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DIET, PREY SELECTION AND BIOMASS CONSUMPTION OF THE GREAT CORMORANT, *PHALACROCORAX CARBO* (SULIFORMES, SULIDAE), IN ALGERIA

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Diet, Prey Selection and Biomass Consumption of the Great Cormorant, *Phalacrocorax carbo* (Suliformes, Sulidae), in Algeria. Belfethi, L., Moulaï, R. — This is the first study on the diet of the Great Cormorant wintering in Algeria. It is carried out in Beni Haroun, the largest dam lake in the country, in north-east of Algeria. The trophic menu of *Phalacrocorax carbo* in this lake is based on four fish species: *Abramis brama, Carassius carassius*, *Barbus barbus* and *Cyprinus carpio*. However, *Barbus barbus* and *Carassius carassius* represent the two most important species in Great Cormorant's diet. The total consumed biomass is 155,364.18 g, and the average biomass contained in each pellet varies between 330.7 and 2,953 g. The biomass of consumed fish varies between 36.89 g and 2,501 g. The size of the caught fish records values between 13.7 cm and 52.49 cm. The number of consumed fish per pellet varies between 1 and 9. The results show that the Great Cormorant of Beni-Haroun Dam Lake consumes between 573 g and 2,353.3 g of fish per day and between 49.8 t and 185 t each month. However, the highest value is recorded in January (between 81.5 and 300.5 t). The Great Cormorant of Beni-Haroun dam lake could have a significant impact on continental and recreational fishing at this site.
Key words: *Phalacrocorax carbo*, diet, Algeria, fish, biomass.

Introduction

The Great Cormorant (*Phalacrocorax carbo*) is a widespread large aquatic bird; it lives in the coastal and continental waters of Eurasia, Africa and North America (Klimaszyk & Rzymski, 2016). In Algeria, the great cormorant is a common wintering bird, between October and March. It lives in coastal and continental freshwaters. Most winter visitors are from northern Europe (Isenmann & Moali, 2000). Recent censuses of the wintering population of Great Cormorant in Algeria, gave a number of 5,250 individuals, with nearly 70 % wintering in the Beni Haroun dam lake in the northeast of the country (DGF, 2013; Belfethi & Moulaï, 2018).

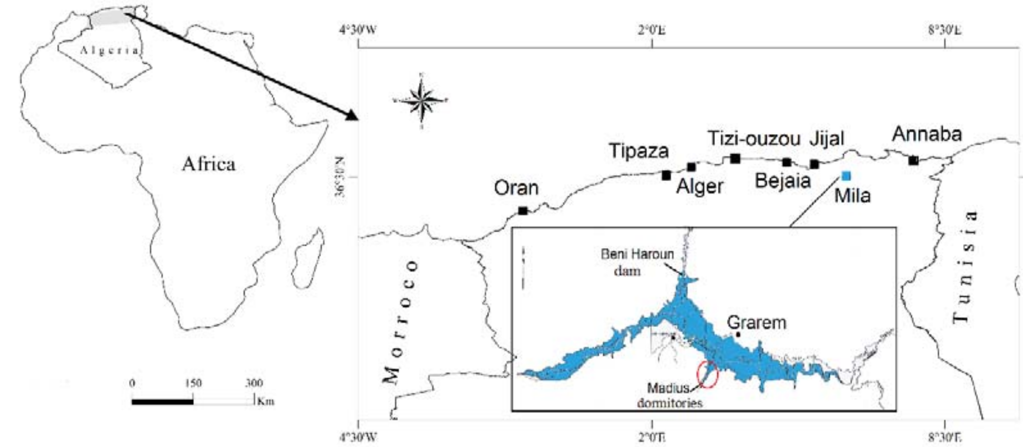

Fig. 1. Geographical location of Beni-Haroun Dam Lake in Algeria.

The Great Cormorant is considered as a pest bird, because of its impact on soil chemistry, especially under dormitories, but also on the transfer of nutrients from the soil to the aquatic ecosystem (Klimaszyk & Rzymski, 2016). The diet of this species is mainly composed of fish (Ichthyophagus), explaining the fear of fishermen and fish farmers of the large increase in the population of Cormorants, which can have a significant impact on the fishing sector (Lebreton & Gerdeaux, 1996; Billard, 1995).

