

BIOLOGICAL STUDIES ON SUDANESE INLAND FISHES

III. Hydrocyon Forskalii Cuvier

BY

S. Z. RAFAIL, A.A. AL-KHOLY AND M. A. MAHDI

- I** Head of Department of fisheries statistics and population dynamics Institute of Oceanography and Fisheries, Alexandria, Egypt.
- II** Director, Institute of Oceanography and fisheries, Cairo, Egypt.
- III** Director, Fisheries Research Department Ministry of Animal production, Khartoum, Sudan.

INTRODUCTION AND METHOD

The reader is referred to Al Kholy, Rafail and Mahdi (1973 a). In these studies investigations were carried out on *Hydrocyon forskalii*.

I Length distribution

Length of the studied *Hydrocyon forskalii* ranged from 280 - 500 mm (Table 3). Length distribution was smoothed by combining length intervals. Thus, length frequencies shown in Table 1 are given.

TABLE 1.—LENGTH FREQUENCY OF *Hydrocyon forskalii*.

Length in mm.	Frequency
280	19
300	38
320	73
340	75
360	158
380	151
400	216
420	193
440	290
460	124
480	64
500	52
520	30
540	20
560	5

Figure 1 shows the length distribution of *Hydrocyon forskalii*. This has 3 modes at 360, 400 and 440 mm. These modes probably represent age groups X, X + 1 and X + 2 respectively.

Thus, the growth of *Hydrocyon forskalii* is shown as follows :

