GROWTH OF THE CATFISH *CLARIAS GARIEPINUS* (CLARIIDAE) IN THE RIVER ASI (ORONTES), TURKEY

by

Şükran YALÇIN (1), Kemal SOLAK (2) & Íhsan AKYURT (3)

ABSTRACT. - Vertebrae from 720 *Clarias gariepinus* from the River Asi were used for the study of age and growth. The population consisted of 0+ - 5 age groups including females to 48.75% in addition to males to 50.83% and the abnormal (intersex) of 0.42%. According to the Von Bertalanffy growth model, length equations obtained for females and males were $L_t = 82.94\ [1 - e^{-0.15(t + 1.72)}]$ and $L_t = 85.32\ [1 - e^{-0.144(t + 0.69)}]$ respectively. The Von Bertalanffy equations did not fit the data satisfactorily, because there were not enough old fish in the data. The absolute length increments for the major age groups (0-3) were 5.32 cm, 9.74 cm, 8.22 cm and 5.68 cm, 10.11 cm, 8.63 cm for females and males respectively. The weight increments for the major age groups (0-3) for females and males were 48.07 g, 179.41 g, 245.51 g and 50.31 g, 167.19 g, 195.02 g respectively. The relationships between the total length in cm (L) and the weight in g (W) for the female and the male were calculated to be $W = 0.010\ L^{2.90}$ and $W = 0.016\ L^{2.74}$ respectively. The condition value of *C. gariepinus* population was found to be high at young ages (0+ and 1) whereupon the increase to 0.8 was replaced by decline in the River Asi. The monthly fluctuation of the condition of catfish is more related with temperature and feeding. It is observed that *C. gariepinus* population in the River Asi that have a commercial value is under some stress factor such as lack of water, excessive fishing and pollution.

RÉSUMÉ. - Croissance de *Clarias gariepinus* (Clariidae) poisson-chat du fleuve Asi (Orontes), Turquie.

Les vertèbres de 720 *Clarias gariepinus* du fleuve Asi ont été utilisées pour l'étude de l'âge et de la croissance. La population est composée des 0+ - 5 groupes d'âge et comprend 48,75% de femelles, 50,83% de mâles et 0,42% d'individus anormaux (inter sexuels). Selon le modèle de croissance de Von Bertalanffy, les équations de longueur obtenues pour les femelles et les mâles étaient $L_t = 82{,}94\ [1 - e^{-0{,}15(t + 1{,}72)}]$ et $L_t = 85{,}32\ [1 - e^{-0{,}144(t + 0{,}69)}]$, respectivement. Les équations de Von Bertalanffy n'ajustent pas les données d'une manière satisfaisante, parce que le nombre de vieux poissons dans les données est insuffisant. Les incréments absolus de longueur pour les principaux groupes d'âge (0-3) étaient respectivement 5,32 cm, 9,74 cm, 8,22 cm pour les femelles et 5,68 cm, 10,1 cm, 8,63 cm pour les mâles. Les incréments de poids pour les mêmes groupes d'âge étaient respectivement 48,07 g, 17,41 g, 24,51 g pour les femelles et 50,31 g, 167,19 g, 195,02 g pour les mâles. Les relations taille-poids entre la longueur en centimètres (L) et le poids en grammes (W) étaient, respectivement, $W = 0{,}010\ L^{2{,}90}$ pour les femelles et $W = 0{,}016\ L^{2{,}74}$ pour les mâles. Le facteur de condition de la population de *C. gariepinus* est élevé chez les jeunes âges (0+ et 1) où il atteint 0,8 chez les individus dans le fleuve Asi. La variation mensuelle de l'état du poisson-chat est associée à la température et à l'alimentation. La population de *C. gariepinus* dans le fleuve Asi, d'importance commerciale, est soumise à certains facteurs de stress tels que le manque de l'eau, la pêche excessive et la pollution.

Key words. - Clariidae - *Clarias gariepinus* - Turkey - River Asi - Orontes - Growth.

Clarias gariepinus (Burchell, 1822) a catfish species, which has an almost Pan-African distribution also occurs in Asia Minor from Jordan, Israel, Syria to Turkey (Teugels, 1986). In Turkey, it is wide spread in the southern and the central Anatolian freshwaters like the River Asi, where it has commercial importance, Ceyhan, Seyhan, Goksu, Aksu and Sakarya rivers.

C. gariepinus is a benthopelagic, dioecious, omnivorous fish and widely tolerant to extreme environmental conditions. They spawn in a period from May to August when the water temperature range between 21-30°C in the River Asi. However, most papers indicate that spawning takes place during the rainy season in flooded deltas. They start reaching maturity at age 1 and in the River Asi, all the fishes become mature by the end of the second year (Yalçin *et al*., 2001a). The fishes make a lateral migration towards the flooded plans to breed and return to the river or lake soon afterwards in tropical regions. The presence of an accessory breathing organ enables this species to breath air when very active or under very dry conditions (Teugels, 1986). These peculiarities allow it to be one of the most frequently used aquaculture species in the world. Thus *C. gariepinus* is widely farmed in Africa, America, Europe and Asia.

Previous studies on the growth of *C. gariepinus* were made mostly in the southern regions in Africa and in diffe-

(1) Mustafa Kemal University, Science and Literature Faculty, Biology Department, 31024 Antakya Hatay, TURKEY. [syalcin@mku.edu.tr]

(2) Gazi University, Gazi Education Faculty, Biology Department, Ankara, TURKEY.

(3) Mustafa Kemal University, Fisheries Faculty, Antakya Hatay, TURKEY.

rent types of environment as in artificial tropical and equatorial lakes, fish farms, eutrophic reservoirs, marshes, sandy alkaline coastal plains and lakes of arid region (De Kimpe and Micha, 1974; Pivnicka, 1974; Van der Waal and Schoonbee, 1975; Van der Waal, 1976; Willoughby and Tweddle, 1978; Bruton, 1979; Clay, 1979; Bruton and Allanson, 1980; Clay and Clay 1981; Quick and Bruton, 1984). Growth is a change in size of an individual, usually as an increase, measured in units of length, weight, or energy (Wootton, 1992). Environmental conditions are an important factor to cause the effect that *C. gariepinus* may have different growth rates in different locations. As the River Asi is situated in the Levant, a subtropical arid region, the growth rate of catfish may show recognizable differences. There is as yet no record on culturing or production of this fish; only a few studies of its biology were made in Turkey so far (Erençin *et al.*, 1972; Ergüven, 1978; Tekelioglu, 1980). This study aims to estimate the population structure and the growth of C. *gariepinus* in the River Asi with perspective of a successful management of natural fisheries or of an aquaculture facility.

