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Age, Growth and Mortality of the Common Carp (*Cyprinus carpio*) Population in Merdja Sidi Abed Dam, Algeria.

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ABSTRACT

We tried to estimate age, growth parameters, condition factor, length-weight relationship and mortality rates (*Z, M*, and *F*) of the common carp in Merdja Sidi Abed dam. *Cyprinus carpio* specimens were captured by long line between April and June 2013 in Merdjea Sidi abed. 220 individuals were collected and weights ranged between 265.5 and 620.3 g while the total length ranged between 26.3 and 35.6 cm. Length-converted catch curve was used to estimate total annual instantaneous mortality rates (*Z*), natural mortality was calculated using Pauly formula [$ln(M) = -0.0152 - 0.279\ ln(L_\infty) + 0.6543\ ln(K) + 0.463\ ln(T)$]. Recruitment patterns were determined from the routine implemented in FISAT II. For all individuals (*n = 220*) of the common carp, the relationship between total length and body weight was: $W = 0.0384\ L^{2.70}$ ($r^2 = 0.906$) for females and $W = 0.0467\ L^{2.653}$ ($r^2 = 0.976$) for males a minor allometry was found for this species, mean condition factor K was estimated at 1.41. The maximum value of recruitment was recorded in March-April period with 19.56 and 15.20% respectively. The Battacharya method was used to estimate age of individuals that was comprised between 1 and years 3. The equation of Von Bertalanffy growth was: $L = 36.75\ [1\text{-}e^{-0.46\ (t\ +\ 0.33)}]$ for all the population. Total mortality (*Z*), natural mortality (*M*) and fishing mortality (*F*) were as follows: $Z = 1.08,\ M = 0.82,\ F = 0.26\ yr^{-1}$ while exploitation ratio (*E*) was evaluated at *0.24* indicating an under exploitation of this local resource.

***Keywords*:** Common carp, *Cyprinus carpio*, Sidi Abed dam, age, growth, fisheries.

1. Introduction

The common carp (*Cyprinus carpio* L. 1758) belongs to a family Cyprinidae of order Cypriniformes is a freshwater species inhabiting warm, deep, slow-flowing and still waters such as lowland rivers and large, well vegetated lakes (Kottelat and Freyhof 2007). Hardy and tolerant of a wide variety of conditions but generally favor large water bodies with slow flowing or standing water and soft bottom sediments. Thrive in large turbid rivers (Scott and Crossman 1998). Most active at dusk and dawn. Both adults and juveniles feed on a variety of benthic organisms and plant material. Common carps *(Cyprinus carpio)* are frequently cultured and are of great commercial value as a food fish both over their native and introduced range (Aguirre and Poss, 2000).

It is known to be a non-native fresh water species in Algeria, it's first introduction dates from 1860 (Dieuzeide and Roland, 1951). It has been chosen as an ideal candidate for repopulating Algerian wetlands given its easy adaptation to a large variety of aquatic environments (dams, lakes, reservoirs).

Scarce data exist on the common carp from the south side of the mediterranean basin and especially from Algeria except works of Hadjlaoui *et al.,* 2016 on Tunisian carp, Tandjir and Djebar 2008 focusing on general traits of carpiculture in Algeria, Kara 2012 focusing on fresh water fish biodiversity and Mimeche *et al.,*

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2015 describing the growth of this species for Eastern Algeria, the aim of our study is to give primary results on age, growth and exploitation of this cyprinid in order to adopt the appropriate management for it's conservation.

2. Material and Methods

Common carp *Cyprinus carpio* (Linnaeus 1758) specimens were captured by long line between April and June 2013 in Merdja Sidi abed dam (figure 1) in Wilaya (district) of Ghelizane (36°00'12"N, 1°00'37"E). Total length (*L*) was measured with an ichthyometer to the nearest 0.1 cm and total weight (*W*) weighed with 1 g precision digital scale. Length-weight relationship was calculated as follows:

$$W=aL^b$$ **(Ricker, 1973).**

where "W" is the body weight (g) and "*L*" is the total body length (cm), "*b*" is the regression coefficient and "*a*" is the regression constant. A Student's t-test (Zar, 1999) was used to test the difference of the parameter "*b*" from the theoretical value of 3.