The study of the trophic ecology of Great Cormorant has never been approached in its wintering area in North Africa and more particularly in Algeria. It is in this context that our study takes place which aims to assess the consumption of fish in terms of diversity, abundance and biomass in the Beni Haroun dam lake which harbors the population of the Great Cormorant, the largest on the national scale.

Study site

The Beni Haroun dam is a large strategic hydraulic complex in Algeria. It is located in the department of Mila in the northeast of Algeria (ANB, 2002). Its geographic coordinates are 36˚33'50" N, 6˚16'35" E. It is considered as the second largest Algerian artificial wetland on the African continent (after the Al Sad El Alli dam in Egypt). It covers an area of 5,328 km^2. This dam is located 40 km north of Constantine (ANDI, 2013) and fed by two main arms of wad Rhumel and wad Endja (ANB, 2002) (fig. 1). It is characterized by a Mediterranean climate (Djeddi et al., 2018). The average temperature varies from about 5 C° in January to about 25 C° in August. The Average precipitation near the center of the basin varies from about 7 mm / month in July to about 80 mm / month in December; relative humidity varies between 50 % in August and 70 % between November and March (ANB, 2002). On the lake shore, there is agricultural land, forest and pre-forest formations and the main existing species are: *Olea europea*, *Pinus halepensis*, *Tamarix africana*, *Eucalyptus camaldulensis* and *Populus alba*. Most of these trees are used as dormitories and resting places by Great Cormorants (fig. 1).

Methodology

The study of the trophic ecology of the Great Cormorant is carried out by analyzing fish otoliths contained in the regurgitated pellets. Cormorants' pellets are collected, under the dormitories between October 2016 and January 2017. It is noted that only fresh pellets are selected. A total of 75 pellets is thus recovered.

In the laboratory, each pellet is placed separately in a solution of water and alcohol, then the mucus is eliminated and the solid residues are preserved. Otoliths are isolated and identified under a microscope. The pairs of otoliths and their number are determined and numbered in each pellet. Each pair of otoliths represents a fish. The otoliths are identified using reference otoliths extracted from the fish species that live in the Beni Haroun dam lake. (Barquete et al., 2008)

The length of the otoliths is calculated using a micrometric microscope, which makes it possible to measure the length of the consumed fish and their biomass, using the equations (table 1). Whereas, to determine the importance of the fish species found in the great cormorant's diet, it is necessary to calculate the contribution of each fish by the number (N and N %), contribution by the biomass (M and M %) and the frequency of occurrence (FO) and relative (FO %).

The analysis of variance (ANOVA) is used to measure the variations between the lengths and the biomass of the consumed fish, as well as the monthly variations of these two parameters.

Table 1. Relationship between (otolith length / fish length) and (fish biomass / fish length) of consumed fish by the Great Cormorant

Species	TL · OtL	References	BM · TL	References
Abramis brama	TL = 4.655 OTL 1.180	(Yilmaz et al., 2015)	BM = 0.0207 TL 3.080	(Khristenko, & Kotovska, 2016)
Carassius carassius	TL = 4.828 OTL 1.180	(Yilmaz et al., 2015)	BM = 0.0214 TL 2.945	(Bobori et al., 2010)
Barbus barbus	FL = 16.1 OTL -10.3	(Bostanci, 2009)	BM = 0.0069 TL 3.232	(Amouei et al., 2013)
Cyprinus carpio	OTL = 0.104 FL+0.551	(Kontas, & Bostanci, 2015)	BM = 0.01 TL 2.972	(Prokeš et al., 2006)

Note. TL — fish length, OtL — otolith length, BM — fish biomass.

Relative importance is also calculated (IRI and IRI %) by the equation of Buttu et al. (2013) :

$$IRI = (N\,\% + M\,\%).\ FO\,\%$$
$$IRI\,\% = IRI/\Sigma IRI \times 100,$$

where: M % — average weight in percentage, N % — average number in percentage, FO % — Percentage frequency of occurrence.

The individual consumption of the Great Cormorant is calculated using two methods. The first consists of calculating the consumed energy by a single Cormorant per day (FMR) according to the equation of Ellis and Gabriels (2002):

$$FMR = 16.69 \times m0.651,$$

where: m — biomass of the great cormorant in g.

In this study, the used Great Cormorant's weight to calculate FMR is 2210 g (Liordos and Goutner, 2008). On the other hand, the second method to calculate daily consumption consists of using the average biomass of the collected pellets. Monthly consumption is calculated using the equation of Barquete and al. (2008):

$$Cm = Cd \times t \times n,$$

where: Cd — daily consumption of a single cormorant per g, t — length of month (28, 30 or 31), n — number of great cormorants in the specified month.