Age in years	X	X+1	X+2
Fish length in mm. . . .	360	400	440

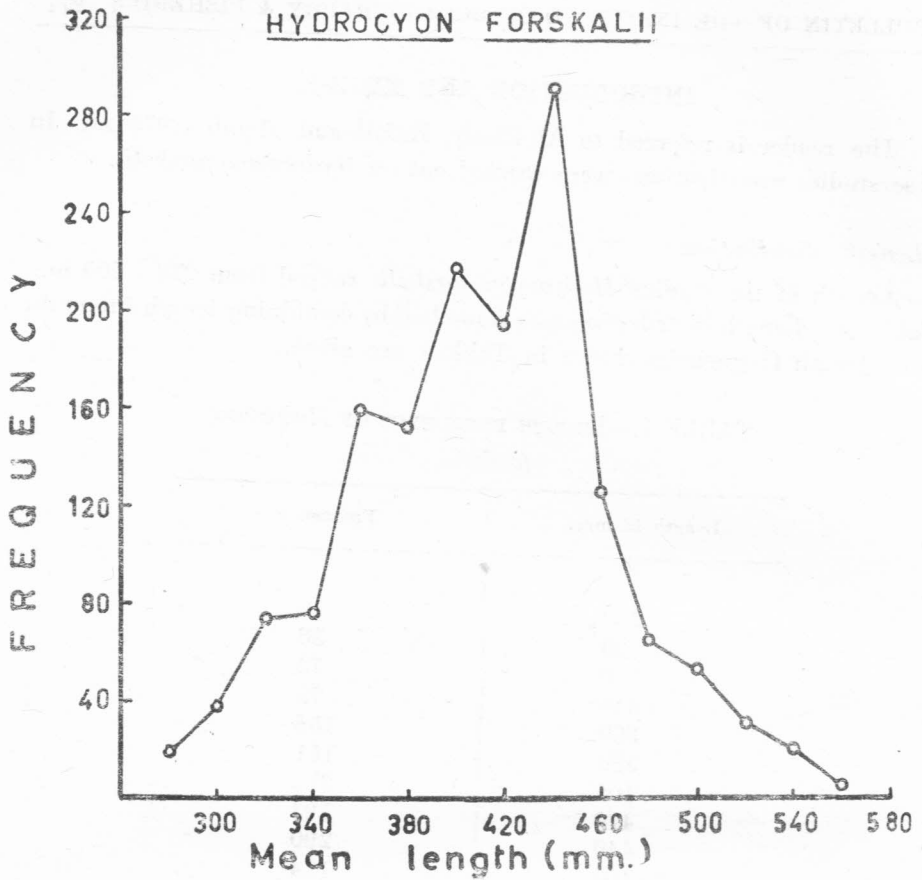


Fig 1 — Length-distribution of hydrocyon forskalii

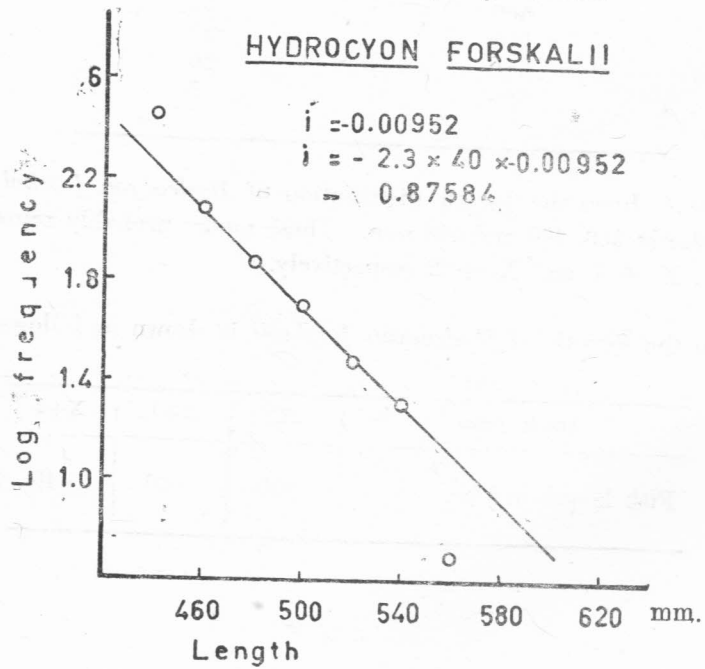


Fig 2 — Log frequency against length of hydrocyon forskalii

From the scale reading studies, age group X was found to be equivalent to age group II (see chapter on age length key). Thus age group I was missing in these studies.

Instantaneous total mortality :

The length frequency at which *Hydrocyon forskalii* becomes fully represented (f) was 440 mm which is shown in Table 1.

TABLE 2.—LENGTH, FREQUENCY AND LOG FREQUENCY
OF *Hydrocyon forskalii*.

Length in mm.	Frequency (No. of fish)	Log 10 frequency
440	290	2.4624
460	124	2.0934
480	64	1.8062
500	52	1.7160
520	30	1.4771
540	20	1.3010
560	5	0.6990

When the log frequency was plotted against length Fig. 2, then i' was equivalent to 0.00952

$$\begin{aligned}
 i' &= 0.00952 \\
 K &= \frac{440 - 360}{4 - 2} = \frac{80}{2} \\
 &= 40 \\
 i &= -2.3 \times 40 \times -0.00952 \\
 &= 0.876 \\
 \therefore S &= 0.417
 \end{aligned}$$

i.e. about 42% of *Hydrocyon forskalii* survive per year after 4 years old.

II Age - distribution

a — Length-weight relationship

In order to study the length-weight relationship of *Hydrocyon forskalii*, 1508 specimens were examined. Their lengths ranged from about 275 - 555 mm. These were distributed as shown in table 3. According to the scatter diagram (Fig. 3), two sub — ranges were made from about 275 — 455 mm and from about 465 to 555 mm.

