Turk J Zool
25 (2001) 453-460

Certain Reproductive Characteristics of the Catfish (*Clarias gariepinus* Burchell, 1822) Living in the River Asi, Turkey

Şükran YALÇIN
Mustafa Kemal University, Science - Literature Faculty, Biology Department, Antakya, Hatay - TURKEY
Kemal SOLAK
Gazi University, Gazi Education Faculty, Biology Department, Teknikokullar, Ankara - TURKEY
İhsan AKYURT
Mustafa Kemal University, Fisheries Faculty, İskenderun, Hatay - TURKEY

Received: 10.08.2000

Abstract: A total of 523 *C. gariepinus* caught in the River Asi were surveyed from October, 1996 to September, 1998 to find out the age distribution throughout the population that varied between 0+ and 5 years of age, with the one year age group observed to be dominant in number. Findings also showed that both sexes started to reach maturity at the age of 1, and all the fishes examined had become mature by the end of the second year. The average diameter of ripened eggs was 1.41 – 1.66 mm. They spawned in a period from May to August when the water temperature ranged between 21°C and 30°C. The fecundity observed was related more linearly than exponentially to fish weight, and was formulated by the equation: F = 84.391 W – 31454. Fecundity varied from 4,483 to 336,157 eggs per female.

Key Words: *Clarias gariepinus*, reproduction, the River Asi, fecundity, spawning period, maturity

Asi Nehri'nde Yaşayan Karabalık (*Clarias gariepinus* Burchell, 1822)'ın Bazı Üreme Özellikleri

Özet: Ekim 1996 –Eylül 1998 tarihleri arasında Asi Nehri'nden yakalanan toplam 523 *C. gariepinus* incelenmiştir. Populasyonun yaş dağılımı 0+ ile 5 yaşları arasında değişmekte olup, 1 yaşındaki bireylerin dominant olduğu belirlenmiştir. Dişi ve erkeklerin 1 yaşında eşeysel olgunluğa erişmeye başladıkları, 2 yaşında tüm populasyonun olgunlaştığı saptanmıştır. Olgunluğa erişmiş yumurtaların ortalama çapı 1.41 – 1.66 olarak belirlenmiştir. Üreme mevsiminin su sıcaklığının 21 °C – 30 °C olduğu Mayıs - Ağustos ayları arasında gerçekleştiği belirlenmiştir. Balık ağırlığı ile yumurta verimi arasında, üssel ilişkiye göre doğrusal ilişki daha anlamlı bulunmuş ve F = 84.391W – 3145.4 olarak formule edilmiştir. Yumurta verimi 4483 - 336157 yumurta/dişi olarak hesaplanmıştır.

Anahtar Sözcükler: *Clarias gariepinus*, Asi Nehri, yumurta verimi, eşeysel olgunluk, üreme dönemi

Introduction

Clarias gariepinus (Burchell 1822), which has a wide distribution from the South and Central Africa to the Middle East and Turkey, is commercially important in the south of Turkey, especially in Hatay province. It is seldom consumed by local people but sold to Eastern Anatolia (Turkey) and Syria. Information on the reproduction of *C. gariepinus* has been given by several researchers in Africa (1-11), however, little information on this species in Turkey has been made available so far (12). The ecological perspective of freshwater in Africa is extremely different from that in Turkey. The aim of this study is to contribute information on the first spawning, age and length, reproduction period, and fecundity, as well as to determine correlation fecundity with total length, total weight, age and gonad weight of catfish in the River Asi. Thus, the studies about the culturing of this species and applications in commercial fields could be initiated from this study in Turkey.

Materials and Methods

A total of 523 specimens, including 297 females and 226 males, were collected with nets (38x38mm - 54x54mm) from 14 locations throughout the River Asi (only in Turkey) between October 1996 and September

1998 periodically (Figure 1). After being caught, the fish specimens were brought to the laboratory where the total lengths and weights were measured to the nearest 1.0 mm and 0.1 g respectively. The age of samples was recorded using their sixth and seventh vertebra (13). The sex was determined by examining the gonads with the naked eye in large specimens and by using a stereo microscope for smaller ones.