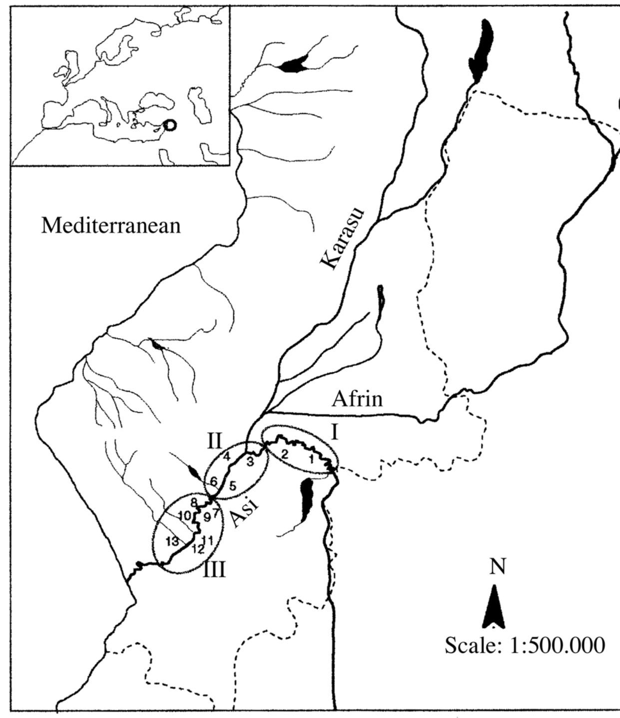

Figure 1. - Map of the sampling locations where the specimens were collected (I. Demirkopru 2. Uzumdali 3. Guzelburç 4. Narlica 5. Antakya 6. Asagiokcular 7. Turunclu 8. Subasi 9. Seyhhasan 10. Meydancik 11. Tavlakoyu 12. Asagidover 13. Sinanli). For some of results presented here the data were grouped according to the three circled strata.

MATERIAL AND METHODS

The river Asi originates in El-Bekaa valley, between Lebanon and Antilebanon Mountains, crosses Syria and ends in Turkey. The length of the river is 380 km, the Turkish taut accounting for 94 km. The river is 35-40 m wide and 0.3-2.5 m deep. The annual rainfall is 1173.4 mm in Antakya (Anonym, 1982). The rainy season extends from autumn to spring. The River Asi could flow all year, but during summer almost all the water is pumped for irrigation. Therefore the depth of the river decreases to 0-1.5 m in the summer months.

Catfish were collected monthly with several kinds of nets (38 x 38 mm - 54 x 54 mm) like fyke net, cast net which were operated by professional anglers and some traps from 13 locations throughout the River Asi from October 1996 to September 1998. Sampling locations were grouped into three strata upper (I), roughly middle (II) and lower part of the river (III) for the assessment of the length distribution (Fig. 1).

A total of 720 catfish were brought to the laboratory and the total lengths and weights were estimated to the nearest 1.0 mm and 0.1 g respectively (Lagler, 1966). The first three unattached vertebrae behind the first four-combined vertebra, which is called complex vertebra by Nawar (1954), were used for age estimation. Pivnicka (1974), Van der Waal (1976), Willoughby and Tweddle (1978) and Clay and Clay (1981) used vertebrae to indicate the ages of *C. gariepinus* populations. Clay (1982), compared different methods used for ageing *C. gariepinus* and concluded that rings of vertebrae are better indicators of growth (according to length frequency data) than those of pectoral spines. The major problem in age estimations is that there seems to be too many rings in old specimens. Calculation of the growth rates of *C. gariepinus* individuals was based on vertebrae that provided reliable age estimation since the population of the River Asi is young.

The three vertebrae of each fish were cleaned and air-dried and later separated, enveloped and numbered. The vertebra was kept in a xylol solution to improve the contrast between opaque and hyaline zones, and the sections were examined with an x4 stereomicroscope. The rings were counted upon adding a hyaline ring (dark in reflected light) formed in winter to an opaque ring (light in reflected light) formed in summer, which was assumed to be equally each year (Clay and Clay, 1981). The ages of 1+, 2+, 3+, 4+ and 5+ were taken as 1, 2, 3, 4, and 5 respectively. The countings were repeated three times by two different readers. The sexes are determined through the gonadal examination with naked eye for the relatively large individuals and with a stereomicroscope for the smaller ones.

The formula, $L_t = L_\infty [1 - e^{-k(t-t_0)}]$, $W_t = W_\infty [1 - e^{-k(t-t_0)}]^b$ and $W = aL^b$, were used to determine the age length, age-weight and length-weight relationships, respectively (Von

Bertalanffy, 1957; Chugunova, 1963). Where L_t = total length at age t, L_∞ = asymptotic length (cm), k = growth coefficient year^{-1}, t_0 = theoretical time when length is zero years, W_t = weight at age t (g), W_∞ = asymptotic weight (g), and "a" and "b" = constants. Excel 7.0 graphic and statistical programs were used to determine regression slope and correlation between weight and length of specimens.

The absolute increment in length (L_i) (cm) and weight (W_i) (g) and the relative increments in length (Cl) and weight (Cw) were computed by the following formulas (Ricker, 1975): $L_i = L_2 - L_1$ and $W_i = W_2 - W_1$, $Cl = (L_2 - L_1)/L_1$ and $Cw = (W_2 - W_1)/W_1$.

The average absolute length increments in the first years (n) of life, n i_{1-n} = Ln (average length of fish at the same age) was computed to compare the different *C. gariepinus* populations (Zivkov *et al.*, 1999).

The values of condition factor of individual specimens of males and females were calculated using the formula $C = W/L^3 \times 100$, W being the weight of each specimen in grams and L, the total length of individuals in centimeters (Tesch, 1968). The student t test (Excel 7.0) was used to test differences for months and sexes.