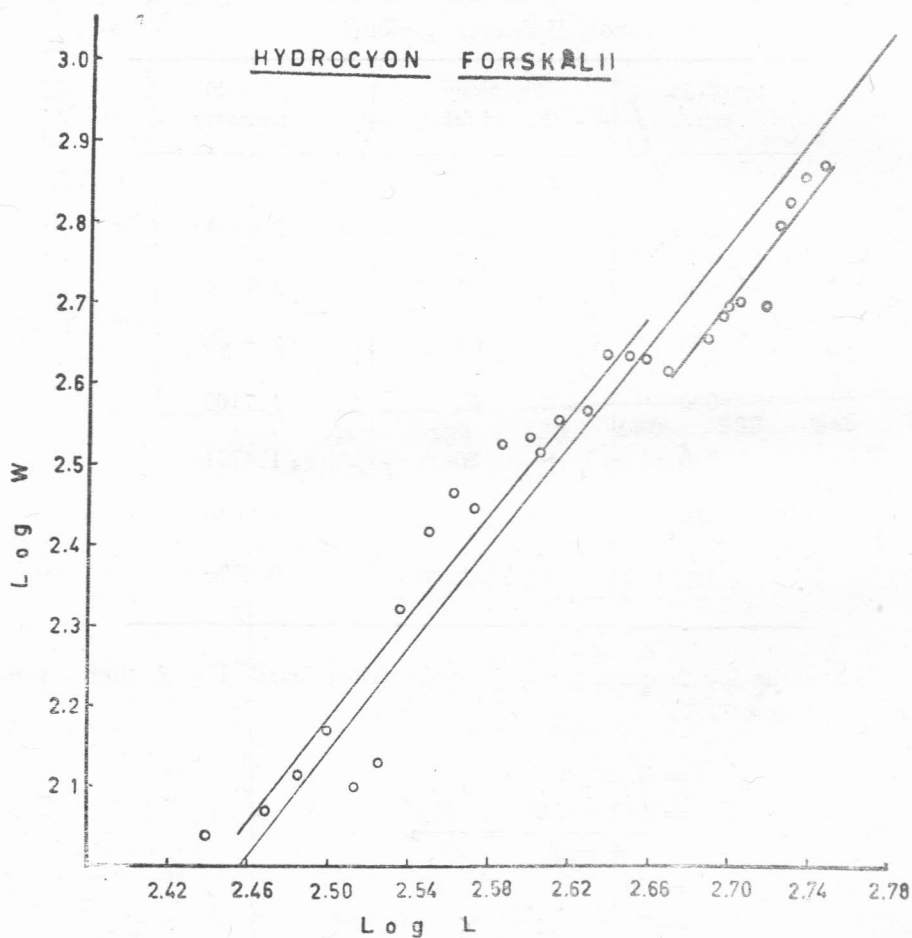


Fig 3 —Log W-logl Selsationip of Hydsocon Fonkalii

The empirical weight of the investigated fish ranged from about 109 to 750 gms. As clear from Fig. 3, the scatter diagram between log W

against log L can not be described by means of one equation. Thus, two sub-divisions were made with their following equations :

Length range	Equation
1. 275 — 455 mm	$\log W = - 5.8461 + 3.2120 \log L$ $W = 1.425 \times 10^{-6} L^{3.212}$
2. 465 — 555 mm	$\log W = - 6.2767 + 3.3324 \log L$ $W = 5.288 \times 10^{-7} L^{3.3324}$

The following equation was obtained when pooling all data (Fig 3) and fitting a single equation :

Length range	Equation
275 — 555 mm	$\log W = - 5.912 + 3.2234 \log L$ $W = 1.225 \times 10^{-6} L^{3.2234}$

Weights calculated from the above single equation were compared with those calculated from the two equations which were fitted to the two sub-divisions (Table 3). Thus, sub-divisions gave much closer theoretical weights to the empirical values than the single equation obtained by pooling all data as shown by table 3. Sub-dividing the range gave much better fitted equations.

b— Age-length key

One hundred and thirty seven specimens of *Hydrocyon forskalii* which belong to six different age groups were investigated. Their lengths ranged from 185—545 mm. Age group I ranged from 185—245 mm with a mode at 205 mm (Table 4); age group II ranged from 265—355 with a mode at 355 mm; age group III ranged from 375—445 mm with a mode at 445 mm; age group IV ranged from 465—485 mm with a mode at 475 mm; age group V ranged from 475—515 mm with a mode at 515 mm and age group VI ranged from 505—545 mm.

TABLE 3.—LENGTH-WEIGHT RELATIONSHIP OF *Hydrocyon forskalii*

Length in mm L	Frequency	Empirical mean weight in gms. W	Log L	Log W	Calculated log W	Calculated W	Calculated W without sub- divisions Pooled
275	3	109	2.4393	2.0374	1.9888	97.45	89.3
285	16	118	2.4548	2.0718	2.0386	109.3	100.8
295	20	115	2.4698	2.0607	2.0868	122.1	111.9
305	18	130	2.4843	2.1139	2.1333	135.9	124.8
315	13	138	2.4983	2.1703	2.1783	150.8	138.4
325	60	125	2.5119	2.0969	2.2220	166.7	153.1
335	43	140	2.5250	2.1461	2.2641	183.7	160.7
345	32	210	2.5378	2.3222	2.3052	201.9	185.5
355	81	260	2.5502	2.4150	2.3450	221.3	203.3
365	77	293	2.5623	2.4669	2.3839	242.0	222.5
375	65	281	2.5740	2.4487	2.4215	263.9	242.7
385	86	335	2.5855	2.5250	2.4584	287.5	264.3
395	105	346	2.5966	2.5391	2.4940	311.9	287.0
405	111	328	2.6075	2.5159	2.5291	338.2	311.2
415	73	360	2.6180	2.5563	2.5628	365.4	336.4
425	120	380	2.6284	2.5798	2.5962	394.6	363.4
435	212	442	2.6385	2.6454	2.6286	425.2	391.6
445	78	440	2.6484	2.6435	2.6604	457.5	421.5
455	43	430	2.6580	2.6335	2.6913	491.2	452.7

Table 3 (Cont.)