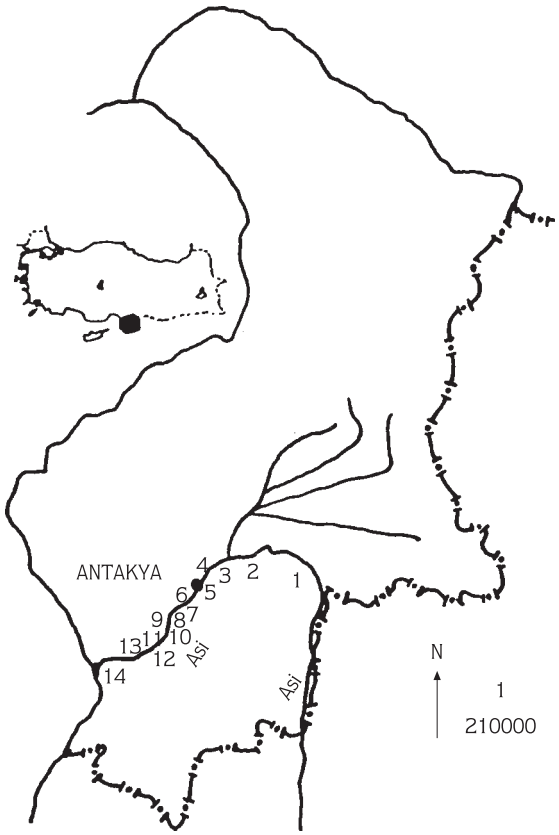

Figure 1. Themap of research area (1. Demirköprü, 2. Üzümdalı, 3. Güzelburç, 4. Narlıca, 5. Antakya centre, 6. Antakya, 7. Turunçlu, 8. Subaşı, 9. Şıhhasan, 10. Meydancık, 11. Tavlaköyü, 12. Aşağıdöver, 13. Sinanlı, 14. Samandağ)

The gonads were removed, dried and weighed, and the sexual cycle of females was divided into six stages (7). The monthly gonadosomatic indices (GSI) were calculated using the formula:

$$\%GSI = \frac{\text{Gonad weight (g)}}{\text{Body weight (g)}} \times 100$$

Sexual maturity was determined by observation of the stages of the maturation of the gonads according to Clay (1979) (7). The egg size was measured to 0.1 mm using a micrometer eyepiece. Fecundity (F) was calculated by gravimetric methods (14). The relationships between Fecundity, Total Length (TL), Body Weight (W), Gonad Weight (GW) and Age (t) were calculated by exponential and linear regression.

Results

The distribution of the samples in the population varied between 0+ and 5 years of age, with the 1-year age group being dominant in the population. The number of males exceeded that of females, except in the 2 and 3 years of age groups (Table 1).

Table 1. Number of specimens of each sex of species caught at each age, to indicate the sex ratios.

Ages	Male	Female	Intersex	Ratio (Male/Female)
0+	101	68	-	1.49
1	139	132	-	1.05
2	88	105	2	0.83
3	25	36	1	0.69
4	12	6	-	2.00
5	1	3	-	0.33
Total	366	350	3	1.05

Maturation stages

The stages of 134 females were:

Stage 1: *Immature*, ovary was thin ribbon-like structure, creamy white and translucent. GSI: 0.3 – 1.7, ova diameter: 0.2>

Stage 2: *Not Ripe*, ovary was small sac-like, red and smooth. GSI: 1.65– 7.55,

Ova diameter: 0.2 – 0.8 mm

Stage 3. *Almost Ripe*, The ovary had some large ova visible, becoming fuller with much thinner mesentery walls. It was reddish-brown GSI: 2.33 – 20.68; ova diameter: 0.7 – 1.32 mm

Stage 4. *Ripe*, the ovary membrane was very thin, and red - mat green, eggs are visible with the naked eye, and no ova were released when the abdomen was squeezed. The blood vessels in the wall were very prominent. GSI: 2.74 – 24.31; ova diameter: 1 – 1.54 mm

Stage 5. *Running Ripe*, the ova were at their largest and the abdominal cavity was filled with ovary.

Membrane of the ova was thin, green and transparent. The eggs could be released by stripping or rough handling. GSI: 12.25 – 35.95; ova diameter: 1.41 – 1.66 mm

Stage 6. *Spent*, the ova were observed to vary in colour, such as black, mat green, transparent green and red. Also determined was a variation in ova size. A few large ova were found. GSI: 1.37 – 13.83; ova diameter: 1.07 –1.54 mm

The percentage of fish caught in each month over the six maturation stages is shown in Figure 2. From May to August, the ovaries of the majority of fish were at the ripe stage. The period between November to April was a sexual resting time for the catfish in the River Asi. Most of the ovaries in this period were at stage 1 and stage 2 (not ripe).