RESULTS

Sex ratio, age and length composition

The ovaries of *C. gariepinus* are paired elongate organs situated dorsally in the body cavity. Each ovary continues posteriorly into a distinct oviduct, the oviducts fusing terminally and opening into a urogenital papilla. Immature or resting ovaries are opaque and cream in colour, but at later stages of growth they turn reddish brown and distended with ova, which are shown through the transparent ovary wall. The testes are paired and connected by means of fused spermatic ducts, which open into an elongate, pointed urogenital papilla. The testes have a series of indentations along their anterior and lateral margins, which became more prominent as maturation is reached. During the peak of the breeding season the morphology of testes in *C. gariepinus* is externally differentiated into two distinct regions: an anterior portion, the true testis, and a semitransparent posterior part, the seminal vesicles with elongate urogenital papilla externally. In a ripe male the seminal vesicles are turgid and consist of a series of finger-like lobes, but in the non-breeding season they regress and are inconspicuous (Bruton, 1979). The intersex specimens looked like a mature male with elongate urogenital papilla externally and have seminal vesicles that are turgid and consist of a series of finger-like lobes. But, the anterior portion of their testes was different from the one previously described by Bruton (1979) in that the anterior part of the testis was white and opaque. They had a series of indentations along their anterior and lateral margins and were distended with ova seen through the transparent ovary wall. These specimens had ripe ova in the testis sacs. They might be abnormal individuals.

After excluding the intersex specimens, there was no significant difference in the sex ratio at age according to student t test ($p > 0.05$), the overall sex ratio from age 0 to 9 is almost 1:1 (Tab. I).

C. gariepinus population in the River Asi consisted of 0+, 1+, 2+, 3+, 4+ and 5+ age groups, whose percentages were 23.47%, 37.64%, 27.08%, 8.61%, 2.5%, and 0.56%, respectively. No specimen of age 6, 7, and 8 was caught of but one of age 9 was in the whole sample caught. Age group 1 was found to be dominant for both sexes. The lengths of the specimens studied ranged from 12.0 cm to 82.6 cm and the majority was between 20 and 35 cm (Fig. 2). Monthly length distributions of *C. gariepinus* in both sexes combined are shown in figure 3. Catfish bigger than 35 cm were dominant only in March, in July and in August especially in the lower course of the River Asi (Fig. 4).

Growth in length

Mean length (L) in cm for both sexes of the different age groups and significance level of differences between females and males in the same age groups of *C. gariepinus* are given in table II. There was no significant difference between the mean lengths of the sexes ($p > 0.05$). The absolute and relative increments in length decreased over age 2 in both sexes (Tab. II, Fig. 5). There was no significant difference between sexes.

The von Bertalanffy growth equations obtained for males and females are expressed as follows:

Females $L_t = 82.94\ [1 - e^{-0.15(t + 1.72)}]$

Males $L_t = 85.32\ [1 - e^{-0.144(t + 0.69)}]$

Measured lengths of individual catfish within each age group were compared with that the calculated length taking into consideration the equation given above. The differences in length between measured and calculated data were found to be statistically significant in 1, 2 and 4 age's groups. This finding confirms that the Von Bertalanffy

Table I. - Sex ratio and age composition of *C. gariepinus* from the River Asi. N: number of individuals.

Age	N	Male	Female	Ratio (Male/Female)
0	169	101	68	1.49 : 1. 00
1	271	139	132	1.05 : 1.00
2	195	88	105	0.84 : 1.00
3	62	25	36	0.69 :1.00
4	18	12	6	2.00 : 1.00
5	4	1	3	0.33 : 1.00
9	1	0	1	
Total	720	366	351	1.04 : 1.00

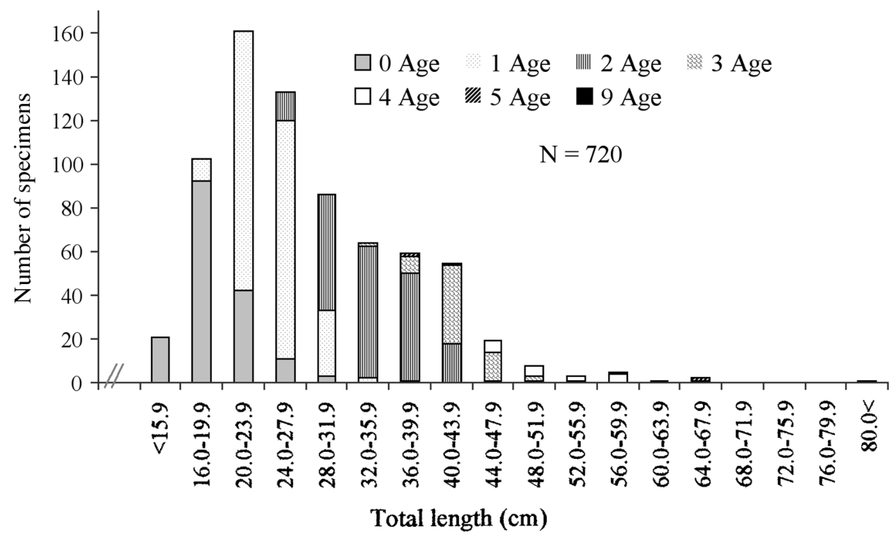

Figure 2. - Distribution of length classes of *C. gariepinus* samples from the River Asi.

growth model is not adequate to explain the growth of *C. gariepinus* in the River Asi.

Growth in weight

There was no significant difference in weight between males and females (Tab. III). The largest absolute growth in weight at the fourth year in both sexes was ignored because of insufficient number of specimens in this age. The weight increments for the major age groups (0-3) were 48.07 g, 179.41 g, 245.51 g and 50.31 g, 167.19 g, 195.02 g for females and males respectively. Relative increments in weight decreased along with the subsequent ages (Fig. 5).

The equations obtained for males and females according to Von Bertalanffy growth model are expressed as follows:

Females $W_t = 4581.6\ [1 - e^{-0.15(t + 1.72)}]^{3.03}$

Males $W_t = 3334.7\ [1 - e^{-0.144(t + 1.69)}]^{2.74}$

Table II. - Length at age and absolute increments in length of the different age groups of *C. gariepinus* samples from the River Asi. N: Number of individuals; SE: Standard Error; p: Significance level.

