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Trophic Menu of the White Stork Ciconia Ciconia L. 1758 (Aves, Ciconiidae) in the Tebessa Region

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ABSTRACT

The study of diet variation of the white stork Ciconia ciconia, according to the biological cycle in the region of Tébessa is based on the decortication of the rejected pelots. In 2014, during the nesting period of this wader, rejection pelots under the nests in El-Merdja colony were regularly collected. In the study area, the White Stork consumes different ranges of prey, both invertebrate and vertebrate, where Gasteropods, Arachnids, Aves and insects were included. Its diet was different in number and depended on the different phases of the life cycle. During the pre-breeding period, the food of this bird was based on 3 orders of prey: The Orthoptera represented a peak of 39.67%, followed by the Coleoptera 35.53%, and finally the Dermaptera 24.79%. While during the breeding and rearing period, the total consumption of the Order Coleoptera was almost doubled by a maximum peak of 63.51%, the Orthoptera decreased to 8.11%, and the Dermaptera reached a percentage of 25.56% by showing a stability of consumption between the different periods of the biological cycle, as well as 2 new orders which appeared in a very minimal way: The Hymenoptera 0.71%, and the Neuroptera 2.15%. Maximum richness was observed at the young chick rearing period with 24 species, and the Shannon diversity index applied to prey species was high; This explained the high availability of many preys in the field by the need to feed the chicks, while the equitability index values was 0.76 which showed that the numbers of the consumed preys tended to be in equilibrium with each other.

Keywords: *Tebessa, Ciconia ciconia, White Stork, El Merdja, Insects, Diet.*

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1. INTRODUCTION

The White Stork *Ciconia ciconia* has attracted the attention of several authors, due to the role it plays in the ecological balance. It gives an image of the faunistic availability of the frequented biotope. It has been considered a good biological model for understanding the health of ecosystems and their evolution (Schulz, 1999 *in* Zennouche 2002). The species is still relatively abundant, but the decline is evident compared to the 1935 and 1955 censuses of poor wintering conditions (Kanya-Mibwa et al., 1990 and Mullie et al., 1995 *in* Isenmann & Moali, 2000). Other authors have been interested in the diet of the white stork: Schierer (1962) analyzed 24 pelots of regurgitation in Alsace, his research has shown that the stork seeks its food near various crop fields and uncultivated lands, while others have looked at the urban areas and landfills. In Algeria, few scientific works have been devoted to it (Jespersen, 1949; Moali-Grine, 1994; Boukhemza et al., 1995; Boukhemza, 2000; Zennouche, 2002; Fellag, 2006; Sbiki, 2008; Saker, 2010; Boukhtache & Si Bachir, 2010).

This work was mainly devoted to the study of the diet of *Ciconia ciconia*, the frequented types of biotope, the availability of food resources, and the situation of the populations. In order to have a clearer idea about the diet of this species according to its phenological periods, the study of the trophic niche that was approached by the analysis of the diet in the colony of El-Mardja has been implemented based on the analysis of the regurgitation pelots and the variation in time between the composition and the structure of the bolus.

2. MATERIAL AND METHODS

This present study was carried out in the region of El-Merdja, which is located in the north-east part of Tebessa province (35 ° 29 'N, 08 ° 08'E). According to Lambert coordinates, this region is located in the high plains, and is a part of the Mediterranean semi-arid cold winter stage. Studies on the diet of birds have been based on different methods: the analysis of stomach contents, the analysis of rejection pelots in adults or regurgitation in chicks, and the direct observation methods (Saker, 2010). The collection of 40 pelots of *Ciconia ciconia* rejection was carried out during 08 months, from January to August 2014, where 8 pelots were taken during each phase among 05 life cycles of this wader. The regurgitation pelot

analysis method was better for this study because of lighter application in the field (pelots easy to harvest at the nests) and no disturbance to the bird; as well as the presence of the non-digestible parts of the main consumed prey, in particular the arthropodological prey from the chitinous fragments, in the regurgitated pelots. This technique, already used during the study of the feeding of the White Stork, Herons and raptors; has been based on the recognition of indigestible fragments released by these predatory species (Musinic & Razaski, 1992; Boukhemza, 2000; Si Bachir et al., 2001). The different sclerotized pieces were determined by comparing reference collections and using of the keys of Chopard (1943) and Villiers (1978). After processing the results by the quality of the sampling, the exploitation of the obtained results was carried out by ecological indices of composition including: relative abundance (AR %), total richness (S) and mean richness (Sm). Ecological structure indices were represented by Shannon-Weaver diversity, and the equitability was measured by statistical analysis techniques and the statistical methods by corresponding factor analysis. This analysis was carried out by the software Chessel & Doldec (1992).