Results

Of the 75 collected pellets of the Great Cormorant, nine (9) did not contain otoliths and of the 223 otoliths extracted, only 210 could be identified. The total biomass of consumed fishes estimated at 155,364.18 g (minimum 330.7 g-maximum 6,006.17 g). 72.7 % of consumed fish have a weight between 330.7 g and 2,953 g (the weights 330.7 g to 869.6 g and 1,536.3 g to 2,953 g represent 22.7 % and 33 % respectively). It is followed by the weight class which varies between 3,007.7 g to 4,820.1 g or 21.2 %, (4,025.5 g to 4,619.7 g represents 13.6 %.). Finally, 6 % of consumed fish have a biomass that varies from 5,013.5 g to 6,006.17 g.

The consumed biomass varies monthly. In October, 60 % of the fish have a weight that varies between 2,378.7 g and 4,619.7 g. In November, 70 % of the pellets weigh between 752.8 g and 2,713.5 g. In December, 64.7 % of the fish biomass varied between 330.7 g and 1,713.7 g, which 41.2 % varied from 330.7 g to 880.6 g. While in January, 78.9 % of pellets weigh between 330.7 g and 2,735.64 g and of them 42 % of have an estimated weight between 1,536.3 g and 2,388 g.

The diet of the Great Cormorant that winters in the Beni Haroun dam lake is entirely composed of fish. They are represented by four (4) species: the freshwater bream (*Abramis brama* Linnaeus 1758), crucian carp (*Carassius carassius* Linnaeus 1758), common barbel (*Barbus barbus* Linnaeus 1758) and common carp (*Cyprinus carpio* Linnaeus 1758). The most consumed species in number and in biomass is the common barbel, with about 64 individuals (31.9 %) and 45,934.98 g of biomass which represents 29.6 %. In second position comes carp, with 57 individuals (27.14 %). However, in terms of biomass, it is the crucian carp which comes in second place with 39,883.98 g, or 25.7 % of the total biomass. The freshwater bream is the least consumed in number and biomass with 14.76 % and 19.5 % respectively. It is noted that these consumed fish are all present in the Beni Haroun dam lake; the latter were introduced mainly for the needs of inland and recreational fisheries.

According to the values of the occurrence frequency and the centesimal frequency, we can say that the common barbel (FO = 74.24, FO % = 33.35 and IRI % = 39) and crucian carp (FO = 62.12 , FO % = 27.9 and IRI % = 27.5) are the most represented species in the Great Cormorant's diet that winters in the Beni Haroun dam lake. Bream is the least consumed species and represents the lowest relative importance (IRI % = 9.3) (table 2).

The otolith analysis also allowed us to estimate the length of the consumed fish (table 3). The length of the fish varies between 13.7 cm and 52.49 cm. The length of 48 % of fish varies between 30 cm and 39.6 cm (the length 38 cm represents on its own 13.33 %.). It is followed by the length which varies between 40 cm and 49.27 cm (29.2 %). Finally, we note that 10.9 % of fish present the length of 42.8 cm. The length of the eaten fish varies from month to month. In October, fish length varies from 20.7 cm to 39.6 cm represent 57.4 % (14.9 % have a length of 38 cm.). Next comes the consumption of fish whose length varies from 40.9 cm to 52.5 cm (31.9 %) (The length of 42.8 cm represents 12.8 %). In November, fish with a length ranging from 30 to 38.5 cm are consumed with a percentage of 46.8 % (the length of 38 cm represents 14.5 %). 40.3 % of fish have a length which varies from 40.8 cm to 52.4 cm (the lengths 42.8 cm and 43.7 cm represent respectively 12.9 % and 11.3 %). In December, the great cormorant prefers fish whose length varies from 31 cm to 38.6 cm or 67.4 % (the lengths 36.2 cm and 38 cm represent 16.3 % and 11.6 % respectively.). In January, it feeds on fish whose length varies from 30.8 cm to 39.58 cm, or 50 % (the length 38 cm represents 12 %) (table 3)

The average length of the common barbel consumed by the great cormorant is 41.9 cm (min. 15.9 cm, max. 52.4 cm). The length of 60 % of the barbel varies between 42.8 cm and 47.6 cm, 16.4 % of it belong to the length of 42.8 cm. In October and November, the great cormorant consumes mainly barbels whose length varies between 40.9 cm and 47.58 cm or 65 % (the length 42.8 cm presents 26.6 %). For the months of December and January, it appears that the length of the consumed barbell is less compared to the previous months. It varies between 28.4 and 42.8 cm, which represents 74.5%. The lengths 33.16 cm and 42.8 cm represent 21 % and 30.3 % respectively (table 3).

