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FEEDING HABITS OF INTRODUCED INVASIVE SPECIES PIKEPERCH SANDER LUCIOPERCA (LINNE, 1758) IN THE RESERVOIR OF GHRIB DAM (NORTHWEST ALGERIA)

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Abstract : - When an introduced fish species successfully adapts to new ecological conditions, they significantly reduce the number of indigenous species. This paper aims to determine impacts that introduction of invasive species Sander lucioperca (Linnaeus 1758) has on native fish species in the reservoir of Ghrib dam (western Algeria). The diet of the introduced pikeperch was studied from September 2020 to August 2021. Trophic activity was assessed using the digestive vacuity coefficient (Cv). The index of relative importance (IRI), which combines frequency of occurrence (F), the number (Cn), and restored weight (Cp) of different ingested prey, was used to characterize the relative importance of different food taxa. Qualitative and quantitative variations in diet were studied according to pikeperch size (small, medium and large) and season. In total, 193 stomachs were empty, corresponding to a digestive vacuity coefficient of 44.47%. Qualitative study of stomach contents indicates that this species is omnivorous, with an ichtyophage trend. Three groups of prey were identified: Amphipodan (IRI = 1.03; Gammarus sp.), Dipteran (IRI = 4.73; Chironomus sp.) and primarily fishes (IRI = 94.24; Cyprinus carpio, Rutilus rutilus, and Sander lucioperca). Significant differences in feeding habits occur according to season and pikeperch size, showing also, the risk of cannibalism was highest among the largest pikeperch.

KEY WORDS: - Feeding habits, Predation pressure, Sander lucioperca, The Index (IRI), The reservoir of Ghrib dam.

INTRODUCTION

The Pikeperch (Sander lucioperca, Linnaeus 1785) is a kind of Eurasian percid fish that is widely distributed in the fluvial paths. The boundaries of their native reach extend from the Elbe in Onega Lake in the north and the Maritsa River on the South Arale Sea (Saisa et al. 2010). In order to increase catches and create new fishable populations, many introductions of Pikeperch have occurred in many countries,

In accordance with the National Plan for the Development of Fishing and Aquaculture, fingerlings of various species of freshwater fish, including Sander lucioperca (Percidae), Cyprinus carpio, Aristichthys nobilis, Hypophthalmichthys molitrix, and Ctenopharyngodon idella (Cyprinidae) were imported from Hungary and introduced in several dams and hill reservoirs located in the north Algeria during 1985–1986, namely the reservoir of Ghrib dam (Meddour et al. 2005).

In many European countries, Sander lucioperca is characterized as an invasive species with a long period of introduction outside its /natural biotope. It has been managed and stocked in Europe to regulate forage fish stocks (Peltonen et al. 1996) And usually plays an important role in eutrophic inner water, reducing abundance of planktivorous and omnivorous fish (Frankiewicz et al. 1999). In some cases, this species was used as a biological regulator of unwanted cypriniforms populations (Ridanovic et al. 2017).

Despite the possible economic benefits of introduced fisheries, the introduction allochthonous species has many disadvantages. These introduced species naturally affect native populations and can damage biodiversity by the pressure that they exert (Yagci et al. 2014).

Information about the trophy ecology of the adjacent indigenous species and non-aboriginal predators is important for virtually every aspect of the risk assessment of biological invasions. Particularly, understanding the potential effect of introduced predators on co-occurring prey can improve our ability to predict the impact of the change on the composition of the fish community (Pérez-Bote and Roso 2012).

Various studies on the feeding ecology of pikeperch are available (Argillier et al. 2003; Poulet 2004; Didenko and Gurbyk 2016).

In general, knowledge on S. lucioperca biology is scattered in north Africa. The rare published studies focus on morphometry (Turki-Missaoui et al. 2011), growth (M’hetli et al. 2011; Ben khemis et al. 2014), and genetics (Louati et al. 2016). An Algerian study examined the growth of S. lucioperca (Bouamra et al. 2017). No detailed studies have performed on the diet of S. lucioperca. This paper, however, aims to meet a need for information on the Sander genus. We provide the first complete study to describe and evaluate diet composition, prey selectivity, and trophic relationships of pikeperch. The obtained results will complement and expand available information regarding these piscivorous fish, enabling sustainable fisheries and conservation development in the region.

