higher in spring and summer than in autumn and winter especially for adult fishes. This coincide with the period of sexual maturation. The data also indicates that the condition factor for the females is somewhat higher than for the males of the same length.

The study of the growth in weight of *B. bynni* in the N-hydrodrome shows that the smallest growth increment was during the first year and a marked increase was obtained during the second and subsequent years, with the largest growth increment during the middle ages. Therefore it would be economically important to protect the *B. bynni* of the N-hydrodrome from capture till their fouth year of life, after they have reached a total body length of about 55 em., and a total body weight of about 2 kg., which is a good marketable size.

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