The average length of the consumed common carp is 33.74 cm (minimum 18.7, maximum 52.49 cm). It should be noted that the length of 75.4 % of the consumed common carp varies between 29.95 cm and 38 cm. Between October and January; measurements of 67% of the consumed common carp vary between 29.95 and 38 cm.

For the estimated lengths for the crucian carp and freshwater bream, they appear to be less than those measured in the two previous species (crucian carp with a minimum of 16.6 cm, a maximum of 43.7 cm and an average of 33.89 cm, freshwater bream with a minimum of 13.7 cm, a maximum of 42.8 cm and an average of 32.74 cm). However, 64.2 % of

Table 2. Diet composition of the Great Cormorant wintering in Beni-Haroun dam lake in Algeria

Species	N	N %	M	M %	FO	FO %	IRI	IRI %
Barbus barbus	67	32	45935	29.6	74.24	33.35	2060.3	39
Cyprinus carpio	57	27	39261	25.3	54.5	24.5	1284.8	24.4
Carassius carassius	55	26	39884	25.7	62.12	27.9	1447.7	27.5
Abramis brama	31	15	30284	19.5	31.8	14.3	489.9	9.3

Note. N — effective, N % — average number in percentage, M — biomass in g, M% — average weight in percentage, FO —occurrence frequency, and relative (FO %), IRI — Relative Importance, and relative (IRI %).

Table 3. The length and the biomass of consumed fish by the Great Cormorant in the Beni Haroun dam lake in Algeria

Species	Month	Total length, cm						Biomass, g						N	BM total
		avg.	SD	min.	max.	dom	var.	avg.	SD	min.	max.	dom	var.		
Barbus barbus	Oct.	38.9	11	15.9	52.4	42.8	129.5	645.58	377	36.89	1,288	704.7	151,261.7	17	10,974.79
	Nov.	44.1	5.7	23.4	52.4	42.8	33.8	805.89	243	113.5	1,289	704.7	62,058.9	21	16,923.7
	Dec.	41.2	5.8	33.2	51.4	42.8	36.8	664.91	267.3	330.7	1,218	330.7	77,390.4	13	8,643.8
	Jan.	39.4	5.8	28.4	52.4	42.8	35.3	587.04	253.2	207.6	1,287	704.7	68,364	16	9,392.69
	Total	41.1	7.8	15.9	52.4	42.8	61	685.6	301.9	36.89	1,289	704.7	92,539.2	67	45,934.98
Cyprinus carpio	Oct.	34.4	8.8	18.7	52.49	38	83.1	792.6	620.4	88.7	2,501	880.5	408,957.1	17	13,474.05
	Nov.	36.2	5.1	25.1	46.05	38	15	803.63	341.2	231	1,638	880.5	63,641.6	15	12,054.5
	Dec.	35.1	3.4	30	38	38	12.8	705.97	198.7	407.9	880.5	880.5	44,431.2	9	6,353.8
	Jan.	30	5.7	21.9	38	29.95	34.6	461.15	264.3	148.5	880.5	407.9	7,466.8	16	7,378.4
	Total	33.7	6.9	18.7	52.49	38	47.89	688.78	438.8	88.7	2,501	880.5	195,989.4	57	39,260.75
Carassius carassius	Oct.	30.2	4.8	22.9	39.6		26.6	522.98	250.9	217.3	1,084		75,949.2	8	4,183.88
	Nov.	34.3	3.8	28.8	43.7	36.2	15.6	733.3	242.1	425.4	1,452	831.6	61,680.8	20	14,666.9
	Dec.	34.7	6.3	16.6	43	36.2	42.25	798.4	326.6	83.8	1,385	831.6	115,552.4	13	10,379.1
	Jan.	34.7	5	28.2	43	43	26.5	761	347.1	3320	1,385	831.6	129,779.2	14	10,654.1
	Total	33.9	5.2	16.6	43.7	36.2	27.14	725.16	306.5	83.8	1,452	831.6	95,655.3	55	39,883.98
Abramis brama	Oct.	23.2	10.4	13.7	42.78		134	284.97	232.5	65.98	704.7		67,558	5	1,424
	Nov.	36.8	9	17	42.8	42.8	97.3	1,102.4	628.9	128	1,898	42.8	474,627.8	6	6,614.3
	Dec.	34.8	3.1	31	38.6	38.6	10.9	1,189.7	322.7	819.4	1,590	38.6	159,025.2	8	9,517.4
	Jan.	33.3	3.7	27.5	40	31	14.9	1,060.7	370.4	577.6	1,791	31	149,661.5	12	12,727.94
	Total	32.7	7.7	13.7	42.8	38.6	62	976.91	509.8	65.98	1,898	819.4	268,583.7	31	30,283.64