3. RESULTS

The systematic list of prey species in the diet of the white stork *Ciconia ciconia* in the Tebessa province showed a large variety of both invertebrate and vertebrate prey. In this food spectrum, there was a total of 31 families, 10 orders and 4 classes: Arachnids, Insects, Gastropods and Aves. The calculation of centesimal frequencies focused first on the different zoological classes. The number of prey species identified in the pelots was 1387 individuals, showing a very high percentage of 97.27% for insects, 1.01% for Arachnids, 1.44% for Aves, and 0.28% for gastropods which were very occasionally consumed (Table 1). Therefore, the calculation was focused only on insects. The total number of captured insects taken into account was 1349 individuals. Figure 01 shows that during the pre-breeding period, all the insects consumed were distributed in 3 Orders: Orthoptera presented a peak in the graph above by a percentage of 39.67%, followed by Coleoptera 35.53% and Dermaptera 24.79%.

During the breeding and rearing period of chicks, the order of Coleoptera was mainly consumed with a percentage of 63.51%, followed by Dermaptères with a percentage of 25.56%, Orthoptera with a percentage of 8.11 %, the Neurotics with a percentage of 2.11% and Hymenoptera with a percentage of 0.71%. From a total of 1349 prey insects identified in the diet of *Ciconia ciconia*, 25 families of insects were recorded, of them, 15 were regularly introduced in each life cycle period.

Table 1. Centesimal frequencies applied to the different orders of prey-insects captured by *Ciconia ciconia* in 2014 in El-Merdja

Preys	effectives	Relative abundance (%)
Arachnida	14	01.01
Insecta	1349	97.27
Gastéropoda	04	00.28
Aves	20	01.44
Total	1387	100

On the other hand, some of the remaining 10 families had a strong predominance. Figure 02 illustrates these families according to the two periods of the biological cycle.

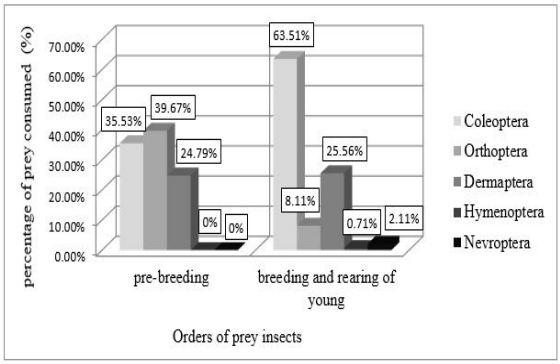

Figure 1. The orders of prey insects identified in the diet of the White Stork in the El-Merdja region according to the life cycle

During the breeding season, a maximum diversity of prey components of the diet of the white stork was mentioned with a very remarkable peak of the Coleoptera. Absolute dominance of Carcinophoridae families was noted with 24.34%, Carabidae with 18.25%, Scarabiedae with 18.25% and Tenebrionidae with 12.88% (Figure 2). During the pre-breeding period, the Acrididiae family was consumed in a high rate compared to previous families with a significance of 30.02% followed by Carcinophoridae with 24.80%, Scarabidae with 14.60%. The other families were lowly consumed where Melolontidae family was represented by 1 individual during this period (0.27%).