Sex	Age	N	Mean (cm) ± SE	Min - Max	Absolute increments $L_i - L_{i-1}$	Difference between ♀ and ♂
♀ + ♂	0	169	18.61 ± 0.24	12.0 - 28.6		
♀	0	68	18.83 ± 0,35	14.1 - 28.6		
♂	0	101	18.46 ± 0.33	12.0 - 28.6		p > 0.05
♀ + ♂	1	271	24.15 ± 0.18	18.4 - 38.8	5.54	
♀	1	132	24.15 ± 0.25	19.3 - 38.8	5.32	
♂	1	139	24.14 ± 0.25	18.4 - 32.7	5.68	p > 0.05
♀ + ♂	2	195	34.19 ± 0.32	24.2 - 45.5	10.04	
♀	2	105	33.89 ± 0.38	25.9 - 42.2	9.74	
♂	2	88	34.25 ± 0.49	24.2 - 45.5	10.11	p > 0.05
♀ + ♂	3	62	42.45 ± 0.42	35.7 - 53.0	8.26	
♀	3	36	42.11 ± 0.61	35.7 - 53.0	8.22	
♂	3	25	42.88 ± 0.57	36.7 - 51.4	8.63	p > 0.05
♀ + ♂	4	18	51.88 ± 1.36	42.4 - 64.3	9.43	
♀	4	6	52.55 ± 3.18	42.4 - 64.3	10.44	
♂	4	12	51.54 ± 1.40	45.5 - 59.2	8.66	p > 0.05
♀ + ♂	5	4	52.63 ± 5.52	37.1 - 62.0	0.75	
♀	5	3	52.60 ± 7.82	37.1 - 62.0	0.05	
♂	5	1	52.70		1.03	

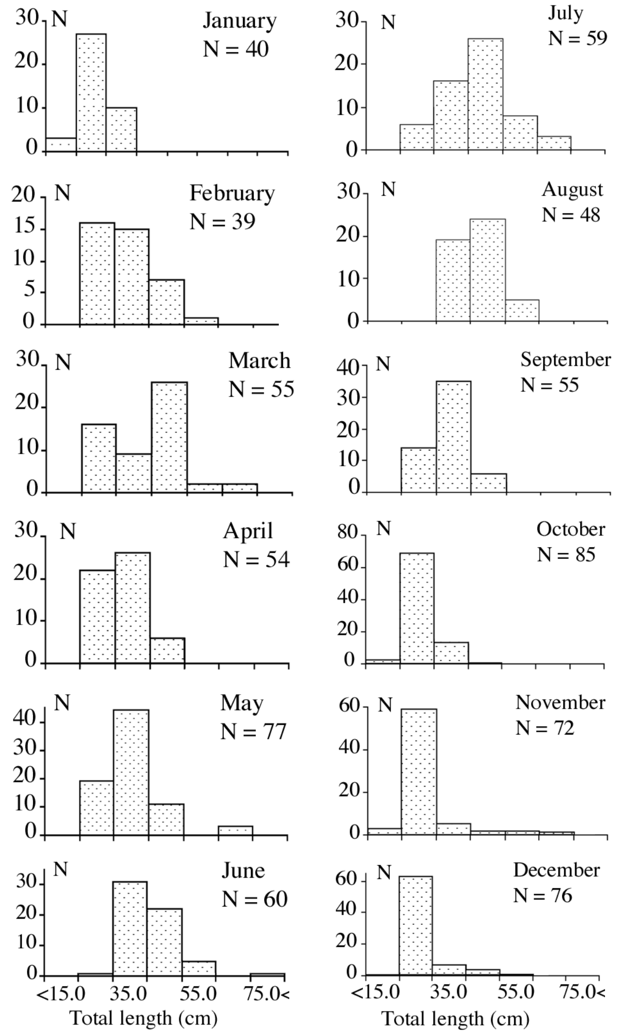

Figure 3. - Monthly length frequency distribution of *C. gariepinus*, both sexes combined.

Length - weight relationship

The relationship between the total length in cm (L) and the weight in g (W) for female and male was calculated by the equation:

Females $W = 0.010L^{2.90}$ ($r^2 = 0.96$; n = 351)

Males $W = 0.016L^{2.74}$ ($r^2 = 0.97$; n = 366)

The curves of the length-weight relationships obtained from these equations are shown in figure 6.

Condition factor

The calculated condition factors for males and females with respect to age groups are given in table IV. The mean condition factors ranged between 0.8 at the age of 0+ and 0.59 at the age of three. Condition factors of the females at the age of 2 and older were higher than those of males and the differences between males and females were statistically significant at these ages ($p < 0.05$).

In spring and in summer months, the mean condition factor of *C. gariepinus* was low in both years (Fig. 7). Condition increased throughout the summer months and was maintained with some fluctuations until December. There was no significant correlation between fish condition and sampling location.

DISCUSSION

The overall sex ratio of *C. gariepinus* in the River Asi was 1.04:1 in favour of males. There was no statistically significant difference between sexes. However, in a previous study a higher percentage of females were observed in age groups 2 and 3 when *C. gariepinus* individuals preferred the shallow water for spawning in the breeding season from May to August (Yalçin *et al.*, 2001a). Rather shallow water levels in these summer days allowed the fish to be captured more easily. Furthermore, during this period anglers use the cast net which are made heavier with iron chains instead of lead. Males were also more abundant than females in large size groups of catfish in the Elands River, Hardap Dam, Lower Shire River and Lake Sibaya (Van der Waal, 1972; Gaigher, 1977; Willoughby and Tweddle, 1978; Bruton and Allanson, 1980). The abnormal (intersex) individuals which are 0.4% of all samples, could be a consequence of the bad conditions of the River Asi like pollution or stress related to low water level.

It is apparent in figure 2 that *C. gariepinus* individuals longer than 35 cm were low in number in the sample, which is an evidence for excessive fishing in the River Asi. Moreover, catfish feed mostly on Diptera larvae in the River Asi and larger fishes cannot find adequate large preys in this shallow water (Yalçin *et al.*, 2001b). Similarly, Bruton and Allanson (1980) stated that the large catfish prefer deeper water to feed on larger preys in Lake Sibaya. Indeed, figure 4, which shows that generally bigger fish was collected from the lower course of the river, suggests that catfish bigger than 35 cm might have migrated to deeper water like the estuary and/or lakes connected to the river. In the same way, De Kimpe and Micha (1974) stated that *Clarias* are generally acknowledged as migratory fish by different observers who established that they migrate upstream in rivers and brooks to spawn.