Note. Avg — average, min — minimum, max — maximum, VAR — variance, BM — biomass, dom — dominant value, N — number of fish, SD — standard deviation.

crucian carp represent a length between 30.8 cm and 43 cm during the four months of study (table 3).

The average biomass of the consumed fish is 685.6 g (minimum 36.89 g, maximum 2501 g). 54 % of the consumed fish weigh between 517.8 g and 980 g. The weights 704.7 g and 880.5 g represent 10 % and 11 %, respectively. During the months of October, November and December 59 % of the consumed fish weighed between 517.8 g and 977.4 g. In January, it appears that the biomass of consumed fish has decreased; it varies between 148.3 g and 494.5 g (table 3).

The average biomass of the common barbel in Great Cormorant's diet is 685.6 g (min. 36.89 g, max. 1,289.4 g). In October and November, 65 % of barbel consumed weigh between 614.7 g and 967.7 g. In the months of December and January, we have a decrease in the consumed biomass. The latter varies between 207.6 g and 704.7 g.

The biomass of consumed common carp varies from 88.7 g to 2,501 g, for an average of 688.8 g. Within four months of the study, 66.8 % of common carp weighed between 407.9 and 880.5 g. The weight 880.5 g represents a frequency of 40 %. For the crucian carp, the consumed biomass varies between 83.8 g and 1,451.8 g, with an average of 725.16 g. In October, November and December, 66.5 % of the ingested biomass by this fish varies between 591.6 g and 1385.3 g. The weight 881.6 g represents 36.8 %. In January, 57.14% of common carp, weights varied between 517.9 g and 1,083.9 g.

The average consumed biomass of the freshwater bream is 976.9 g (min. 65.98, max. 1,897.9 g). In October, this fish has a lower consumed biomass compared to other species where 80% of individuals have weights varying between 65.89 g and 364.8 g. Between November and January, consumed biomass shows a certain increase compared to October (83.4 % of individuals have weights varying between 704.7 g and 1,790.7 g).

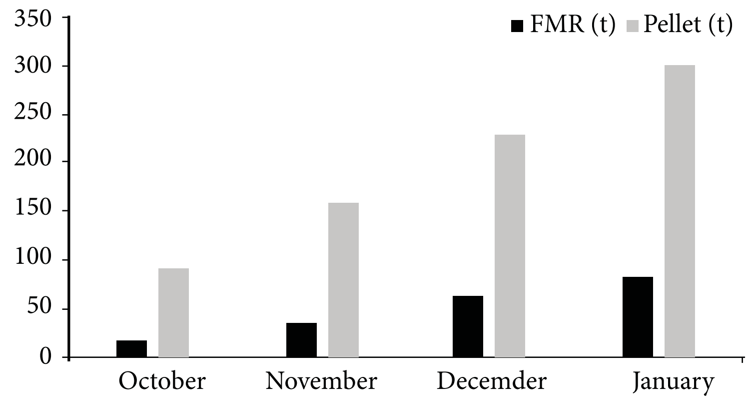

Fig. 2. Monthly variation of the biomass of consumed fish by the great cormorant in Beni Haroun Dam Lake in Algeria.

By examining the results of the standard deviation (table 3), it appears that the length and the biomass of the consumed fish are close to the average, particularly in the months of November, December and January. The applied ANOVA shows that there is a significant difference between the lengths of the consumed fish ($p = 0.02$) and between their biomass ($p = 0.48$). The same applies for monthly variations in length ($p = 0.32$) and in biomass ($p = 0.25$) where the differences are always significant.