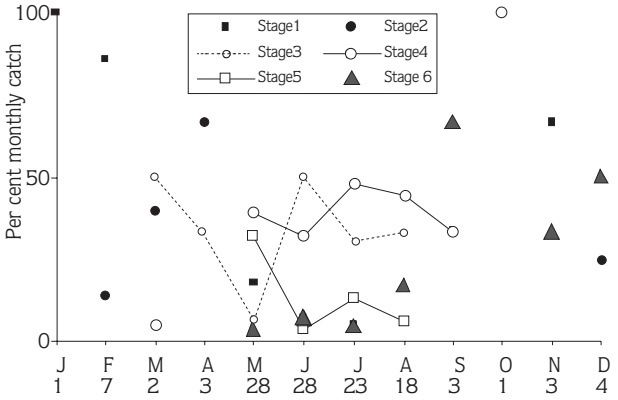

Figure 2. The percentage of fish caught in each month for six maturation stages: The numbers below the letters of the months are the numbers of annual catches in each month.

Age and Length at First Spawning

The age of specimens was determined and summarised in Table 2. In the River Asi, the smallest mature female and male were a year old. The average size and weight of females and males at first maturity for 507 *C. gariepinus* caught in summer in both 1997 and 1998 were 25.05 cm TL, 108.7 g and 24.7 cm TL and 113.2g respectively. The smallest mature female and male were 23.3 and 24.7 cm TL respectively.

Gonadal Development and Spawning Period

The monthly variation of the gonadosomatic index (GSI) is presented in Figure 3. The GSI values of both sexes were at their highest in June and July of the first year, and in May, June and July during the second year of this study. As seen in Figure 3, a parallel change took place in the ranges of temperature and GSI. In the River Asi, water temperatures normally ranged between 21 and 30°C during the period May to August. Spawning always took place at temperatures above 22°C.

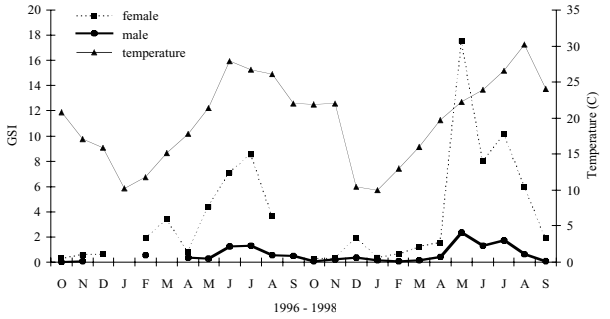

Figure 3. Monthly changes in the temperature of the water in the River Asi and GSI of males and females

Fecundity

Fecundity is defined here as the number of ripened eggs in the ovary just before spawning. The fecundity of 40 ripe female *C. gariepinus* from the River Asi in the size range 23.3-82.6 cm TL was determined. The length frequency of ripe female *C. gariepinus* is plotted in Figure 4. A modal size female produced about 35,853 eggs.

Table 2. Maturity of *C. gariepinus* population according to ages and mean total length and weight at each ages (standard deviation was plotted in the bracket)

	Ages	0+	1	2	3	4	5
	Immature	43	108	14	-	-	-
Female	Mature	-	4	82	34	5	3
N = 293	Mean TL (cm)		25.05 (± 0.85)	34.64 (± 0.39)	42.09 (± 0.65)	53.66 (±3.69)	52.6 (±7.8)
	Mean W (g)		108.7 (± 6.67)	299.9 (±10.01)	530.6 (±31.07)	1216.7 (±65.8)	1322.5 (±493.4)
	Immature	36	83	25	-	-	-
Male	Mature	-	1	34	23	12	0
N = 214	Mean TL (cm)		24.7	36.57 (±0.74)	42.78 (±0.61)	51.54 (±1.4)	
	W (g)		113.2	331.2 (±19.43)	461.03 (±19.0)	836.9 (±65.28)	

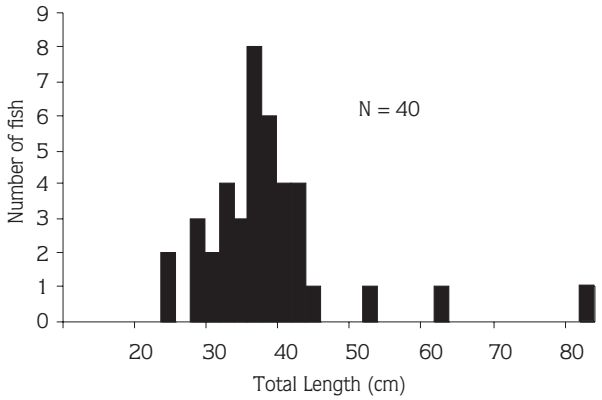

Figure 4. Numbers of females caught at the mature stage

The fecundity of the catfish ensured a rather tenuous relationship with the total length of the fish (Figure 5). The power curve $y = ax^b$ failed to give a sensible relationship at first; however, when fitted to the data, a linear curve F = 50.52 TL – 152,945 (n = 40, $r^2 = 0.78$) provided a much higher coefficient which helped establish the relationship.