In the Shire Valley, Malawi, the largest specimen recorded was a 100 cm male of weighting 8.5 kg (Willoughby and Tweddlle, 1978). In Lake Sibaya the largest specimen recorded was 108.8 cm in total length for 8.79 kg (Bruton and Allanson, 1980). In the River Asi the largest specimen captured was an 82.6 cm female only weighting 4.02 kg.

In the Shire Valley, Malawi, asymptotic length (L_∞) was estimated to be 139.4 cm and 78.9 cm for males and for females respectively (Willoughby and Tweddle, 1978).

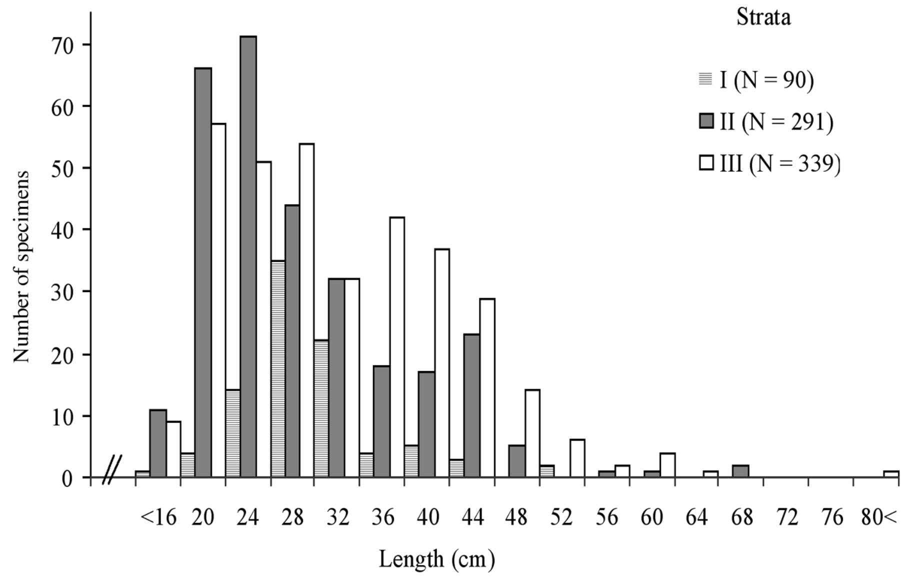

Figure 4. - Length distribution of *C. gariepinus* samples in the three strata of the River Asi (see Fig. 1).

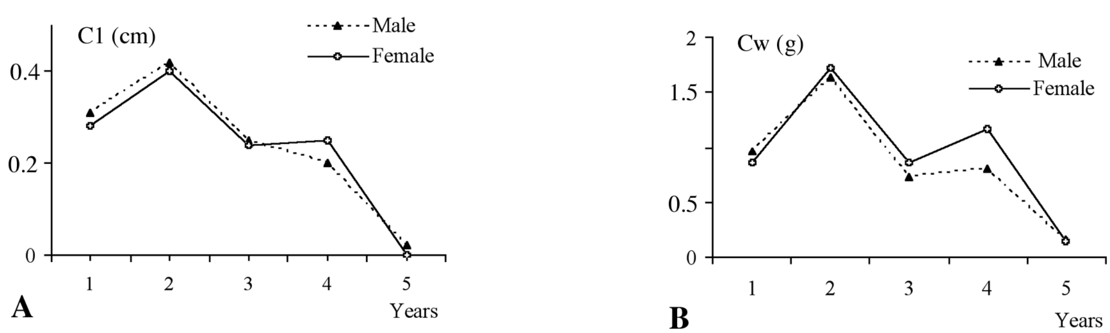

Figure 5. - Relative increments in **A**: length (Cl in cm) and **B**: weight (Cw in g) of *C. gariepinus* in the River Asi.

Bruton and Allanson (1980) stated that the asymptotic lengths were respectively 76.0 and 67.4 cm TL for male and female *C. gariepinus* at Lake Sibaya. Clay and Clay (1981) found a linear correlation between total length and ages of *C. lazera* that is a junior synonym of *C. gariepinus*, according to Von Bertalanffy growth model and pointed out the value of asymptotic length as 338.38 cm in a shallow river in Israel. The annual length increments of catfish in the River Asi initially increased from age 1 to 2, then decreased at age 3. Zivkov *et al*. (1999) stated that the estimated parameters from the Von Bertalanffy equation L_∞ and k are sensitive to the age structure of the sample. The number of samples at age 4 was very low in the River Asi. Consequently, the growth curve of the Asi population did not fit the Von Bertalanffy growth model.

In commercial aspects, sex may be important in the cultivation of fish. Gaigher (1977), in the Hardap Dam related with the River Orange, Southwest Africa, maintains that *C. gariepinus* differs from most South African silurids, and cyprinids where the females normally grow faster and have a larger average size than males. It is likely that, in Transvaal, South Africa, in Lake Liambezi, South West Africa, in the River Shire, in Lake Sibaya, in the P.K. le Roux Dam, the females grew more slowly after their third year, and the majority of large specimens were males (Van der Waal and Schoonbee, 1975; Van der Waal, 1976; Willoughby and Tweddle, 1978; Bruton and Allanson, 1980; Quick and Bruton, 1984). In the River Asi, however there was no significant difference between males and females according to student t test, observed annually and relative length increments were higher in males than in females for the age groups properly sampled. The number

Table III. - Weight at age and absolute increments in weight of the different age groups of *C. gariepinus* from the River Asi. N: Number of individuals; SE: Standard Error; p: Significance level.

Sex	Age	N	Mean (g) ± SE	Min - Max	Absolute increments $W_i - W_{i-1}$	Difference between ♀ and ♂
♀ + ♂	0	169	53.84 ± 2.25	14.8 - 169.5		
♀	0	68	56.09 ± 3.47	17.1 - 169.5		
♂	0	101	52.37 ± 2.96	14.8 - 165.2		p > 0.05
♀ + ♂	1	271	103.40 ± 2.61	36.6 - 429.4	49.56	
♀	1	132	104.16 ± 4.07	45.0 - 429.4	48.07	
♂	1	139	102.68 ± 3.33	36.6 - 231.3	50.31	p > 0.05
♀ + ♂	2	195	281.44 ± 7.91	85.4 - 937.5	178.05	
♀	2	105	283.57 ± 9.27	109.8 - 497.2	179.41	
♂	2	88	269.87 ± 11.23	85.4 - 594.3	167.19	p > 0.05
♀ + ♂	3	62	504.10 ± 18.86	321.9 - 1131.2	222.65	
♀	3	36	529.08 ± 29.41	321.9 - 1131.2	245.51	
♂	3	25	464.89 ± 17.65	325.3 - 649.4	195.02	p > 0.05
♀ + ♂	4	18	940.26 ± 90.55	565.8 - 2143	436.16	
♀	4	6	1146.85 ± 227.94	613.9 - 2143	617.77	
♂	4	12	836.97 ± 65.36	565.8 - 1226	372.08	p > 0.05
♀ + ♂	5	4	1234.43 ± 359.86	363.5 - 2003.2	294.17	
♀	5	3	1322.57 ± 493.97	363.5 - 2003.2	175.72	
♂	5	1	970.00		133.03	

Table IV. - The condition factors of the different age groups of *C. gariepinus* samples from the River Asi. SE: Standard Error; p: Significance level.