Length in m	Frequency	Mean weight in gms (Empirical W)	Log L	Log W	Calculated log W	Calculated W	Calculated W without sub-divisions (Pooled)
465	81	419	2.6675	2.6222	2.6125	409.8	485.7
475	46	463	2.6767	2.6656	2.6432	439.7	520.1
485	18	490	2.6857	2.6902	2.6732	471.2	556.0
495	11	482	2.6946	2.6830	2.7028	504.3	594.0
505	41	510	2.7033	2.7076	2.7318	539.3	633.6
515	22	500	2.7118	2.6990	2.7602	575.7	674.3
525	8	630	2.7202	2.7993	2.7881	613.9	718.3
535	3	680	2.7284	2.8325	2.8155	653.9	763.3
545	17	730	2.7364	2.8633	2.8421	695.2	810.0
555	5	750	2.7443	2.8751	2.8685	738.7	859.0

375				2	100.0							2
385				2	100.0							2
395				2	100.0							2
405				4	100.0							4
415				6	100.0							6
425				10	100.0							10
435				10	100.0							10
445				12	100.0							12
465						3	100.0					3
475						5	83.3	1	16.7			6
485						3	100.0	0	0.0			3
495								1	100.0			1
505								1	50.0	1	50.0	2
515								3	100.0	0	100.0	3
525										0	100.0	0
535										0	100.0	0
545										1	100.0	1
Total . .	50		20		48		11		6		2	137

Age group I, II, and III did not show any mixed lengths. Length 465 mm belongs to age group IV. Length ranges 475 - 485 mm are mixtures of age group IV and V. Length 495 mm is only age group V where as length range 505 - 515 mm is a mixture of age group V and VI. At 545 mm, only one fish which belonged to age group VI.

According to the scale readings the number of fish belonging to each age group with their length ranges are shown in table 5. In this table the average length of age groups I, II, III, IV, V and VI were 214, 327, 424, 475, 503 and 525 mm respectively. Their length ranges were 185 - 245 mm, 265 - 355 mm, 375 - 445 mm, 465 - 485 mm, 475 - 515 mm, and 505-545 mm respectively.

TABLE 5.—LENGTH RANGES OF THE DIFFERENT AGE GROUPS OF *Hydrocyon forskalii* AS ESTIMATED FROM SEALES.

Age group	Number	Length in mm		
		Interval	Mean	Increment
I	50	185—245	214	—
II	20	265—355	327	113
III	48	375—445	424	97
IV	11	465—485	475	51
V	6	475—515	503	28
VI	2	505—545	525	22
Total . . .	137	—	—	—

The majority of fish studied were found to belong to age group I. These were 50 individuals whose length range was 185 - 245 mm. Age group III ranked the second as far as abundance is concerned as it contains 48 specimens ranging from 375 - 445 mm. Twenty specimens were found to belong to age group II with a length range of 265 - 355 mm. Age groups IV, V and VI were found to contain 11, 6 and 2 individuals. Their length ranges were 465 - 485 mm, 475 - 515 mm and 505 - 545 mm.

Growth estimated from the length distribution curves were as follows :

Age in years	X	X+1	X+2
Fish length in mm	360	400	440

Thus from the scale readings, age group X is probably equivalent to age group II. Age group I was missing from the length distribution studies. Growth estimates from length distribution are as follows :

Age in years	2	3	4
Fish length in mm. . . .	360	400	440

In the scale reading only 11 specimens were found to belong to age IV. The small number and the narrow range of length investigated belonging to age group IV, explain the slight difference between results obtained from scale reading and length distribution.

The two estimates of growth of *Hydrocyon forskalii* are shown on Table 6.

TABLE 6.—GROWTH ESTIMATES OF *Hydrocyon forskalii*.

Age	Growth estimated by		Accepted estimates mm.	Weight in gms
	Length frequency mm.	Scale readings mm.		
1	—	214	214	40
2	360	327	360	232
3	400	424	400	325
4	440	475	440	441
5	—	503	503	626
6	—	525	525	718

With the exception of age 2, scale reading gave higher values as it was noticed in the previous examples. The length frequency of fish belonging to age groups II and III aged by their scale (Table 4) shows a higher frequency of larger fish, thus, confirming the effect of non-random sampling for scales as well as the relative validity of estimates by length frequency.