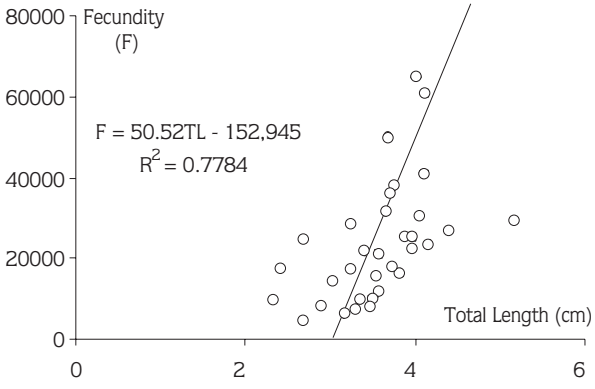

Figure 5. Relationship between fecundity and total length.

As seen Figures 6, 7, and 8, the fecundity of *C. gariepinus* in the River Asi was related more linearly than exponentially to fish weight, gonad weight, and age. According to these linear expressions, a 40 cm TL female produces about 49,000 eggs, while a 37.46 cm female, the middle length of the spawning population, about 36,310 eggs, and the largest female produced about 316,891 eggs, which was larger than the projected value from the above linear equation. Similarly, the smallest female (90.4g) produced about 4,483 eggs; where as the largest female (4020.6g) produced about 336,157 eggs.

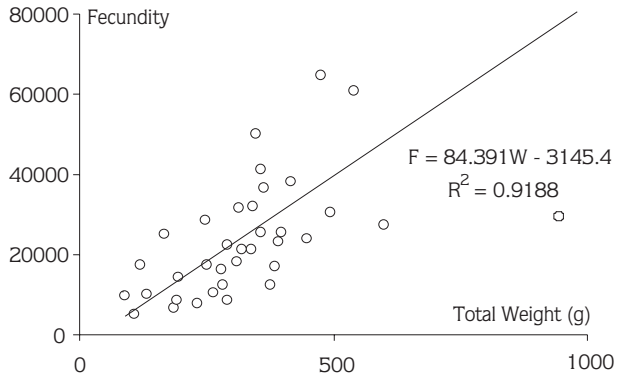

Figure 6. Relationship between fecundity and total weight.

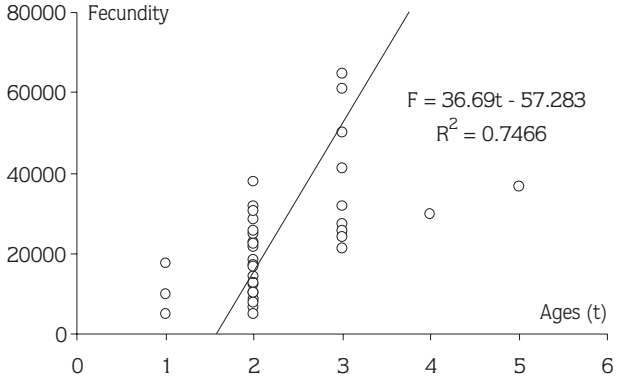

Figure 7. Relationship between fecundity and age

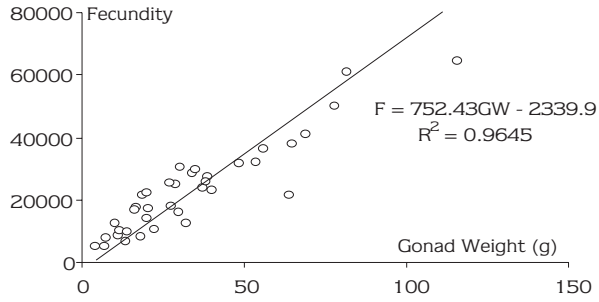

Figure 8. Relationship between fecundity and gonad weight

Egg Size Distribution

Monthly variations of the egg diameters of 112 female *C. gariepinus* are given in Figure 9. It was observed that egg diameters showed an increase after March versus a decrease after August. These findings were parallel to the fluctuation of GSI values throughout the years.