The daily calculated energy of the Great Cormorant by (FMR) is 2,509.9 kJ / D-1 and its daily and monthly average consumption is 573 g per day and 49.8 t respectively. The highest consumption rate was recorded in January (81.5 t). Concerning the daily consumption of the Great Cormorant, calculated by using contained biomass in the pellet, it ranges from 29.53 g to 330.7 g (72.7 % of the pellet). Average daily and monthly consumption was 2,353.5 g, and 185 t respectively, and the highest consumption rate was recorded in January (300.5 t). Overall consumption during the study period is estimated at 780 t (fig. 2).

Discussions

The diet of the Great Cormorant wintering in Beni-Haroun dam lake in Algeria is entirely composed of fish. These all belong to the Cyprinidae family. In Lagoados Patos (Brazil), fish make up 99.84 % of the diet's biomass of neotropic cormorants (*Phalacrocorax brasilianus*) (Barquete et al., 2008). Numerous studies indicate that the Cyprinidae family is dominant in Great Cormorant's diet (90 to 99.3 %) (Keller, 1995; Santoul et al., 2004; Carss & Ekins, 2002; Gagliardi et al., 2007). In the Beni Haroun dam lake, the common barbell is considered as the most common species in Great Cormorant's diet, followed by the common carp in terms of number and the crucian carp in biomass. Frequency of occurrence (FO) and relative importance (IRI) data show that common barbel and crucian carp are the most characteristic prey species in Great Cormorant's diet, while the freshwater bream seems to be less consumed. Most studies indicate that the Cormorant's interest in a specific fish species does not seem to exist or is not highlighted and all depends on the availability of prey. A study carried out in the Gorame river in Mulhouse (France) showed that the Cormorant consumed the freshwater bream significantly (162 individuals), followed by the consumption of common carp and crucian carp with 5 and 6 individuals respectively (Santoul et al., 2004). In Great Britain, 3.8 % of consumed fish's number and 4.8 % of the biomass belong to bream (Carss & Ekins, 2002), while in Dummer Lake in Germany, the Cormorant consumes the freshwater bream at the rate of 1.22 % in term of number and 2.87 % in biomass (Emmrich & Düttmann, 2011). It also consumed 85 individuals of the common carp representing 3.5 g, and 58 g of the common barbel representing 4.5 % of the total biomass (Warke & Day, 1995). This difference is due to the fact that the Cormorant is considered as an opportunistic predator (Magath et al., 2016; Buttu et al., 2013). The composition of the Great Cormorant's trophic menu depends largely on the available fish species, the more they are abundant, the more likely they are to be eaten (Enstipp et al., 2007). A study on the predation of cormorants in a water body in southern Poland showed that carp was consumed at 73.4 %. This species of appears to form more than 80 % of the pond ichthyofauna (Opačak et al., 2004). The biotic and abiotic characteristics of aquatic environments, as well as the structure of the existing icthyofauna, play an important role in the composition of the great cormorant's diet (Morat, 2007; Magath et al., 2016).

The Great Cormorant of the Beni Haroun dam lake consumes fish ranging in length from 13.7 cm to 52.49 cm and most of them have lengths ranging between 30 cm and 39.6 cm. It is approximately the same consumed length by Cormorants of Great Britain which is between 8.7 and 44 cm (Carss & Ekins, 2002). In northwest Italy, a study conducted on consumed fish by cormorants' shows dimensions between 18.7 cm and 94 cm, with a small presence of small fish (Delmastro et al., 2015). The Great Cormorant can eat both small and large fish. The fact that small fish are not present in great numbers in the menu of cormorants in this study is certainly linked to the gastric juices of this predator which degrade more easily the otoliths of small fish. The same was noted in Romania, through the analysis of the regurgitated pellet of Great Cormorants (Martucci et al., 1993).

The average biomass of consumed fish in the Beni Haroun dam lake varies between 36.89 and 2,501 g. Most of them represent weights varying between 517.8 and 980 g. From October to December, the consumed biomass varies between 517.8 and 977.4 g, the latter seems to be decreasing in January. In the lakes and rivers of Bavaria in southern Germany, the biomass of consumed fish by the cormorant varies from 1 to 900 g (Keller, 1995). The length of the fish appears to affect the consumed biomass. It should also be noted that in northern Germany, in early spring and summer, the presence of small fish in great numbers in the river has an effect on the diet of the cormorant, where small prey represent an average of 86.6 % in the months of April, June and August. Large prey dominates in May with 87 % (Magath et al., 2016). The presence of large fish in the cormorant's diet is also linked to the temperature of water, when it decreases it affects the activity of fish that can be caught more easily (Čech et al., 2008). In January, the greater consumption of small fish compared to large fish is due to the fact that fish stay in the depths to take advantage of the heat, which makes them less accessible (Voslamber et al., 1995).