MATERIALS AND METHODS

Study site

The reservoir of Ghrib dam constitutes one of the largest Algerian reservoirs. It controls a catchment area of 2800 km². Created on the Cheliff oued in 1927 and commissioned in 1939. It is located in the southwestern of Algiers in the wilaya of Ain Defla (36°08' 41.66" N, 02°34' 18.08" E) (Figure 1). The area belongs to a sub-humid bioclimatic stage at cool winter.

The fish fauna includes 8 species and is dominated by Cyprinids, mostly common carp Cyprinus carpio, roach Rutilus rutilus, bream Abramis brama and barbel Barbus callensis which is the only native fish species. Pikeperch were sampled with gillnets (bar mesh sizes of 18, 25, 35, 45, 55, and 65 mm; length 200 m; height 4–6 m). Nets were set in the evening (between 16:00 and 18:00) and lifted the following morning, with a fishing period of approximately 14 hours. Diet was studied monthly from September 2020 to August 2021. A total of 434 pikeperch caught at four selected sampling sites were examined. Their lengths varied from 12.8–79.0 cm and their weights ranged from 38–4600 g.

In the laboratory, the total length of each fish was measured to the closest mm (TL) and was weighted to the nearest g (W). Stomachs were taken from fresh fish and preserved in a solution of 5% formalin. Each stomach was dissected, and prey items were sorted, weighed to the nearest g, identified to the lowest possible taxonomic level using the identification keys of references (Elliot et al. 1996), and counted using the naked eye or under binocular magnifier. When a prey item was largely digested, pharyngeal teeth (cyprinids), opercula bones, vertebrae, scales, and the position of the eyes and mouth were used for identification. Unrecognizable elements were classified as "diverse" group. Unidentified food items were not used in the calculations.

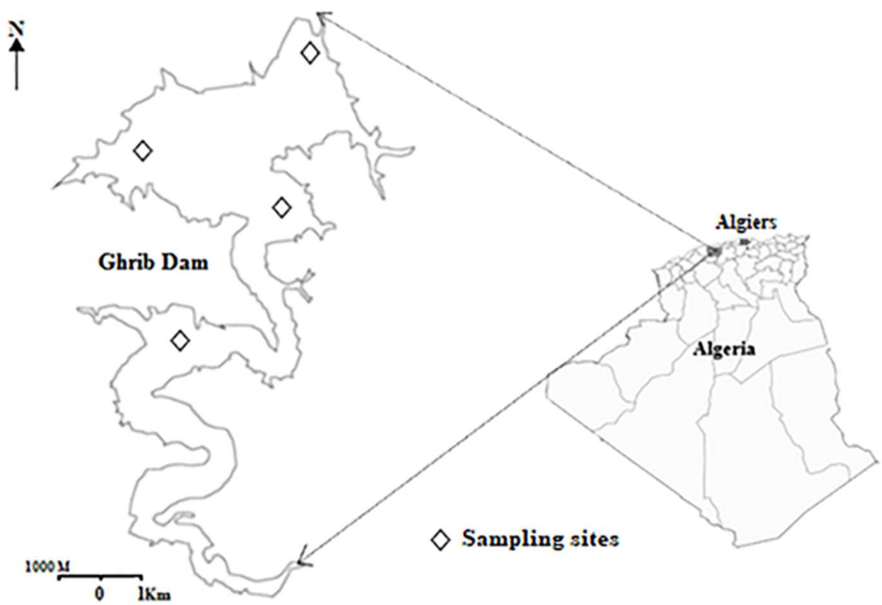

Figure 1. Sampling sites of the pikeperch Sander lucioperca in the reservoir of Ghrib dam northwest of Algeria

Statistical analyses

The quantitative analysis of the diet is to calculate the coefficient of digestive vacuity (Cv) for each season. This is the percentage of empty stomachs, compared with the total number of examined stomachs. Significant changes in digestive vacuity depending on seasons were evaluated by the X^2 test using R software (2010).