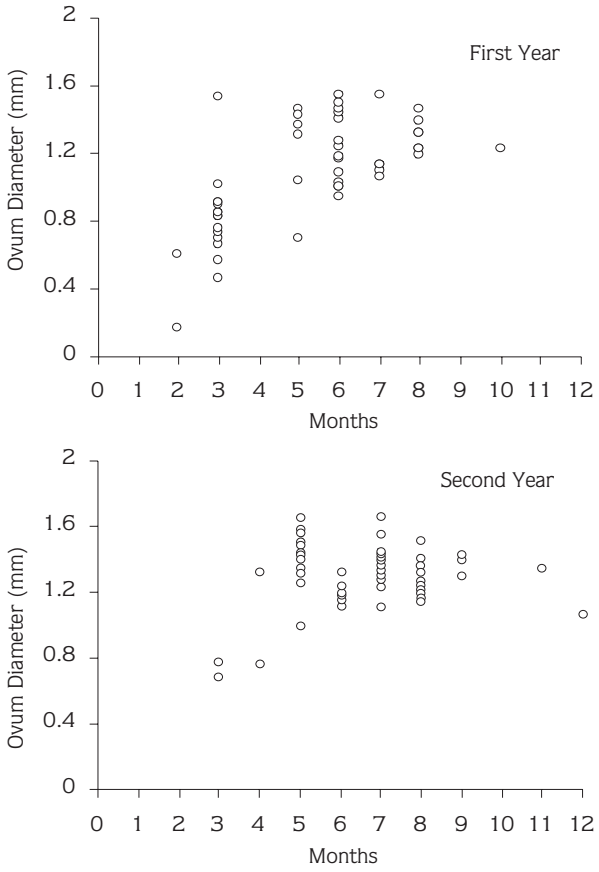

Figure 9. Monthly variation of ovum diameter of catfish

Discussion and Conclusion

The anatomy of the *C. gariepinus* ovary was identical to previous studies (7, 8, 15). The overall sex ratios in each of five age groups are given Table 1. However, *C. gariepinus* was dioecious and the sex could be determined externally on most fish exceeding 18 cm in length, and internally in specimens exceeding 12 cm, and three intersex specimens were caught at 2 and 3 years of age. These specimens had ripe ova in the testis sacs. They might be abnormal individuals. Willoughby and Tweddle (1978) stated that in the Shire Valley, Malawi, males were caught in greater numbers than females (6). In the River Asi, the ratio of males to females was not different from their previous findings.

Clay (1979), in Lakes Kariba and Kyle, Central Africa, noted the relatively short time that *C. gariepinus* was sexually mature and ready to spawn during each cycle, and also the rapidity of sexual development (7). Similarly, in the River Asi, the population passed from stage 2 to stage 3 in a very short time, for example, from April to May, and the ovaries were active during the summer period. There were no fish caught in stage 1 from June to November or in stage 2 from May to December (Figure 2). It can be said that the catfish in stage 3 a wait suitable conditions for spawning, and that when they find the suitable conditions, in summer, they reach the spawning stage in a short time. A combination of physical, chemical and biological factors, such as changes in water level, chemistry, pH, temperature, clarity and flow velocity, flooding of marginal plants, associated chemical changes, and access to suitable spawning sites, is responsible for triggering the spawning of catfish. (8).

In the River Asi, male and female *C. gariepinus* individuals started to reach first maturity in the first year of age (247 - 233 mm), and they had all become mature in the second year (366 – 346 mm). The sizes of first maturity in several *Clarias* populations (Table 3) show remarkable variation. Maturity sizes range from 250 mm in McIlwaine, Rhodesia to 750 mm in Hardap dams in various *C. gariepinus* populations. *C. lazera* in Lake Rudolph in North Africa also reached maturity at the relatively large size of 500-650 mm TL. Increases in the growth rate of the fish slowed down in the age of maturity, and this was the effect of an environmental change on the age (and size) at maturity (16). Yet, it was observed that the growth rate of the Asi population was not much higher than other populations. (17). Wootton (1992) stated that the fish reach sexual maturity at an unusually small size in stunted populations (16). Some factors, such as pollution, uncontrolled hunting and other physical and chemical factors, may stunt the *C. gariepinus* population in the River Asi.