Sex	Age	N	Mean ± SE	Min - Max	Difference between		
					♀ - ♂	♀ - ♀	♂ - ♂
♀ + ♂	0	169	0.78 ± 0.12	0.48 - 1.18	0.96		
♀	0	68	0.80 ± 0.14	0.48 - 1.08	(p > 0.05)		
♂	0	101	0.78 ± 0.12	0.53 - 1.18			
♀ + ♂	1	271	0.71 ± 0.13	0.31 - 1.11	0.05		
♀	1	132	0.73 ± 0.12	0.31 - 0.94	(p > 0.05)	2.95	
♂	1	139	0.74 ± 0.13	0.34 - 1.11		(p < 0.05)	1.70
♀ + ♂	2	195	0.67 ± 0.08	0.36 - 0.93	5.07		(p > 0.05)
♀	2	105	0.70 ± 0.08	0.36 - 0.88	(p < 0.05)	2.84	
♂	2	88	0.64 ± 0.09	0.48 - 0.93		(p < 0.05)	6.08
♀ + ♂	3	62	0.65 ± 0.09	0.48 - 0.86	3.95		(p < 0.05)
♀	3	36	0.69 ± 0.09	0.52 - 0.86	(p < 0.05)	0.63	
♂	3	25	0.59 ± 0.07	0.48 - 0.77		(p > 0.05)	1.92
♀ + ♂	4	18	0.65 ± 0.10	0.51 - 0.81	9.00		(p < 0.05)
♀	4	6	0.75 ± 0.05	0.68 - 0.81	(p < 0.05)	1.04	
♂	4	12	0.60 ± 0.08	0.51 - 0.77		(p > 0.05)	0.10
♀ + ♂	5	4	0.78 ± 0.05	0.71 - 0.84			(p > 0.05)
♀	5	3	0.78 ± 0.06	0.71 - 0.84			
♂	5	1	0.77				

of specimens at age 4 is too small to compare both sexes reliably (n = 6) (Tab. II).

De Kimpe and Micha (1974) stated that *C. gariepinus* females grow less than males and the mean weight of females and males were 292 g and 427 g respectively in aquaculture conditions. El Bolock (1972) indicated that the weight of two-year old males and females were 207 g and 188 g respectively in semi-natural *C. gariepinus* population in the Egypt. In the River Asi, there was no significant difference but males younger than two grew faster in weight than females. The reason of weight increments after the age of two when they reach sexual maturity, females grew faster

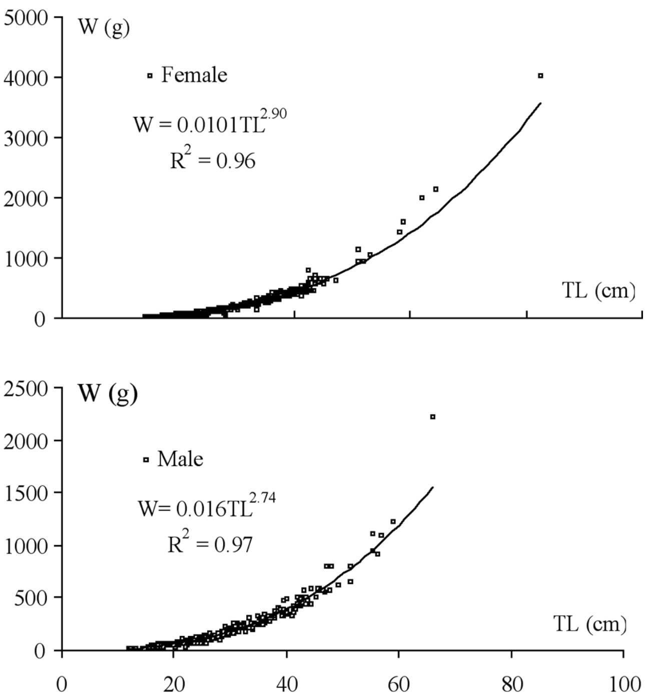

Figure 6. - Length - weight relationships of *C. gariepinus* from the River Asi.

than males in weight is gonadal development.

There are many studies of the growth of *C. gariepinus* in South Africa, Namibia, Zimbabwe, and Malawi. The growth rate varies considerably between populations. Van der Waal (1976), in Liambezi Lake, Southwest Africa and Willoughby and Tweddle (1978) in the River Shire, Malawi, stated that the growth of *C. gariepinus* slows down after age 3. Bruton and Allanson (1980) stated that the annual length increments decreased after the first year in Lake Sibaya. In the River Asi, annual length increments in both sexes were the highest in the second year and decreased afterwards (Fig. 5). In the same way, the condition factor supports the growth pattern of *C. gariepinus* in the River Asi. Yalçin *et al.* (2001a) stated that catfish in the River Asi become mature by the end of the second year. Therefore the condition was determined to be higher in females than in males at the age of 2 and older fish. In any case, Bruton (1979) used the adult males, when calculating the condition considering that length-weight relationship was less affected by ovary, which contained about 12% of total mass in Lake Sibaya. The higher growth increments until age two may also result from feeding. The feeding ratio is the highest at the second year individuals in the River Asi (Yalçin *et al.*, 2001b). Hence, we suggest that regulations should ban catch of fish shorter than 35 cm and/or lighter than 300 g.