Prey were classified using three methods (numerical, gravimetric, and frequency of occurrence) to calculate the index of relative importance (IRI) as described by Pinkas et al. (1971) and modified by Hacunda (1981). This blended index has the advantage of integrating in its expression the three main descriptors of prey: the numerical percentage Cn (%), weight percentage Cp (%) and the

$$IRI = F_i * (Cn_i + Cp_i), \text{ with:}$$

F_i (%) = frequency of prey

$$= \frac{\text{Nuber of stomach containing prey i or Ni}}{\textit{Number of full stomach examined}} \times 100$$

Cn_i (%) = numerical percentage of prey

$$= \frac{\text{Number of individuals of prey i or ni}}{\textit{Total number of prey}} \times 100$$

Cp_i (%) = weight percentage of prey

$$= \frac{\text{Total weight of prey i or pi}}{\textit{Total weight of prey}} \times 100$$

To better appreciate the taxonomic proportions ingested by this predator, these values were converted to percentages of relative index (%IRI) (Rosecchi and Nouaze 1987), then the preys were ordered in descending order of their contribution to the diet.

$$\%IRI = (IRI / \Sigma\ IRI) \times 100$$

In this order, the percentage of relative index of the first food was added progressively until obtaining 50% or more. These items were called preferential foods. The calculation was continued until obtaining 75% or more and these items were classified as secondary foods. Other items on the list were considered accidental or accessory food.

The composition and variations in the diet of S. lucioperca were also compared according to size (small: $10 < TL < 25$ cm, medium: $25 < TL < 40$ cm, large > 40 cm TL) and seasons. The statistical significance of these modifications was evaluated by the Spearman Correlation coefficient (Fritz 1974), applied to the ranking occupied by the various prey.

$$rho = 1.0 - \frac{(6\sum d^2)}{(n^3 - n)}\ , \text{ with:}$$

n, number of ingested items, d, difference between ranks.

The preys were classified in the descending order of index to obtain two sorted series. The rank of the number must be identical in both samples, so that one of the taxa categories does not occur in any of the patterns, it will always be awarded. If the percentage of relative importance index .is identical within the taxonomic series, we assign each item to a common rank, which will be the average of the ranks that prey would have if there was no tie. Statistical significance is known through the distribution of Student's t at n-2 degrees of freedom (Dagnelie 1975):

$$t = \left[\frac{p}{(1-p^2)^{\frac{1}{2}}}\right] * (n-2)^{1/2}$$

RESULTS

A total of 434 stomachs were examined. Of these, 193 were empty, corresponding to an average annual vacuity of 44.47%.

Table 1 reports the overall results of the qualitative and quantitative analysis of prey ingested by pikeperch collected from the reservoir of Ghrib dam. The primary food categories for S. lucioperca were identified as Teleosts, Dipterans and Amphipods. The teleosts included Cyprinids (Cyprinus carpio, Rutilus rutilus) and Percids (Sander lucioperca), Dipterans are represented by Chironomus sp. (larvae or pupae) and Amphipods are represented by Gammarus sp.

Table 1. Qualitative and quantitative composition of the diet of the Sander lucioperca in the reservoir of Ghrib dam

		F %	Cn %	Cp %	IRI	IRI %
Teleost						
Cyprinids	*Cyprinus carpio*	2.49	1.22	3.18	10.97	0,14
	Rutilus rutilus	57.26	52.80	59.57	6434.18	80,20
Percid	*Sander lucioperca*	19.50	19.93	21.62	810.25	10,10
Dipteran	*Chironomus* sp	23.65	17.48	9.15	629.99	7,85
Amphipodan	*Gammarus* sp	9.13	8.57	6.48	137.35	1,71

Total						
	Teleost	79,25	73.95	84.37	12547.18	94.24
	Dipteran	23,65	17.48	9.15	629.99	4.73
	Amphipodan	9,13	8.57	6.48	137.35	1.03

N=434. Fi%, prey frequency; Cni%, prey numeric percentage; Cpi%, prey weighting percentage; IRI, importance relative index; %IRI, percentage of relative importance index.

Prey fish were found in the stomachs of 241 pikeperch (F = 79.25%, Cn = 73.95%), represented by Rutilus rutilus, Sander lucioperca and Cyprinus carpio (Table 1). The highest frequency of occurrence was seen in R. rutilus (57.26%), followed by S. lucioperca (19.50%) and C. carpio (2.49%). Dipterans were represented mainly by Chironomus sp. (F = 23.65%, Cn = 17.48%). Amphipodan consisted primarily of Gammarus sp. (F = 9.13%, Cn = 8.57%).

Prey fish species were the most frequently ingested prey, comprising 84.37% by weight. According to weight, the dominant prey fish was R. rutilus (Cp = 59.57%), followed by S. lucioperca (Cp = 21.26%) and C. carpio (Cp = 10.97%). Rutilus rutilus was an important component of the pikeperch diet, in frequency, numerically, and weight.