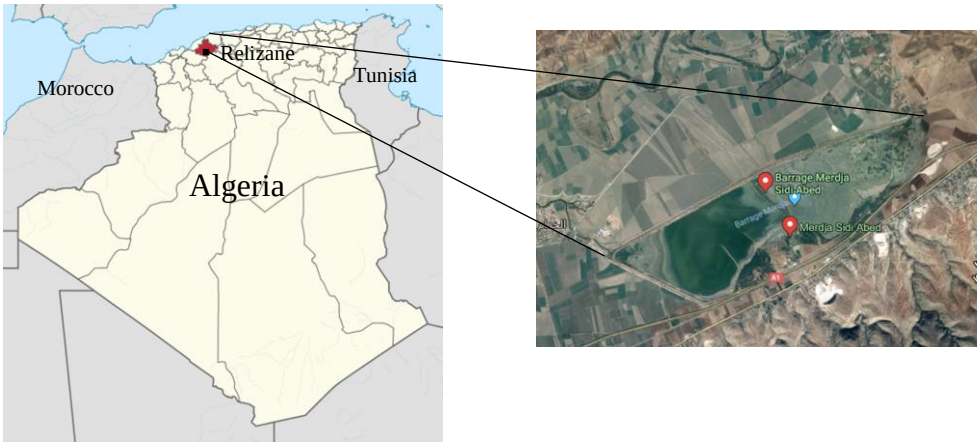


Figure 1. Study area (googlemap 2018, modified).

Fulton's condition factor calculated as follows:

$$C=(W*100)/L^3$$ **(Fulton, 1904).**

where "*W*" is the body weight (g) and "*L*" is the total body length (cm).

The Von Bertalanffy growth function was used to describe the growth of this Cyprinidae. The Battacharya method was employed to determine age of individuals. Bhattacharya's method, distinguishing parameters with normal distribution from a combined distribution pattern (Sparre and Venema 1992) was used for splitting composite distributions for fish length distributions into separate normal distributions, applicable to cohorts. Length-converted catch curve was used to estimate total annual instantaneous mortality rates (*Z*), natural mortality was calculated using Pauly formula [$ln(M) = -0.0152 - 0.279\ ln(L_\infty) + 0.6543\ ln(K) + 0.463\ ln(T)$] *K*: growth coefficient; *T*: annual mean water temperature (°C); Recruitment patterns were determined from the routine implemented in FISAT II; and fishing mortality deducted from the Equation:

$$F=Z-M.$$ **(Pauly, 1984).**

3. Results

The length frequency distribution of 220 fish is shown in Table 1. The total length of individuals ranged from 17 to 47.8 cm, while the weight ranged from 72 to 1275.2 g.

Table 1. Maximum and minimum values of the total length and total weight for males, females and undetermined of *C. carpio* off Merdja Sidi Abed, Algeria.

	Total length (cm)		Total weight (g)	
	Minimum	Maximum	Minimum	Maximum
Males	17	46.2	72	1180
Females	18.2	47.8	89.9	1275.2
undetermined	13.8	40.9	41	170.9

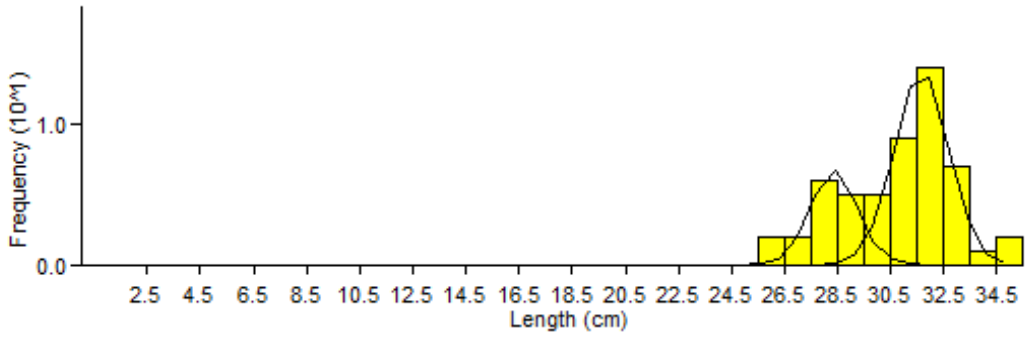
The length–weight relationships (Table 2) were calculated as $W= 0.0252L^{2.8014}$ ($r^2=0.9928$) for females, $W=0.0178L^{2.9015}$ ($r^2 = 0.9905$) for males and $W = 0.0197L^{2.8704}$ ($r^2=0.9936$) for all specimens showing negative allometric growth. The parameter "b" of length–weight relationships was significantly different from 3 ($t=3.58>t_{0.05,220}=1.65$) while condition factor was calculated as 1.62 for males and as 1.76 for females.