Absolute annual length increment in subsequent years within catfish populations was found to vary widely. As shown in table V, the catfish population in the River Asi generally has less length cost than those elsewhere. Furthermore, comparing the length-weight relationship of different *C. gariepinus* populations suggests that the River Asi population was in worse condition than that in other populations (Tab. VI). This poor condition may be explained by low water level, which favours excessive fishing and reduces food availability especially for the larger individuals. As a result of the high consumption of water for irrigation in Syria and Turkey during the arid summer month, the water level decreases to 0-10 cm, rarely 50 cm, in the summer days in the River Asi. This reduced water level worsens the effect of pollution derived from fields by insecticides from villages, towns, and cities by waste disposal.

REFERENCES

ANONYMOUS, 1982. - Yurt Ansiklopedisi, Türkiye Il Il Dunu

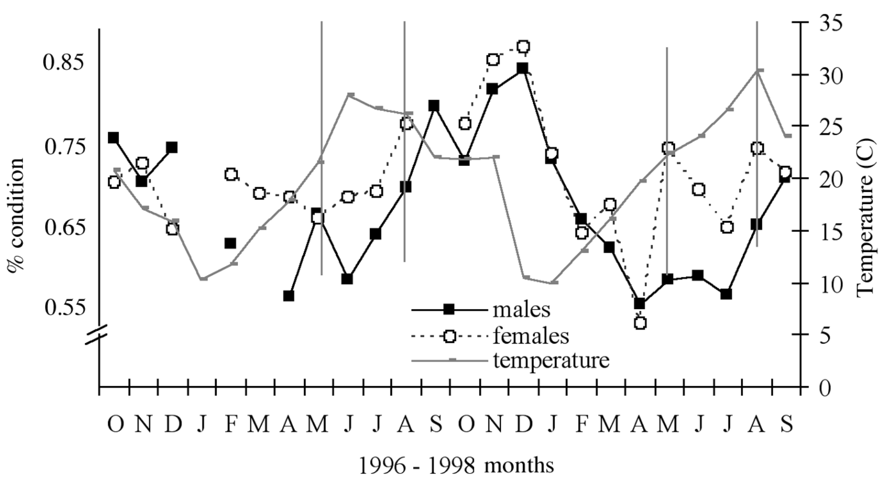

Figure 7. - Monthly fluctuation in the condition factor of *C. gariepinus* from the River Asi. Breeding seasons in the River Asi are indicated by vertical lines (according to Yalçin *et al.*, 2001a).

Table V. - Average absolute annual length increments (L_n in cm) in the first years (n) of life of some *C. gariepinus* populations.

Sex	$L_n = n\ \overline{i_{1-n}}$	(Years) n	Habitat	References
Male	52.23	6	Asi River, Turkey	This study
Female	52.94	6		
Male	100.50	8	Elands and Olifants Rivers,	Van der Wall and Schoonbee (1975)
Female	72.80	6	Transvaal	
Male	72.60	8	Sibaya River, South Africa	Bruton and Allanson (1980)
Female	64.80	7		
Male	96.40	8	P.K. Le Roux Dam, South Africa	Quick and Bruton (1984)
Female	89.70	8		
Male	90.20	8	Incomati River	Potgieter (1974)
Female	84.40	6		
Male	91.00	6	Lake Liambezi, South West Africa	Van der Waal (1976)
Female	87.30	6		
Male	72.00	4	Lake McII waine, Zimbabwe,	Munro (1965)
Female	58.00	4	Rhodesia	
Both	79.90	6	Orange River, South Africa	Mabitsela (1981)
Both	85.50	8	Piet Gouws Dam, Lebowa	
Both	89.50	8	Liepelane Dam, Lebowa	
Both	92.00	8	Krokodilheuvel Dam, Lebowa	
Both	80.00	7	Coetzees Draai Dam, Lebowa	

Table VI. - Length (TL in cm, except when mentioned in brackets) - weight (W in g) relationships of *C. gariepinus* from different populations.

Habitat	Length-weight relationship	References
River Elands, Transvaal, South Africa.	$W = 0.007\ TL^{2.99}$ (male)	Van der Waal (1972)
Hardap Dam,South West Africa	$W = 0.000004\ TL^{3.07}$ (TL in mm)	Gaigher (1977)
Shire Valley, Malawi	Log W = 3.136 Log TL - 2.3396	Willoughby and Tweddle (1978)
Hendrik Verwoerd Dam	$W = 0.0028\ TL^{3.26}$	Hamman (1981)
Lake McIlwaine, Rhodesia, Southern Africa	$W = 0.000002834\ TL^{3.18}$ (100 - 340 mm fish) (TL in mm)	Clay (1979)
Lake Sibaya, South Africa	$W = 0.00004\ TL^{2.70}$ (male) $W = 0.00004\ TL^{2.71}$ (female) (TL in mm)	Bruton and Allanson (1980)
P.K. le Roux Dam, South Africa	$W = 0.0000016\ TL^{3.23}$ (TL in mm)	Quick and Bruton (1984)
Asi River, Turkey	$W = 0.016\ TL^{2.74}$ (male) $W = 0.010\ TL^{2.90}$ (female) $W = 0.0127\ TL^{2.82}$ (both)	This study

Bugunu Yarini Cilt 5, S: 3370-3378.

BRUTON M.N., 1979. - The food and feeding behaviour of *Clarias gariepinus* (Pisces: Clariidae) in Lake Sibaya, South Africa, with emphasis on its role as a predator of Cichlids. *Trans. Zool. Soc. Lond.*, 35: 47-114.

BRUTON M.N. & B.R. ALLANSON, 1980. - Growth of *Clarias gariepinus* in lake Sibaya, South Africa. *S. Afr. J. Zool.*, 15(1): 7-15.

CHUGUNOVA N.I., 1963. - Age and Growth Studies in Fish. Translation from Russian, Israel Program for Scientific Translations. 130 p. Jerusalem.

CLAY D., 1979. - Population biology, growth and feeding of African catfish (*Clarias gariepinus*) with special reference to juveniles and their importance in fishculture. *Arch. Hydrobiol.*, 87(4): 453-482.

CLAY D. & H. CLAY, 1981. - Back calculated age and growth of the catfish, *Clarias lazera*, in Israel. *Isr. J. Zool.*, 30: 16-21.

CLAY D., 1982. - A comparison of different methods of age determination in the sharptooth catfish *Clarias gariepinus*. *J. Limnol. Soc. Sth. Afr.*, 8: 61-70.