According to IRI values, prey fish (IRI = 94.24%) have a greater importance in the diet of pikeperch than prey Dipteran (IRI = 4.73%). Amphipods are consumed in negligible quantities (IRI = 1.03%). The Roach was the most important prey fish for pikeperch in the reservoir of Ghrib dam (IRI = 80.2%), while pikeperch, Chironomus sp., carp, and Gammarids were of secondary importance (IRI = 10.10%, 7.85%, 1.71%, 0.14% respectively).

Seasonal variation of diet composition

Variations in digestive vacuity as a function of season are presented in Table 2. Digestive vacuity is highest in summer (Cv = 50.00%) and lowest in winter (Cv = 39.33%). No significant difference was observed according to seasons (X^2Spring/Summer = 0.37; X^2Summer/Autumn = 0.1.82; X^2Autumn/Winter = 0.10; X^2Winter/Spring = 0.88; $P \geq 0.05$).

Seasonal variation was seen in the pikeperch food composition (Table 2). Prey fish species were predominant during all seasons. In autumn and winter, the variety of prey was lower than that in the other seasons. In autumn, prey fish species represented by R. rutilus and congeners S. lucioperca were observed in 98.95% of stomachs. Rutilus rutilus was the most important prey (F = 71.01%, Cn = 86.24%, Cp = 91.29%). Similarly, pikeperch accidentally consume Chironomus sp. (F = 15.94%, Cn = 5.50%, Cp = 4.36%) during the autumn months.

These feeding habits continue until winter, although R. rutilus remains the most important prey species in the winter months (F = 66.67%, Cn = 89.01%, Cp = 93.73%). In the winter months, the presence of Gammarus sp. in the diet (F = 5.56%, Cn = 10.99%, Cp = 6.27%) and the loss of Chironomus sp. was observed.

In the spring, R. rutilus remains the primary prey fish species (F = 40.00%, Cn = 44.13%, Cp = 24.41%). Chironomus also is an important component of the diet during spring (F = 45.00%), despite its proportion was small in terms of number and weight (Cn = 34.64%, Cp = 20.81% respectively). Sander lucioperca and Gammarus sp. were also important prey during this season.

The three principal descriptors (F, Cn, and Cp) of the prey fishes' category increase from spring to summer. During the summer, the most important prey species is S. lucioperca (F = 51.72%, Cn = 40.93%, and Cp = 45.83%). Rutilus rutilus and Chironomus sp. were also important prey (F = 50.00%, Cn = 24.87%, and Cp = 21.77% for S. lucioperca; F = 32.76%, Cn = 16.58%, and Cp = 14.47% for Chironomus sp.). Cyprinus carpio and Gammarus sp. were also observed in the stomach contents during this season.

According to the seasonal index of relative importance (IRI), R. rutilus is the most important prey during spring, autumn and winter (IRI = 40.14%, 98.07%, and 99.22%, respectively). Rutilus rutilus and Chironomus sp. are also important prey during spring (IRI = 36.53%). Congeners are the primary diet of the pikeperch in summer, followed by R. rutilus (IRI = 54.93% and 28.55%, respectively).

Cyprinus carpio and Gammarus sp. are encountered intermittently during the four seasons. Seasonal comparison of Spearman correlation coefficients on prey rank shows heterogeneity between all seasons (Figure 2).

Table 2. Variations in percentage of index of relative importance of the main items ingested by pikeperch in the reservoir of Ghrib dam according to the seasons.

		Autumn N=118 CV%= 45.95				**Winter N=89 CV%=39.33**				**Spring N=111 CV%=41.53**				**Summer N=116 CV%=50.0**			
		Fi %	**Cni%**	**Cpi%**	**IRI %**	**Fi %**	**Cni%**	**Cpi%**	**IRI %**	**Fi %**	**Cni%**	**Cpi%**	**IRI %**	**Fi %**	**Cni%**	**Cpi%**	**IRI %**
Teleosts	*Cyprinus carpio*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.34	3.63	11.28	1.89
	Rutilus rutilus	71.01	86.24	91.29	98.07	66.67	89.01	93.73	99.22	40.00	44.13	24.41	40.14	50.00	24.87	21.77	28.55
	Sander lucioperca	7.25	8.26	4.36	0.71	0.00	0.00	0.00	0.00	20.00	14.53	39.74	15.89	51.72	40.93	45.83	54.93
Dipterans	*Chironomus* sp	15.94	5.50	4.36	1.22	0.00	0.00	0.00	0.00	45.00	34.64	20.81	36.53	32.76	16.58	14.47	12.45