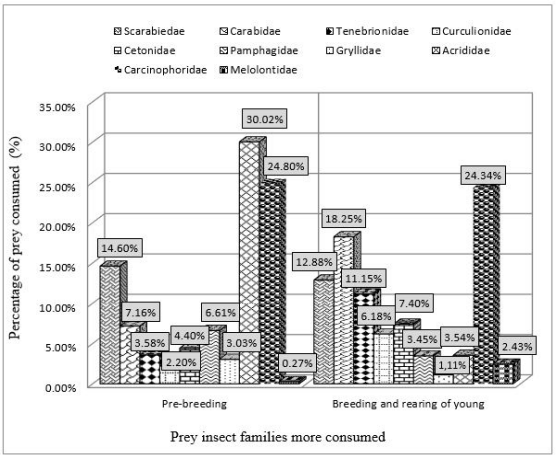

Figure 2. The most important families of prey insects identified in the white stork diet of the El-Merdja region during the study period

To characterize the prey diversity consumed by White Stork, the calculation of the ecological parameters has been mentioned in Table 2. According to the ecological techniques, the value of the diversity index of Shannon index remained high, it was of the order of 3.47 bits. The equitability applied to the prey caught during the same period was quite strong since it reached 0.76.

Table 2. Monthly variation of the diversity parameters of the diet composition of White Stork.

	Pre-breeding	Breeding	Incubation	Chick rearing	flying
Total richness (S)	16	11	17	24	19
Mean richness (Sm)	08	5.5	17	12	9.5
Shannon index (H')	2.7	2.76	3.47	3.47	3.26
Equitability index (*E*)	0.68	0.79	0.67	0.76	0.75

The contribution of all species for the construction of axis 1 was 46%, and 21% for axis 2. The sum of the contributions was 67% for axes 1 and 2. Thus, the plan formed by Axes 1 and 2 contained all the information needed to interpret the results. The spatial distribution of the families involved in the pelots of the regurgitations of these birds in the factorial plane 1-2 showed the existence of 4 clouds of points (Figure 3).

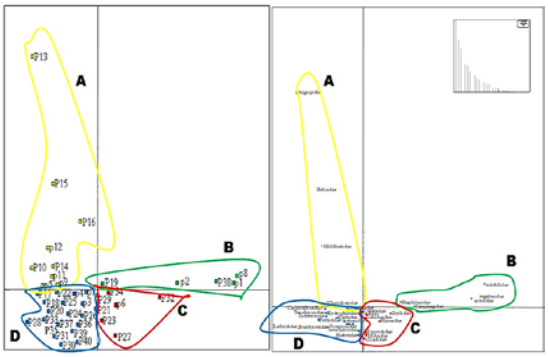

Figure 3. Factorial correspondence analysis (A.F.C) applied to the elements presented in the *Ciconia ciconia* pelots in the El-Merdja region. A: distribution of *Ciconia ciconia* pelots in the EL-Merdja region. B: distrubution of the families of prey insects found in the pelots of *Ciconia ciconia*.

4. DISCUSSION AND CONCLUSION

According to Jakub et al (2006), the White Stork is an opportunist in terms of its food because it uses the resources that are most readily available, a notion proven by the observations made in different types of habitat. From a batch of 40 pelots, the insects were 97,27%. These results confirmed those obtained by the various researches which have been carried out previously; whether in Algeria or elsewhere, and confirmed that *C. ciconia* is an *Entomophagous* predatory wader (Schierer, 1962; Lazaro, 1986; Lazaro & Fernandez, 1991; Pinowska & Pinowski, 1989; Pinowski et al., 1991). In Algeria, these results were similar with those obtained by Sbiki (2008), in which 98.9% of the insects found in the same region of this study and in neighboring areas. In Tizi-Ouzou, the works noted by Boukhemza et al (1995) and Boukhemza (2000) respectively mentioned rates of (94 % and 92.77 %). Saker (2010) in Annaba and El Tarf provinces mentioned (90.45 % and 96.4 %). And finally Boukhtache & Si Bachir (2010) in Batna reported a rate of 99.23%. While the total number of preys consumed in Poland, mentioned 83% of insects (Antczak et al., 2002). In the Tebessa region, the proportion of vertebrates included in the diet of the White Stork was 1.44 % in terms of abundance in numbers, whereas it was more important as a yield by taking the first place, however, the dominance represented by insects as captured prey (Table 1) accounted for only a small part of the consumed biomass, ranking second as a yield. It was found that prey potentially was consumed during the breeding and rearing period of the young (Figure 1); Beetles, rarely were eaten during the pre-breeding period as a result of climatic factors that occurred as a result of the drop in average temperature and rainfall, so most insects hid or entered cryptic diapause (Doumandji et al., 1993). So this result corresponded to that obtained by Sbiki (2008) in Tébessa and Boukhemza (2000) in Tizi-Ouzou and Saker (2010) in Annaba-Tarf and Boukhtache & Si Bachir (2010) in Batna.