DE KIMPE P. & J.C. MICHA, 1974. - First guidelines for the culture of *Clarias lazera* in central Africa. *Aquaculture,* 4: 227-248.

ERENÇIN Z., BARAN I. & H. ERGÜVEN, 1972. - Gelin Baligi *Claria lazera* (Cuv. & Val. 1840). *Türk Vet. Hek. Derg.*, 42: 3-4.

ERGÜVEN H., 1978. - Breeding and cultivation of *Clarias orontis* Günther 1856 (Karabalik or Gelin Baligi), in the condition at fish culture station of A.U. Vet. Fak. Eski§ehir Çifteler Sakaryabasi, Doçentlik Tezi. Istanbul Univ., Istanbul.

EL BOLOCK A.R., 1972. - The use of vertebrae for determining age and growth of the Nile catfish (*Clarias lazera* (Cuv. & Val.) in the A.R.E. *Bull. Inst. Oceanogr. Fish., Cairo*, 2: 53-82.

GAIGHER I.G., 1977. - Reproduction in the catfish (*Clarias gariepinus*) in the Hardap dam, South West Africa. *Madoqua,* 10: 55-59.

HAMMAN K.C.D., 1981. - Aspekte van die visbevolkingsdinamika van die Hendrik Verwoerddam met verwysing na die ontwikkeling van 'n vissery bestuursplan. Ph.D. Thesis. Rand Afrikaans Univ., Johannesburg.

HENKEN A.M., BOON J.B., CATTEL B.C. & H.W.J. LOBEE, 1987. - Differences in growth rate and feed utilization between male and female African catfish, *Clarias gariepinus* (Burchell, 1822). *Aquaculture*, 63: 221-232.

LAGLER K.F., 1966. - Freshwater Fishery Biology. 421 p. Dubuque, Iowa: W.H.C. Brown Company Publishers**.**

MABITSELA C.K., 1981. - An ecological invstigation of the economically viable fish species in certain dams in Lebowa, South Africa. M.Sc. Thesis. Univ. of the North, Lebowa.

MUNRO J.L., 1965. - Feeding relationships and production of fish in a southern Rhodesian lake. Ph.D. Theris. Univ. of London, U.K.

NAWAR G., 1954. - On the anatomy of *Clarias lazera* 1. Osteology. *J. Morph., Khartoum*, 94: 551-586.

PIVNICKA K., 1974. - Age and growth studies 34. The Zambezi barbel *Clarias gariepinus* (Burchell, 1822). *In:* Lake Kariba: a Man-Made tropical Ecosystem in central Africa, (Balon E.K. and A.G. Coche, eds), 24: 318-325. *Monogr. Biol*. The Hague: W. Junk.

POTGIETER F.J., 1974. - 'N Ekologiese studie van de rooibors kurper *Tilapia melanopleura* Dumeril (1859) (Pisces: Cichlidae) in Transvaal met verwysing na geassossieerde varswatervissorrte. M.Sc. Thesis. Rand Afrikaans Univ., Johannesburg.

QUICK A.J.R. & M.N. BRUTON, 1984. - Age and growth of *Clarias gariepinus* (Pisces: Clariidae) in the P.K. Le Roux Dam, South Africa. *S. Afr. J. Zool*., 19(1): 37-45.

RICKER W.E., 1975. - Computation and interpretation of biological statistics of fish populations. *Bull. Fish. Res. Board Can*., 191: 1-382.

TASDEMIR M., 1998. - An investigation on some physical, chemical and biological parameters of orontes river (Antakya). M.Sc. Thesis. Çukurova Univ., Adana.

TEKELIOGLU N., 1980. - A study on body characteristics and fecundity of african catfish (*Clarias lazera* C. & V., 1840) under natural conditions in freshwaters of Çukurova region and the possibilities rearing at Çukurova University, Agriculture Faculty. Ph.D. Thesis. Çukurova Univ., Adana.

TESCH F.W., 1968. - Age and growth *In:* Methods for Assessment of Fishes Production in Freshwater. (Ricker W.E., ed.), pp. 93-123. IBP Handbook, No.3, Black Well Sci. Pub.

TEUGELS G.G., 1986. - A systematic revision of the African species of the genus *Clarias* (Pisces; Clariidae). *Ann. Sci. Zool. Mus. R. Afr. Centr.,* 247: 15-48.

VAN DER WAAL B.C.W., 1972. - 'N Ondersoek na aspekte van die ekologie, teelt, en produksie van *Clarias gariepinus* (Burchell, 1822). M.Sc. Thesis. Rand Afrikaans Univ., Johannesburg.

VAN DER WAAL B.C.W. & H.J. SCHOONBEE, 1975. - Age and growth studies of *Clarias gariepinus* (Burchell) (Clariidae) in the Transvaal South Africa. *J. Fish Biol*., 7: 227-234.

VAN DER WAAL B.C.W., 1976. - 'N Visekologiese stdie van die Liambezimeer in die oos-Caprivi, met verwysing na visontginning deur die Bantoebevolking, Ph.D. Thesis. Rand Africaans Univ., Johannesburg.

VON BERTALANFFY L., 1957. - Quantitative Laws in Metabolism and Growth. *Q. Rev. Biol*., 32: 217-231.

WILLOUGHBY N.G. & D. TWEDDLE, 1978. - The ecology of the catfish *Clarias gariepinus* and *Clarias ngamensis* in the Shire Valley, Malawi. *J. Zool. (Lond.),* 186: 507-534.

WOOTTON R.J., 1992. - Ecology of Teleost Fishes. 404 p. London: Chapman & Hall.

YALÇIN Ş., SOLAK K. & I. AKYURT, 2001a. - Certain reproduction characteristics of catfish (*Clarias gariepinus* Burchell, 1822) living in the river Asi, Turkey. *Turk J. Zool*., 25: 453-460.

YALÇIN Ş., AKYURT I. & K. SOLAK, 2001b. - Stomach contents of catfish (*Clarias gariepinus* Burchell, 1822) in the river Asi (Turkey). *Turk J. Zool*., 25: 461-468.

ZIVKOV M.T., TRICHKOVA T.A. & G.N. RAIKOVA-PETROVA, 1999. - Biological reasons for the unsuitability of growth parameters and indices for comparing fish growth. *Environ. Biol. Fish*., 54: 67-76.

Reçu le 27 avril 2001.
Accepté pour publication le 25 mars 2002.