Amphipodans	*Gammarus* sp	0.00	0.00	0.00	0.00	5.56	10.99	6.27	0.78	23.33	6.70	15.05	7.43	8.62	13.99	6.65	2.18
Total	Teleosts	78.26	94.50	95.64	98.95	66.67	89.01	93.73	99.22	60.00	58.66	64.15	71.05	112.07	69.43	78.88	95.98
	Dipterans	15.94	5.50	4.36	1.05	0.00	0.00	0.00	0.00	45.00	34.64	20.81	24.06	18.97	12.15	6.79	2.07
	Amphipodans	0.00	0.00	0.00	0.00	5.56	10.99	6.27	0.78	23.33	6.70	15.05	4.89	8.62	17.76	21.32	1.95

N=434. Fi%, prey frequency; Cni%, prey numeric percentage; Cpi%, prey weighting percentage; IRI, importance relative index; %IRI, percentage of relative importance index.

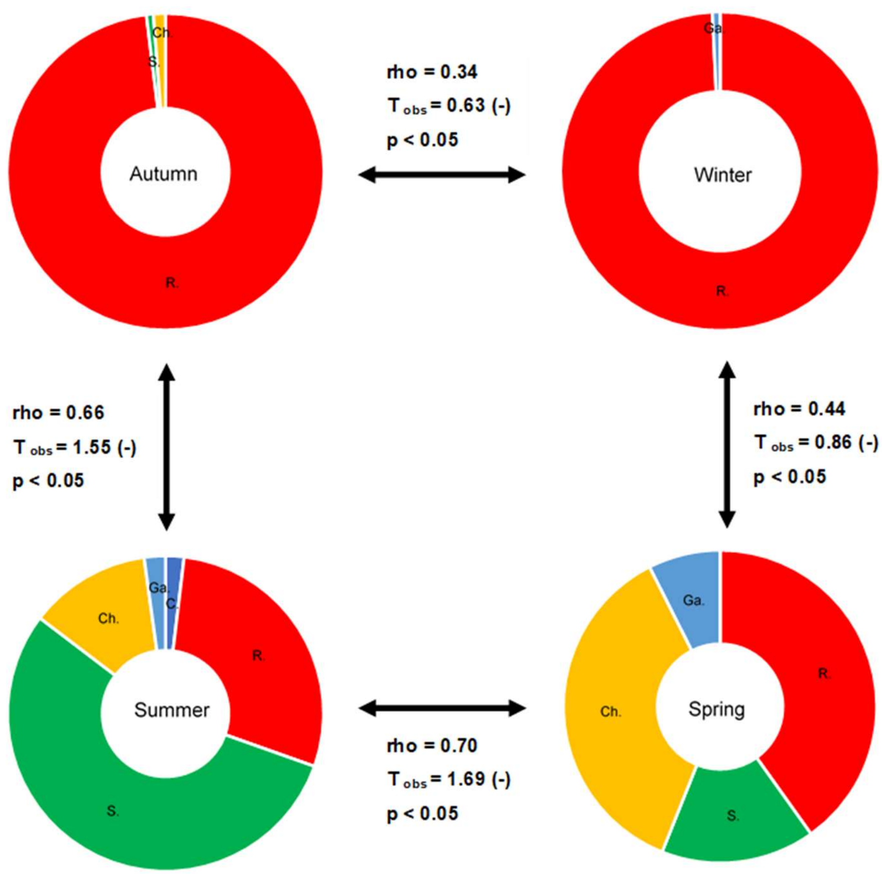

Figure 2. Statistical comparison of the diet of the pikeperch Sander lucioperca of the northwest of Algeria according to seasons. rho: Spearman correlation coefficient. (+: homogeneous diet, -: heterogeneous diet; R.: Rutilus rutilus, Ga.: Gammarus sp, Ch.: Chironomus sp, C.: Cyprinus carpio, S.: Sander lucioperca). Color proportions present the IRI% shown in Table 2.