Age distribution

The lengths of 1372 specimens were measured whereas scale readings were done on 137 individuals. Due to the fact that studies on length were carried out on the length range 275 - 545 mm, scale readings which were taken on fish of lengths less than 275 mm were excluded from these studies. Thus, all fish on length ranges 275 - 355 mm and 375 - 445 mm were assigned to age groups II and III. Lengths 475 mm and 505 mm showed mixtures of age group IV together with V and VI together with VI respectively. Thus, at 475 mm. length about 38 fish were assigned to age group IV and about 8 fish to age group V (Table 7).

Fish belonging to age groups II - VI were as follows :

Age group	II	III	IV	V	VI	Total
Frequency	286	850	137	61	38	1372
Ratio	20.8	62.0	10.0	4.4	2.8	100

The ratio of the frequency of each age group is also shown in the above table. Length frequency was transformed to weight frequency as was previously shown.

The following table shows the total weight of each age group with their ratios :

Age group	II	III	IV	V	VI	Total
Weight in gms . . .	51177	312005	89716	32654	22874	508426
gms weight per kilo-gram	100.7	613.6	176.5	64.2	45.0	1000

TABLE 7.—AGE DISTRIBUTION OF *Hydrocyon forskalii* SHOWING THE RELATION BETWEEN THE AGE GROUPS IN NUMBER AND WEIGHT

Length in mm	Number	Weight	Number of fish in age group						
			II	III	IV	V	VI		
275	3	97.5	3.0						
285	16	109.3	16.0						
295	20	122.1	20.0						
305	18	135.9	18.0						
315	13	150.8	13.0						
325	60	166.7	60.0						
335	43	183.7	43.0						
345	32	201.9	32.0						
355	81	221.3	81.0						
375	65	263.9		65.0					
385	86	287.3		86.0					
395	105	311.9		105.0					
405	111	338.2		111.0					
415	73	365.4		73.0					
425	120	394.6		120.0					
435	212	425.2		212.0					
445	78	457.5		78.0					
465	81	409.8			81.0				
475	46	439.7			38.3	7.7			
485	18	471.2			18.0	0.0			
495	11	504.3				11.0			
505	41	539.3				20.5			
515	22	575.7				22.0	20.5		
545	17	695.2					0.0	17.0	
Total . .	1372								
Sum of number of fish in each group			286	850	137	61		38	
Sum of weight of each group			51177	312005	89716	32654		22874	
Sum of the total weight . .			508'26						

In every kilogram weight of the studied *Hydrocyon forskalii* there were 100.7, 613.6, 176.5, 64.2 and 45.0 gms of age groups II, III, IV, V and VI respectively.

The number of fish belonging to each age group per a kilogram is calculated to give the following :

Age group	Number of fish per a kilogram
II	$0.001966 \times 286 = 0.5623$
III	$0.001966 \times 850 = 1.6711$
IV	$0.001966 \times 137 = 0.2693$
V	$0.001966 \times 61 = 0.1199$
IV	$0.001966 \times 38 = 0.0747$

Thus, in each kilogram weight of *Hydrocyon forskalii* there were 0.5623, 1.6711, 0.2693, 0.1199, and 0.0747 fish of age groups II, III, IV, V and VI respectively.

As far as number of fish is concerned, age group II and III are the most important. Both age groups form over 80% of the catch, whereas age group III alone forms about 62%. Age group III keeps almost same percentage when the weight is considered, whereas the weight of age group II forms half the percentage it attains when the number is concerned. Thus, age group II forms only about 10% of the weight of the catch. Age group IV which forms about 18% of the weight of the catch, becomes more important than age group II.

Both age groups V and VI form about 7% only of the number of fish caught. This is due to the fact that about 40% of the population of *Hydrocyon forskalii* survive after they reach 3 years of age (see chapter on length distribution). Age group VI which forms less than 3% of the number of the catch, becomes more important when the weight is concerned and forms more than 4%.

SURVIVAL RATES

The \log_{10} frequency of the different age groups of *Hydrocyon forsklii* were as follows :

Age group	II	III	IV	V	VI
Percentage . . .	20.8	62.0	10.0	4.4	2.8
\log_{10} percentage .	1.3181	1.7924	1.0000	0.6435	0.4472

When the catch curve was plotted (Fig.4) it showed an increasing left limb from II - III. Age III represents the dome of the curve. From age III - VI the catch curve takes the form of a straight line decreasing right limb.