Bhattacharya's analysis of length frequencies (Figure 2) of *Cyprinus carpio* specimens allowed us to distinguish 2 cohorts for the both sexes summarized in (Table 3.)

Table 2. Parameters of the length–weight relationship for males, females and all *C. carpio* off merdja Sidi Abed and isometry tested by Student t-test∗ ($t > t_{0.05}$, n>200 = 1.96).

	a	*b*	*s.d (b)*	*n*	r^2	*t-test*
Males	0.0178	2.90	0.023	74	0.99	4.69*
Females	0.0252	2.80	0.023	98	0.99	8.58*
All fish	0.0198	2.87	0.025	220	0.99	3.58*

a



b

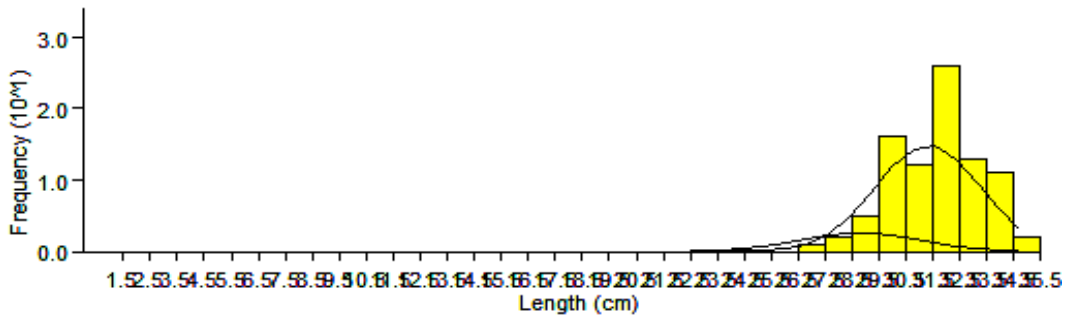


Figure 2. Total length-frequency distribution for *C. carpio* caught in Merdjet sidi abed dam: **a**) males, **b**) females separated into two length groups (cohorts) by Bhattacharya's method.

Table 3. Length-age key for the common carp, of *C. carpio* caught in Merdja sidi Abed dam calculated by Bhattacharya's method.

Age group	Males	Females
1	28.6±0.88 cm	28.83±2.21 cm
2	31.66±1.02 cm	31.30±1.93 cm

Table 4. Parameters of the von Bertalanffy growth equation for males, females and all *C. carpio* off merdjet Sidi Abed.

	n	L_∞ *(mm)*	*k (year^{-1})*	t_0 *(year)*	*Z*	*M*	*F*	*E*
Males	74	36.75	0.35	-0.44	0.85	0.67	0.18	0.21
Females	98	36.75	0.46	-0.33	0.89	0.81	0.08	0.09
All fish	220	36.75	0.46	-0.33	1.08	0.82	0.26	0.24

Von Bertalanffy's growth curve parameters for males, females and all fish were calculated and are shown in Table 4. Total mortality rate (*Z*) for all samples was 1.08 year^{-1}. The annual mean water temperature at the study locality was 17°C. Thus, natural mortality rate (*M*) was estimated as *0.82 year^{-1}*. Fishing mortality rate (*F*) was found to be *0.26 year^{-1}*. The exploitation rate (*E*) was calculated as *0.24 year^{-1}*.

4. Discussion

The exponent b of the length-weight relationships in each sex (*b* = 2.9 for females, *b* = 2.8 for males) showed that weight increased with length in negative allometry which agrees with the majority of works done on this cyprinid and *b* factor variated between 2.66 and 2.93 (table 4) while positive allometry was found for this species in Almus Dam Lake (Karataş *et al.,* 2007) and Hatay province (Özcan, 2008).