The biomass contained in a pellet varies from 330.7 g to 6,006.17 g (72.7 % of the pellets have biomasses ranging from 330.7 to 2,953 g). The pellet with large biomass represents only 6 % of the total number of pellets. Most studies show that the biomass in pellet is linked to the quantity and type (biomass) of daily caught fish. In southern Brazil, neotropic cormorants consumes between 0.82 and 3,446.59 g per pellet, with an average of 372.28 (Barquete et al., 2008). In continental Italy, the average biomass pellet provides figures that vary between 284 and 371 g (Gagliardi et al., 2007). In addition, in central west Sardinia in Italy, the Cormorant consumes between 18 and 478.4 g of fish per day (Buttu et al., 2013). For the cormorants wintering in the Beni Haroun dam lake there is between 1 and 9 fish per pellet, their weights vary between 36.89 g and 2 501 g. In the Dümmer Lake in Germany, cormorants reject pellets that contain between 24.9 and 69.9 fish per pellet, whose weight varies between 160 and 320 g (Emmrich & Düttmann, 2011).

The biomass contained in the pellet varies monthly in the dam lake of the present study; in October, the recorded weights varied between 2378.7 g and 4619.66 g. The number of consumed fish per pellet during this month varies from 1 to 9 fish, an average of 4.6 fish. For the months of November and December, the average consumption varies between 2.53 and 3.15 fish per pellet with a biomass varying between 330.7 g and 2,735.64 g. The consumed biomass largely depends on seasonal variations in water temperature and the ecology of fish (Santoul et al., 2004).

The FMR consumed by neotropic cormorants is estimated at 2,007.37 kJ / D-1 and the daily consumption at 425.29 g (Barquete et al., 2008), which is slightly lower than the FMR consumed by the great cormorant of the Beni Haroun dam lake in Algeria. In the Chiemsee Lake in Germany, the cormorants in captivity consumed between 130 and 1325 kJ / D-1 with a daily consumption of 341 g per day. The free cormorants consumed between 174 and 294 kJ / D-1, with a daily consumption of 539 g per day (Keller et al., 2012).

At the Beni Haroun dam lake, the average daily consumption is 2,353.5 g and the one recorded per month is 185 t. In Overijssel, in the northwest of the Netherlands, cormorants consume 245 t during their period of presence (Veldkamp, 1995). In the Dümmer Lake (Germany), they consumed 32.16 t (Emmrich & Düttmann, 2011). Neotropic cormorants consumes in Brazil each year between 119 and 132 t (Barquete et al., 2008). Finally, we can say that the biomass of consumed fish by the Great Cormorant of the Beni Haroun dam lake during its presence between October and January is quite high. This high consumption is mostly due to the large numbers of Great Cormorants, which may exceed 4,500 individuals in January (Belfethi & Moulai, 2018). Consequently, one can foresee effects on the fishing sector at the level of this dam and possible conflicts with fishermen.

Conclusion

The trophic menu of *Phalacrocorax carbo* in the Beni Haroun dam lake, in northeast of Algeria is based on four fish species: *Abramis brama*, *Carassius carassius*, *Barbus barbus* and *Cyprinus carpio*. However, *Barbus barbus* and *Carassius carassius* represent the two most important species in Great Cormorant's diet. The total consumed biomass is 155 364.18 g, and the average biomass contained in each pellet varies between 330.7 and 2,953 g. The biomass of consumed fish varies between 36.89 g and 2,501 g. The size of the caught fish records values between 13.7 cm and 52.49 cm. The number of consumed fish per pellet varies between 1 and 9. The results show that the great cormorant of the Beni Haroun dam lake consumes between 573 g and 2,353.3 g of fish per day and between 49.8 t and 185 t each month. However, the highest value is recorded in January (between 81.5 and 300.5 t). The Great Cormorant of the Beni Haroun dam lake could have a significant impact on continental and recreational fishing at this site. This first study on the trophic ecology of the Great Cormorant wintering in Algeria is worth pursuing in other dam lakes where the Cormorant is present in order to assess with precision, the potential impact that this bird can have on inland and recreational fishing, a growing activity in the country.

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