Diet variation by fish size

Comparing the diets of pikeperch of different size demonstrated variations in prey choice (Table 3). The primary prey fish for small pikeperch, according to the frequency of occurrence (F), was Chironomus sp. (F = 40.43%), followed by R. rutilus, Gammarus sp. and S. lucioperca (F = 31.91%, 21.28%, and 8.51%, respectively). However, the F, Cn and Cp of ingested Chironomus sp. decreases proportionally with the size of the predator (F = 4.17%, Cn = 5.00%, and Cp = 5.77% in medium-sized pikeperch; F = 1.83%, Cn = 2.64%, and Cp = 1.26% in large pikeperch).

With increasing body size, the diet of pikeperch is enriched mainly with R. rutilus, which becomes the most important prey. As the size of pikeperch increased, the F and weight of R. rutilus in its food increased gradually (F = 75.00% and Cp = 61.34% in medium-sized pikeperch; F = 79.82%, Cp = 67.07% in large pikeperch). Large pikeperch also fed on C. carpio (F = 5.50%). According to the ontogenetic index of relative importance (IRI), small specimens focus mainly on Chironomus sp. (IRI = 56.0%) then R. rutilus (IRI = 28.4%), Gammarus sp. (IRI = 13.8%) and S. lucioperca (IRI = 1.8%). Large and medium-sized individuals eat primarily R. rutilus (IRI = 88.2% and 86.0%, respectively) then S. lucioperca (IRI = 8.9% and 13.0%, respectively), Gammarus sp. (IRI = 2.4% and 0.5%, respectively), and Chironomus sp. (IRI = 0.4% and 0.1%, respectively).

Table 3. Variations in percentage of index of relative importance of the main items ingested by pikeperch in the reservoir of Ghrib dam according to the size.

		Small N=72				**Medium N=121**				**Large N=241**			
		Fi %	**Cni %**	**Cpi %**	**IRI %**	**Fi %**	**Cni %**	**Cpi %**	**IRI %**	**Fi%**	**Cni %**	**Cpi %**	**IRI %**
Teleosts	*Cyprinus carpio*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.50	2.31	5.30	0.35
	Rutilus rutilus	31.91	24.83	31.97	28.42	75.00	65.00	61.34	88.21	79.82	61.72	67.07	86.04
	Sander lucioperca	8.51	4.70	8.85	1.81	22.92	15.83	26.02	8.93	29.36	29.04	24.02	13.04
Dipterans	*Chironomus sp,*	40.43	50.34	38.07	56.02	4.17	5.00	5.77	0.42	1.83	2.64	1.26	0.06
Amphipodans	*Gammarus sp,*	21.28	20.13	21.11	13.75	12.50	14.17	6.87	2.45	9.17	4.29	2.34	0.51
	Teleosts	40.43	29.53	40.82	**38.98**	97.92	80.83	87.36	**98.17**	114.68	93.07	96.40	**99.69**
Total	**Dipterans**	40.43	50.34	38.07	**48.99**	4.17	5.00	5.77	**0.27**	1.83	2.64	1.26	**0.03**
	Amphipodans	21.28	20.13	21.11	**12.03**	12.50	14.17	6.87	**1.57**	9.17	4.29	2.34	**0.28**

N=434. Fi%, prey frequency; Cni%, prey numeric percentage; Cpi%, prey weighting percentage; IRI, importance relative index; %IRI, percentage of relative importance index

Cyprinus carpio (%IRI = 8.75) was also consumed by large size classes (IRI = 0.4%). Cannibalism was observed almost in all length groups of pikeperch (Table 3).

Statistical comparison of the diet based on the three categories of size shows that it is heterogeneous for the two pairings: small/medium and small/large, which implies that the diet of small fish is different from those of medium and large pikeperch (Figure 3).