Secondly, Orthoptera dominated during the pre-reproduction period, so these two orders were negatively correlated, that is to say when the Coleoptera increased, the Orthoptera decreased and *vice-versa*, this increase was due to the availability of these orders. The importance of Coleoptera and Orthoptera in the diet of the Stork has also been reported by several authors in Europe (Schierer, 1962 in France, Skov, 1991 in Denmark, Musinic & Rasajski, 1992 in the Balkans). Thirdly, Dermaptera were fairly noted in the diet with almost the same 25.56% representation during both life cycle periods. Neuroptera represented a percentage of 2.10 % of all the insects ingested by the white stork during the breeding and rearing period of the chicks (Figure 1), similar results were found in the Saker (2010) during the same periods. While the studies carried out by Boukhemza et al. (1995) and Sbiki (2008) showed the total absence of the Neuroptera. Moreover, Barbraud & Barbraud (1997) noted that the majority of the detailed studies carried out in Europe indicated that the White Stork is an essentially insectivorous bird during the reproduction period. This work has identified 18 families of the order Coleoptera, of which, 10 had a clear dominance, which are as follows: Carabidae 18.25%, Scarabidae 12.25%, Tenebrionidae 11.15%, Cetonidae 7.40% and Melolontidae 2.43%, during the period of breeding and rearing young. These results confirmed several others highlighted by various authors, particularly in Algeria including Boukhemza (2000) and Zennouche (2002), who noted the absence of Melolontidae, where the latter was replaced by Dermestidae, while Batna Boukhtache & Si Bachir (2010) was able to report the importance of Carabidae (4.38%) Scarabaeidae (12.10%), Tenebrionidae (5.43%), Silphidae (6.65%), and Harpalidae (4.46%). This suggested that Coleoptera were best represented in species in the environments. So, it is possible to say that it was at the beginning of the season and even in winter, that the storks commonly plowed land. An important fauna of *Coprophagous* beetles and scavengers was also sought (Carabidaie, Tenebrionidae, Dermestidae), which made it possible to say that there was an ethological coincidence between Ardea ibis and its prey (Setbel et al., 2004), this species share the same land plowed by *Ciconia ciconia*. For the order Orthoptera, 4 families were observed, the most dominant of which was Acrididae (30.02%) and Gryllidae (3.03%) during the pre-breeding phase. The highest consumption of the locust was in pre-breeding, which coincided with the results of Doumandji et al (1992, 1993). As

well, the studies of Bentamer et al., (1996) and Salmi et al (2002) indicated a dominance of Acrididae in December. The hatching was in spring. The larvae of the first three stages were too small and could escape the beak. In May, as soon as the fifth larval stage arrived for some species, and the Orthopteran catches by the Guardian Herons increased (Setbel et al., 2004), that was the last breeding species with the White Stork. The work of Boukhtache & Si Bachir (2010) represented the rates of two unidentified groups. Within the Dermaptera order, a presence of the family Carcinophoridae with a nearly similar dominance in both periods of the life cycle was observed with percentages of 24.80% at pre-reproduction, and 24.34% at the time of breeding and rearing of chicks. Whereas in Batna Boukhtache & Si Bachir (2010), it was reported that there was essentially the family of Labiduridae (6,86%), where these rates were decreased during the period of pre-reproduction of biological cycle. The variations and differences observed can be explained by the differences between the hunting biotopes and the considered localities, which did not have the same diversity and abundance of the small fauna. Another reason was the climate change from one region to another, and from one month to another. The highest total wealth was noted at the chick rearing period. The diversity index of Shannon index explained that this increase in diversity was due to the need for food by Storks, it would be normal during breeding period that these birds attack anything that moves as an insect or other, to feed their offspring.