The slope of the straight line fitted from age group III to VI was estimated by the least square method. The regression equation was as follows :

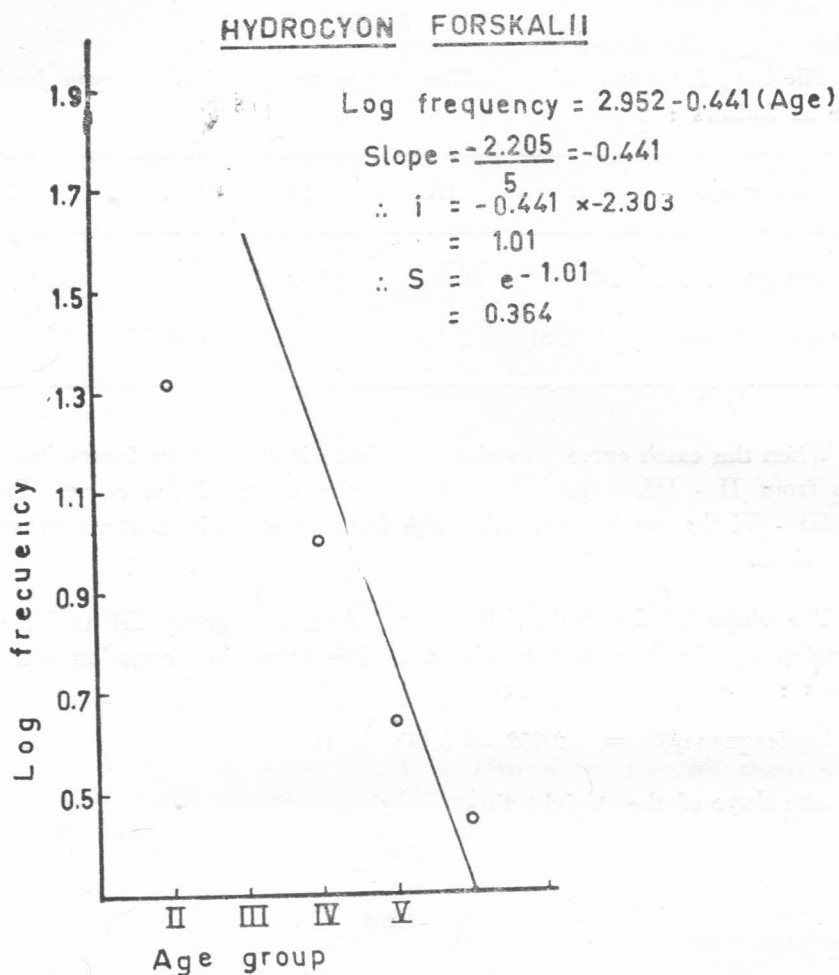
$$\log(\text{frequency}) = 2.952 - 0.441 (\text{age})$$

The slope of the straight line

$$\begin{aligned} &= \frac{\Sigma xy}{\Sigma x^2} \\ &= \frac{-2.205}{5} \\ &= -0.441 \\ i &= -0.441 \times -2.303 \\ &= 1.01 \\ S &= e^{-1.01} \\ &= 0.364 \end{aligned}$$

i.e. the survival rate is equivalent to about 36%.

The survival rate calculated from the length frequency was equivalent to about 42%. Thus, both methods almost gave insignificantly different results.



DISCUSSION

In the second manuscript of the studies of these series (Rafial, Alkholy and Mahdi, 1973 b) mortality and survival rates were studied from both length frequency and age composition. Both studies gave almost the same results in case of *Hydrocyon forskalii*. Mortality was found to be 0.88 when the length frequency was used. This was equivalent to 1.0 when age composition was studied.

Both methods gave almost the same results. The survival rate calculated from the length frequency was equivalent to about 42%, whereas, it was found to be about 36% when age composition was investigated.

The length-weight relationship of *Hydrocyon forskalii* was described by two equations describing two sub-divisions of the length ranges shown in the text.

Investigations on age distribution of *H. forskalii* showed that age group III is the most important of the four age groups investigated. It forms about 60% of the number of fish caught and about 60% of the catch by weight.

REFERENCES

- ALKHOLY, A.A. ; S.Z. RAFAIL and M.A. MAHDI 1973 a.—Biological studies on Sudanese Inland fishes I Bull. Inst. Ocean. fish. A.R.E. III.
- RAFAIL, S.Z. ; A.A. ALKHOLY and M.A. MAHDI 1973 b.—Biological studies on Sudanese inland fishes II. Bull. Inst. Ocean. fish. A.R.E. III.