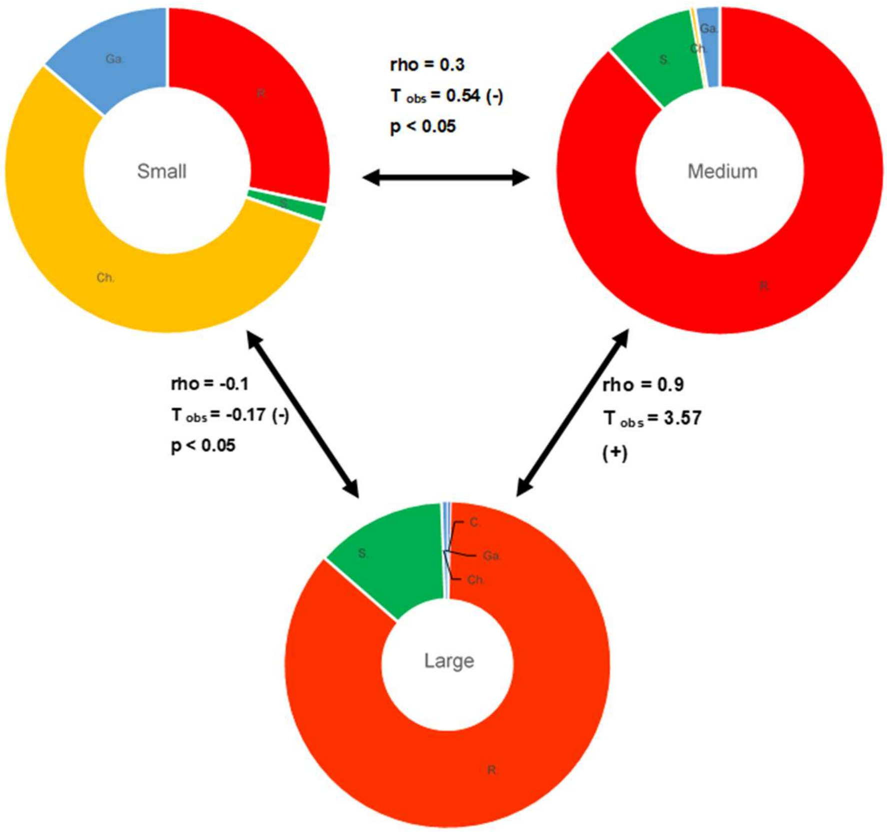

Figure 3. Statistical comparison of the diet of the pikeperch Sander lucioperca of the northwest of Algeria according to size. rho: Spearman correlation coefficient (+: homogeneous diet, -: heterogeneous diet; R.: Rutilus rutilus, Ga.: Gammarus sp, Ch.: Chironomus sp, C.: Cyprinus carpio, S.: Sander lucioperca). Color proportions present the IRI% shown in Table 3

DISCUSSION

The piscivorous habits of pikeperch have been demonstrated in a variety of studies (Kangur and Kangur 1998; Kahilainen and Lehtonen 2003), however their prey species composition varies in different areas. The general composition of the diet in the present study shows that the pikeperch has a broad food spectrum and diet varies with season and fish size. It is composed of R. rutilus (F = 57.26%), Chironomus sp. (F = 23.65%), S. lucioperca (F = 19.50%), Gammarus sp. (F = 9.13%) and C. carpio (F = 2.49%).

Full stomachs were observed in 55.5% of specimens, while 44.5% had empty stomachs. The percentage of full stomachs has previously been observed to vary between 51–77% in pikeperch populations (Balık et al. 2006; Kangur et al. 2007). Variations in the digestive vacuity of pikeperch provide evidence for a feeding seasonal rhythm. The preferential feeding periods are winter (Cv = 39.3%) and spring (Cv = 41.5%), consistent with the works of Goubier (1976). Özyurt et al. (2012) have also suggested that pikeperch feeding is very intense before reproduction (during October). In Yılmaz and Ablak's research (2003) in Hirfanli Dam Lake: Gammarus, Diptera (Chironomus larvae and pupae), fish (Sander lucioperca, Tinca tinca, Alburnus orontis), fish remains, Odonata nymphs, organism remains, Mysis, Isopoda and fibrous algae were discovered in the stomach contents of the S. lucioperca. Campbell (1992) reported that the diet of pikeperch consisted of mysids, gammarids, isopods and fish.

According to the values of the index IRI, an analysis of seasonal diet shows that the main food items of pikeperch in spring were R. rutilus (IRI = 40.14%) and Chironomus sp. (IRI = 36.53%), though cannibalism was also observed in this season (IRI = 15.89%). Rutilus rutilus and Chironomus sp. become less important in the summer (IRI = 28.55% and 12.45%, respectively). The summer diet of pikeperch consists primarily of S. lucioperca (IRI = 54.93%). The most popular food organism in autumn and winter was R. rutilus (IRI = 98.07% and 99.22%, respectively).

Popova (1978) has pointed out that pikeperch is piscivorous, with an annual feeding pattern closely linked to the seasonal abundance of food. Pikeperch are opportunistic in their feeding habits. If food items of choice were not present, alternate food sources such as zooplankton, insects, leeches, frogs, crustaceans, and molluscs were consumed. Didenko and Gurbyk (2016) reported that Roach were the most important prey for the pikeperch in spring, perhaps especially during spawning when they aggregate and probably are less cautious, making them more vulnerable to predation.