The monthly variations of water temperatures and GSI values used to determine the spawning period are plotted in Figure 3, which shows that the spawning period began in May and ended in August. Previous studies in African lakes show that the spawning season of *C. gariepinus* changes at various locations (Table 4). *Clarias* populations living in the south and north of Africa generally spawn during summer time. For example, Clay 1979 indicated that a peak of ripeness occurred during the period between November to December and February to March in Lakes Kariba and Kyle, while the sexual resting occurred in these time intervals in the River Asi (7). In the same way, Bruton (1979) stated that spawning always took place during the period from

Table 3. Median size at first maturity for different *Clarias* populations in Africa (7, 8) (**C. gariepinus* was sinonimyzed with *C. lazera* and *C. mossambicus* by Teugels 1982 (19))

Species	TL (mm)		Habitat	References
	♂♂	♀♀		
C. gariepinus	450	390	McIlwaine,Rhodesia	(20)
C. gariepinus	430	380	Mazoe Dam, Rhodesia	(21)
C. gariepinus	380	380	Rhodesia, S. Africa	(22)
C. gariepinus	400	380	Oliphants River, R.S.A.	(23)
C. gariepinus	430 - 450	450 - 480	Vaal River	(2)
C. gariepinus	350 - 400	350 - 400	Elands River, Transvaal	(24)
*C .lazera**	-	250 SL	Lake Volta	(25)
C. lazera	-	271	Ubangi River, N. Africa	(3)
C. gariepinus	530	440	Lake Kariba, Rhodesia	(26)
C. lazera	7 – 10 month	7 – 10 month	Bangui, Central Africa Rep. (fish ponds)	(27)
C. lazera	8 month	8 month	Bouake, Ivory Coast (fish ponds)	(28)
C. lazera	650 - 700	650 - 700	Lake Rudolph, N. Africa	(29)
C. gariepinus	260	260	Lower Shire River	(30)
C. lazera	320	320	(Review paper)	(4)
C. gariepinus	650 - 750	650 – 750	Hardap Dam, South West Africa	(5)
C. gariepinus	350	350	Lake Sibaya	(8)
C. gariepinus	250	280	McIlwaine Rhodesia	(7)
C. gariepinus	247(1.age)	233(1.age)	Asi River,Turkey	This Paper
	366(2.age)	346 (2.age)		

Table 4. Spawning seasons of different Clarias populations (8)

Species	Spawning season	Place	References
Southern Populations			
C. gariepinus	November to February	Rhodesia	(22), (31)
C. gariepinus	October to February (rarely May)	Transvaal	(32)
C. gariepinus	November to March	Hardap dam, South West Africa	(5)
C. gariepinus	September to March	Malawi: Lower Shire River	(30)
C. gariepinus	November to February (rarely September to April)	Lake Sibaya	(8)
Northern Populations			
C. lazera	*July to September*	Nile River	(33), (34)
C. lazera	June to October	Lake Chad	(35)
C. lazera	March to September	Egypt	(36)
C. lazera	July to September	Ubangui R., West Africa	(27)
C. lazera	July to October	Central & West Africa	(4)
C. mossambicus	April, December	Lake Victoria	(37)
C.lazera	April to June	Naaman River, Israel	(7)
C. gariepinus	May to August	Asi River, Turkey	This paper

September to March in Lake Sibaya, when water temperatures ranged between 21 and 30°C (8). Similarly, in the River Asi, breeding season for *C. gariepinus* population was in the period from May to August when temperatures ranged between 21 and 30°C. Consequently, spawning season was highly dependent on temperature.

The fecundity of the population may be obtained from the product of the expected fecundity of an average-sized female and the total number of spawning females. In this paper, in comparison to total length, fish weight was found to give a more accurate relationship for calculating the fecundity. Therefore, Gaigher (1977) in Hardap Dam, South West Africa, Bruton (1979) in Lake Sibaya, Clay (1979) in South Africa stated that fecundity increased exponentially with total length, while in the River Asi a linear correlation was found between fecundity and the total length (5, 7, 8).

Willoughby and Tweddle (1978) stated that the ripe ovaries contained between 600 and 1,400 eggs per gram wet weight for *C. gariepinus* living in the Shire Valley, Malawi, with 51 and 155 eggs per gram wet weight for *C. gariepinus* living in the River Asi (6).

With regard to the fecundity of the females, Nawar and Yoakim (1962) found 13,900 –164,800 eggs per female in the River Nile, North Africa, while Mulder (1971) in the Transvaal, South Africa, found 293,000 – 446,000; Micha (1973) in the Ubangui River, West Africa found 3,000 – 328,000; Richter (1976) in Central and West Africa found 10,000 – 120,000; Gaigher (1977) in Hardap Dam, South West Africa, 70,000 – 1,100,000; and Bruton (1979) in Lake Sibaya, South Africa, reported a figure of 5,000 - 163,000 eggs per female (1-5, 8). In this paper, the fecundity of females was estimated to be 4,483 to 336,157 eggs per female. The intraspecific variations in the fecundity of *C. gariepinus* living in the River Asi, as seen in those of other *C. gariepinus* populations, were observed. This can be attributed to differences in the sizes of the females making up spawning stock (18). For instance, a female with a total length of 25.5 cm had 40 g of ovaries, while other females with total lengths of 53 cm and 58 cm had 22.38 g and 308 g of ovaries respectively. Intraspecific variations in fecundity and egg size may also be related to the time of spawning. For example, there were eggs of 0.7 and 1.46 mm in May (Fig. 9).