In fact, as fish grows, changes in weight are relatively greater than changes in length. The b values in fish differ according to species, sex, age, seasons and feeding (Ricker 1975; Bagenal and Tesch, 1978). In addition, changes in fish shape, physiological conditions, different amounts of food available, life span or growth increments can all affect the *b* growth exponent (Frost 1945; Treer *et al.,* 1998, 1999; Koç *et al.,* 2007). Changes in fish shape, physiological changes, hydrological environmental conditions, different food availability during life span, growth increment can all affect growth exponent *b* (Sinovčić, 2000).

The Bhattacharya's method determined only two cohorts while in other studies age varied between 5 and 14 determined from scale or otoliths readings. this analysis method needs a sufficient number of individuals in every age group. however, only 220 individuals were available for our study and age should be determined by otolithometry or scalimetry.

L_∞ and *K* values in relevant literature are shown in table 5. In our estimations, the asymptotic length of *C. carpio* was L_∞*=36.75* and *K* value was *0.46* for all individuals, indicating a relatively fast growing speed in Merdjet Sidi Abed as found in some studies in India in Thirumoorthy Reservoir (*K=0.958*, Palaniswamy *et al.,* 2011) and Iran in Mangla reservoir (*K=0.6*, Mirza *et al.,* 2012) which is not the case for other studies where *K* factor was comprised between *0.0754* and *0.28 year^{-1}*.Our findings in *CF* are lower than those estimated in the literature (Table 3).

In Merdjet sidi abed *C. carpio* grows relatively fast during the first years of life with a *K* constant higher than other regions (Table 5) as noticed by Palaniswamy *et al.,* 2011 in India while in other studies this parameter reflects a slow growth of the species.

The length-converted catch curve gave a rate of total mortality (*Z=1.08*) which is in accordance to results shown in table 5, natural mortality (*M*) was evaluated at *0.82* with Pauly empiric formula with a mean annual habitat of 17°C which is similar to works done on the same species (Mirza *et al.,* 2012) in Pakistan and greater than other studies.

Table 4. Length - weight relationships for *C. carpio* in several studies, based on $W=aL^b$ (weight in g, length in cm)

	Locality	Sex	*n*	*a*	*b*	*s.e (b)*	r^2	Author
Iran	Caspian sea	M	130	0.00004	2.84	-	0.97	Fatemi *et al.,* 2009
		F	198	0.00004	2.82		0.98	
		C	2090	0.03140	2.84	0.017	0.93	Moradinasab *et al.,*2012
		F	151	0.00700	3.21	-	-	
		C	604	0.02500	2.90	-	0.92	Sedaghat *et al.,* 2013
Turkey	Gölhisar Lake	F	350	0.02580	2.86	-	-	Alp and Balik. 2000
		M	324	0.02430	2.88	-	-	
	Karamik Lake	C	108	0.02450	2.92	0.031	0.99	Balik *et al.,* 2006
	Liman Lake	C	288	0.02830	2.87	-	0.96	Demirkalp 2007a
		M	121	0.02890	2.86	-	-	
		F	141	0.02820	2.87	-	-	
	Çernek Lake	C	364	0.05470	2.66	-	0.95	Demirkalp 2007b
	Almus Dam Lake	C	308	0.00490	3.31	-	0.94	Karataş *et al.,* 2007
	Hatay province	C	95	0.02100	3.11	0.176	0.98	Özcan 2008
	Lake Işıklı	C	158	0.03500	2.84	-	-	Yağcı et al., 2008
	Damsa Dam Lake	C	160	0.02190	2.90	0.900	0.96	Mert and Bulut. 2014
	Mogan Lake	M	180	0.00004	2.87	-	0.94	Saylar and Benzer.
		F	168	0.000080	2.70	-	0.94	2014
South Africa	Lake Gariep	C	566	0.000053	2.829	-	0.97	Winker *et al.,* 2011
Romania	Brăila Island	C	367	0.027100	2.84	-	0.97	Gheorghe *et al.,* 2011
Tunisia	Sidi Saâd dam	C	2285	0.08600	2.93	-	0.97	Hajlaoui *et al.,* 2016
Algeria	Ain zada reservoir	C	114	0.09100	2.43	0.050	0.95	Mimeche *et al.,* 2013
	K'sob reservoir	C	150	0.04400	2.66	0.060	0.92	Mimeche *et al.,* 2015
	Merdja Sidi Abed	C	220	0.01970	2.87	0.026	0.99	Present study
		M	74	0.01780	2.90	0.023	0.99	
		F	98	0.02520	2.80	0.023	0.99	

A low fishing mortality (*F*) factor was found *F=0.26* as mentioned by other authors (Table 5) (Balik *et al.,* 2006, Karataş *et al.,* 2007; Winker *et al.,* 2011; Mirza *et al.,* 2012; Tesfaye and Wolff. 2015) may be due to the absence of commercial fishing in Merdjet sidi abed.