Pérez-Bote and Roso (2012) also reported changes in the proportion of prey eaten by pikeperch from spring to autumn, showing that hexapods are mainly eaten in spring. Variations in cannibalism rates suggest that the pikeperch eat their own young when only forage fish are scarce (Balik et al. 2006). The fact that cannibalism is common among pikeperch may further indicate the difficulty of finding fish prey (Özyurt et al. 2012). According to Balik et al. (2006) prey fish populations increase in autumn and the importance of invertebrates in the diet decreases during this season. The winter diet of pikeperch consists of only fish and mysids.

A study of the diet according to the individual's length made it possible to highlight variation in prey. Our results showed the importance of dipteran (IRI = 48.99%), teleost (IRI = 38.98%), and amphipodan (IRI = 21.11%) species in the diet of small pikeperch. The stomach contents consisted of roughly equal proportions of invertebrates and fish. Chironomus sp. was the main food in the diet of this length class (IRI = 56.02%) followed by R. rutilus (IRI = 28.42%) and Gammarus sp. (IRI = 13.75%). Steffens (1960) reported that chironomid larvae are one of the most significant live food sources for pikeperch during their first summer. In nature, large crustaceans play an important role in the growth of immature pikeperch and their successful transition to a piscivorous diet. The proportions of Chironomus sp. and Gammarus sp. in the diet of pikeperch in the medium and large length classes were (IRI = 0.42% and 0.06%, respectively, for Chironomus and IRI = 2.42% and 0.51%, respectively, for Gammarus). It is clear from these values that the importance of invertebrates decreases as the size of pikeperch increases. Popova and Sytina (1977) reported that pikeperch may continue feeding on mysids and gammarids up to age two, even while feeding on the young of other fishes, especially if these invertebrates are abundant and prey fish are scarce. Pavlović et al. (2015) also reported that the occurrence of insects and shrimp from Gammaridae in the stomach contents of large pikeperch, which do not typically eat these items, can be explained by remnants of food items consumed by omnivorous fish that were eaten and digested by pikeperch. Fish of bigger sizes (> 25 cm) adopt a diversified diet, comprise of R. rutilus, S. lucioperca, C. carpio, Chironomus sp., and Gammarus sp. The share taken by the R. rutilus becomes important and constitutes the most important prey of the pikeperch in medium and large length classes (IRI= 88.21 and 86.04 respectively). Yağci et al. (2014) determined that the food present in the stomachs of the pikeperches >30 cm in length consists of Odonata larvae, fish and organism remains, Knipowitschia caucasica, Atherina boyeri, Carassius gibelio, Chironomus sp., Gammarus sp., Tinca tinca and Sander lucioperca in Lake Beyşehir.

Cannibalism among pikeperch was found for all length classes (IRI = 1.82% in small pikeperch, IRI = 8.93% in medium pikeperch, and IRI = 13.04 in large pikeperch). This shows that cannibalism increases with increasing size classes. Similar observations were described by Argillier et al. (2003). The intensity of cannibalism can vary because it is strongly coupled to the growth of cannibalistic individuals and to the growth of victim individuals (Persson et al. 2004). Also, some studies have demonstrated that cannibalism is related to the abundance of young-of-year and adult pikeperch (Lappalainen et al. 2006).

CONCLUSIONS

It can be concluded that the primary food items of the pikeperch population in the reservoir of Ghrib dam are Teleosts, Dipterans, and Amphipods. There appears to be intensive cannibalism among the pikeperch, likely because juvenile pikeperch are smaller and more abundant. Diet and feeding features vary with season and fish length.

This study shows that small individual pikeperch feed heavily on Chironomus sp. medium and large pikeperch feed primarily on prey fish (R. rutilus). These results show that the food mode of the pikeperch changes with the age and size, with pikeperch being omnivorous when young and becoming strictly fish-eating with age.

Finally, the results of this study showed that pikeperch do not harm the native ichthyofauna by attacking native fish species such as Barbus callensis that were not encountered in the pikeperch stomach. These data could give us more information on food habits of pikeperch. However, these early results provide a basis of fundamental data for a species of ecological status. Additional information on its sexuality and exploitation would be needed for better management of natural stocks of Sander lucioperca in the Algerian dams.

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