Mature catfish choose shallow water for spawning. Throughout the summer, fishermen capture these catfish by using special nets in swallow water without considering the fact that they are in their spawning period. The final outcome of this repeated process is that the eggs from the mature catfish are destroyed without being given a chance to survive. Considering this fact, we recommend that the spawning areas along the River Asi are determined and regulations are enforced to protect these areas from fishermen at least throughout the spawning period. In addition, considering the principle that the fish that will be caught for consumption should have at least spawned a new generation. In accordance with this principle, we suggest that the capture of fish shorter than 35 cm and/or lighter than 300 g should be banned.

References

1. Nawar, G., Yoakim, E. G., A study on the stream of the Nile catfish Clarias lazera Valenciennes in Cuvier and Valenciennes 1840, Annals and Magazine of Natural History 5 (13): 385-389: in Clay, 1979, 1962.
2. Mulder, P. F. S., 'n Ekologiese studie van die hengelvisfauna in die Vaalriviersistem met spesiale verwysingna *Barbus kimberleyensis*, Gilchrist & Thompson, M.Sc. thesis, Rand Afrikaans University, South Africa: in Bruton 1979, 1971.
3. Micha, J. C., Etudes Populations Piscicoles de l'Ubangui et Tentatives de Selection et d' Adaptation de quelques Especes a l'Etang de Piscisulture. Notes Docum. Peche Piscic. Centre Techn. Forest. Trop. 1 - 110pp: in Bruton 1979, 1973.
4. Richter, C. J. J., The African mudfish, *Clarias lazera* (C&V), a new possibility for fish culture in tropical regions? Misc. Pap. Landbouwhogeschool, Wageningen, 13: 51-70: in Bruton 1979, 1976.
5. Gaigher, I. G., Reproduction in the catfish (*Clarias gariepinus*) in the Hardap Dam, South West Africa, Madoqua 10: 55 – 59, 1977.
6. Willoughby, N. G. and Tweddle, D., The ecology of the catfish *Clarias gariepinus* and *Clarias ngamensis* in the Shire Valley, Malawi, Journal of Zoology (London) 186: 507-534, 1978.
7. Clay, D., Sexual maturity and fecundity of the African catfish (*Clarias gariepinus*) with an observation on the spawning behaviour of the Nile catfish (*Clarias lazera*), Zoological Journal of the Linean Societ, 65: 351 – 365, 1979.
8. Bruton, M. N., The breeding biology and early development of *Clarias gariepinus* (Pisces: Clariidae) in Lake Sibaya, South Africa, with a review of breeding in species of the subgenus Clarias (Clarias), Trans. Zool. Soc. Lond. 35: 1-45, 1979.
9. Clay, D. and Clay, H., Biometry of catfish (*Clarias lazera*) ovaries in Israel, with comments on fecundity and methodology, Israel Journal of Zoology, 30: 177 – 189, 1981.

10. Quick, A. J. R. and Bruton M. N., 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, 1984.

11. Chambray, J. A., Observations on spawning of *Labeo capencis* and *Clarias gariepinus* in the regulated lower Orange river, South Africa, South African Journal of Science, 81: 318 – 320, 1985.

12. Tekelioğlu, N., Çukurova Bölgesinde tatlısu kaynaklarında bulunan Karabalık (*Clarias lazera* Cuv and Val. 1840)'ın Doğal Koşullardaki Bazı Vücut Özellikleri ve Yumurta Verimliliği ile Ç.Ü. Ziraat Fakültesi Balık Üretim Tesislerinde Yetiştirilme Olanakları Üzerine Bir Araştırma, Doktora Tezi, Ç.Ü. Ziraat Fakültesi, Adana, 1980.

13. Geldiay, R., Balık, S., Türkiye Tatlısu Balıkları, Ege Ün. Fen Fak. Kitapları seri no: 97, Izmir, 536 s, 1996.

14. Bagenal, T., Methods for Assessment of Fish Production in Fresh Waters, Blackwell Scientific Publications Ltd., London, pp 365, 1978.

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

16. Wootton , R. J., Ecology of Teleost Fishes, Chapman & Hall, pp.404, 1992.

17. Yalçın, Ş., Asi Nehri'nde Yaşayan Karabalık (*Clarias gariepinus* Burchell, 1822)'ın Bazı Biyolojik Özellikleri, Doktora Tezi, Gazi Üniversitesi, Fen Bilimleri Enstitüsü, 1999.