A suggested by Gulland (1971) the exploitation ratio quite equal to 0.50 reflect an equilibrated situation of the exploited stock which is the case of Almus Dam Lake *C. carpio* population (Karataş *et al.,* 2007). In other studies, this ratio exceeded 0.5 reflecing signs of over exloitation (Alp and Balik. 2000; Balik *et al.,* 2006; Palaniswamy *et al.,* 2011; Njiru *et al.,* 2008; Fatemi *et al.,* 2009) while our findings (*E=0.24*) are similar to those done in Lake Gariep (Winker *et al.,* 2011), Koka Lake (Tesfaye and Wolff. 2015), Mangla reservoir (Mirza *et al.,* 2012) exhibiting an under exploitation of the resource probably due the presence one fishing gear (long lines).

Table 5. Parameters of the von Bertalanffy growth equation, Total (*Z*), natural (*M*) and fishing (*F*) mortality rate and the exploitation ratio (*E*) for males, females and all *C. carpio* in several studies

Locality			*n*	L_∞	*K*	t_0	*Age*	*k*	*Z*	*M*	*F*	*E*	Author
Turkey	Golhisar Lake		693	72.76	0.1723	-0.44	6	1.84	1.36	0.35	1.01	0.74	Alp and Balik. 2000
	Karamık Lake		108	130	0.0754	-0.24	10	2.02	0.40	0.16	0.24	0.6	Balik *et al.,* 2006
	Almus Dam Lake		308	46.39	0.153	-1.92	7	1.33	0.64	0.32	0.32	0.5	Karataş *et al.,* 2007
	Lake Işikli		152	108.4	0.101	-0.22	14	1.92	-	-	-	-	Yağcı *et al.,* 2008
	Damsa Dam Lake		160	88.45	0.168	0.583	8	1.58	-	-	-	-	Mert and Bulut. 2014
	Mogan Lake	M	180	49.06	0.25	-1.44	6	1.99	-	-	-	-	Saylar and Benzer. 2014
		F	168	49.60	0.24	-1.74	6	1.99	-	-	-	-	
South Africa	Lake Gariep		566	62. 58	0.16	0. 39	7	-	0.82	0.6	0.12	0.14	Winker *et al.,* 2011
India	Thirumoorthy Reservoir		1370	58.6	0.958	-0.95	12	-	2.12	0.70	1.41	0.66	Palaniswamy *et al.,* 2011
Kenya	Naivasha lake		-	60.8	0.14		-	-			081	0.65	Njiru *et al.,* 2008
Ethiopia	Koka Lake		6139	74.1	0.28	-0.46	-	-	0.83	0.55	0.28	0.33	Tesfaye and Wolff. 2015
Iran	S.Caspian Sea		328	72.0	0.18		10	-	0.71	0.29	0.42	0.59	Fatemi *et al.,* 2009
Croatia	Vransko Lake		70	8197	0.122	- 0.81	11	1.62	-	-	-	-	Treer *et al.,* 2003
Pakistan	Mangla reservoir		1018 2	80.33	0.60	-0.39	-	-	1.22	0.89	0.33	0.27	Mirza *et al.,* 2012
Romania	Brăila Island		367	84.7	0.161	-0.81	-	-	-	-	-	-	Gheorghe *et al.,* 2011
New Zealand	Whangamarino River		566	67.5	0.21	0.15	12	-	-	-	-	-	Tempero *et al.,* 2006
Algeria	Merdjet Sidi Abed Dam		220	36.75	0.46	-0.33	2	1.4	1.08	0.82	0.26	0.24	Present study

In Merdjet sidi abed *C. carpio* population seems to be under exploited and the actual fishing effort estimated should be increased in response to a growing ichthyophagous population. Also, other appropriate fishing techniques or gears should be employed to capture this *Cyprinidae* without endangering the actual population or harm this stable ecosystem.

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