18. Jobling, M., Environmental Biology of Fishes, Chapman & Hall, pp. 455, 1995

19. Andries, D. and Verraes, W., On the functional significance of the loss of the internal during ontogeny in *Clarias gariepinus* Burchell, 1822 (Teleostei Siluroidei) Belgian Journal of Zoology (Belgium) 124 (2): 139 – 155, 1994.

20. Munro, J. L., Feeding relationships and production of fish in a southern Rhodesian Lake, Ph.D. Thesis, University of London: in Bruton 1979, 1965.

21. Van der Lingen M. I., Some problems of breeding biology of fish in impounded waters, Kariba Research Symposium, 97-103, Kariba: Lake Kariba Fisheries Research Institute: in Clay, 1979, 1965.

22. Holl, A. E., Some notes on the breeding of barbel *Clarias gariepinus* Burchell in Rhodesia, Newsl. Limnol. Soc. Sth. Afr. 7:38-41: in Bruton 1979, 1966.

23. Van der Waal, V. C. W., Breeding and production of *Clarias gariepinus*, Dept. Nature Cons., Lowveld Fish. Station, 1969-1970, Marble Hall, Tvl., Republic of South Africa. Project, No. 5: 30-43: in Clay 1979, 1970.

24. Van der Waal, V. C. W., 'n Ondersoek na aspekte van die ekologie, teelt, en produksie van *Clarias gariepinus* (Burchell, 1822), M.Sc. thesis, Rand Afrikaans Universiteit, South Africa : Bruton 1979, 1972

25. Loiselle, P. V., Ghana preliminary survey of inshore habitats in the Volta lake, Fish. Rep. FAO FI.DP.GHA/67/510/2: in Bruton 1979, 1972.

26. Bowmaker, A. P., A Hydrobiological Study of the Mwenda River and its Mouth, Lake Kariba. Ph.D. Thesis. University of the Witwatersrand, Republic of South Africa: in Clay 1979, 1973.

27. Micha, J. C., Synthese des essais de reproduction, d'alvinage et de production chez un silure Africain: *Clarias lazera*, Val. Bull. Fr. Piscic. No 256: 77-87: in Bruton, 1979, 1975.

28. Pham, A., Donnees sur la production en masse d'alevins de *Clarias lazera*, Val. A la station de Bouake (Cote d'Ivoire). Notes Docum. Peche Piscic. Centre techn. Forest. Trop. 10: 49-57, 1975

29. Hopson, A., Lake Rudolf Fisheries Research Project. Unpublished report to the Fisheries Department, Nairobi, Kenya: in Bruton 1979, 1975.

30. Willoughby, N. G. and Tweddle, D., The ecology of the commercially important species in the Shire Valley Fishery, southern Malawi, Fish. Rep. Malawi Gov. Serv. 1 – 21: Bruton 1979, 1976.

31. Holl, A.E., Notes on spawning behaviour of barbel *Clarias gariepinus* Burchell in Rhodesia, Zoologica Afr. 3:185-188: in Bruton 1979, 1968.

32. Van der Waal, B.C.W., Observations on the breeding habits of *Clarias gariepinus* (Burchell), Journal of Fish Biology, 6: 23-27, 1974.

33. Nawar, G., Observations on the seminal vesicle of the Nile catfish *Clarias lazera*, Ann. Mag. Nat. Hist. (13) 2: 444-448: in Bruton 1979, 1959.

34. Nawar, G. And Yoakim, E. G., A study of the fecundity of the Nile catfish *Clarias lazera*, Valenciennes in Cuvier & Valenciennes, 1840, Ann. Mag. Nat. Hist. (13) 5: 385-389: in Bruton, 1979, 1963.

35. Blache, J. et al., Les poissons du bassin Tchad et du bassin adjacent du Mayo Kebbi. Etude systematique et biologique, Mem. O.R.S.T.O.M. 4 (2): 1 – 485: in Bruton 1979, 1964.

36. Aboul – Ela, I.., Amer, F. I. & El Bolock, A. R., Studies on spawning and spawning behaviour of *Clarias lazera* Cuv. Et Val. In fish farms of the A. R. Egypt. Bull. Zool. Soc. Egypt No. 25: 25-33: in Bruton 1979, 1973.

37. Greenwood, P. H., The reproduction of *Clarias mossambicus* in Lake Victoria, Publs Cons. Scient. Afr. S. Sahara No. 25: 77-78: in Bruton 1979, 1956.