Evenness values that were close enough to unit reflected that prey populations of the White Stork were in equilibrium, the composition of their diet was also well-balanced, and the numbers of the consumed preys tended to be in equilibrium. The spatial distribution in the factorial plane (1-2) of the species involving the pelots of white stork regurgitations based on the direct observations showed the existence of 4 clouds of points A, B, C and D (Figure 3). Groups A, B, C, and D including consumed species as follows:

- Group A: The most consumed species during the breeding period ex was: "Curculionidae", and the species present only during the breeding period ex were: "Argiopidae and Helicidae".
- Group B: It collected species that were consumed during the pre-breeding period ex: "Acrididae"
- Group C: It included species that were least consumed during the period of rearing of young ex: "Meloide".
- Group D: It collected the most consumed species during the periods of incubation, youth rearing, and fledging ex: "Carcinophoridae and Scarabiedae".

Finally, to give a more accurate picture of the qualitative composition of the diet of the species, this work deserves to be refined by the search for food inputs in terms of biomass and energy.

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Conflict of interest

No conflict of interest was disclosed in this study.

REFERENCES

1. Antczak M, Konwerski S, Grobelny S, Tryjanowski P (2002). The Food Composition of Immature and Non-Breeding White Storks in Poland. Waterbirds 25 (4): 224-228.
2. Barbraud C, Barbraud J.C (1997) The diet of white stork chicks Ciconia ciconia, Charente-Maritime: Importance of insects. Alauda 65, no. 3, p. 259-262.
3. Bentamer N, Doumandji S, Boukhemza M, Fellag M (1996) Study of the diet of the white stork Ciconia ciconia (Aves, Ciconidae) in the region of Tizi Ouzou. 2nd Ornithology Day, March 19, 1996, Dep. Zool. Agro. for. Inst. Nat. Agro., El-Harrach, p. 61.
4. Boukhemza M (2000) Bio-ecological study of White Stork (Ciconia ciconia L. 1775) and Cattle Egret (Bubulcus ibis L. 1775) in Kabylia: Demographic and Ethological Analysis and Interpretation of Trophic Strategies. PhD Thesis, Inst. Nat. Agro., El Harrach. (Algiers), 188 p.
5. Boukhemza M, Righi M, Doumandji S, Hamdine W (1995) The diet of the white stork Ciconia ciconia in a region of Kabylie (Algeria). Alauda, 63: 199-207
6. Boukhtache N, Si Bachir A (2010) Variation of the diet of the White Stork Ciconia ciconia L. 1758 (Aves, Ciconiidae) in two localities in the region of Acts of the International Seminar on Fauna Biodiversity in Arid and Semi-Arid Zones. 30-36 p.
7. Chessel D, Doldec S (1992) ADE software. Multivariate analysis and graphical display for environmental date (version 4) University of Lyon, p 121.
8. Chopard L (1943) Wildlife of the French Empire. Orthopteroids of North Africa. Ed. Librairie Larose, Paris, 450 p.
9. Doumandji S, Doumandji-Mitiche B, Hamadache A (1992) Place of Orthoptera in an agricultural environment in the diet of the Cattle Egret Bubulcus ibis Linné at Drâa-El-Mizan in Grande Kabylie (Algeria). Med. Fac. Landbouww. Univ. Gent., (57 / 3a): 675-678.
10. Doumandji S, Harizia A, Doumandji-Mitiche B, Aït Mouloud S.K, (1993) Diet of the Cattle Egret Bubulcus ibis (L.) in an agricultural environment in the region of Chlef (Algeria). Med. Fac.Landbouww. Univ. Gent., (58 / 2a): 365-372.
11. Fellag M (2006) Trophic ecology of the white stork (Ciconia ciconia Linne 1758) chicks in the Sébaou valley in Kabylie (Algeria). Thesis Magister, Science of Agronomy, National Institute of Agronomy, El Harrache, p.187.
12. Isenmann P, Moali A (2000) Birds of Algeria, Birds of Algeria. S.E.O.F. (Society of Ornithological Studies of France), Paris. 336 pp.
13. Jakub Z, Kosicki L, Profus P, Pawel T, Dolata, Marcin T (2006) Food composition and energy demand of the White Stork Ciconia ciconia breeding population. Literature survey and preliminary results from Poland ». The White Stork in Poland: studies in biology, ecology and conservation. p. 169-183.

14. Jespersen P (1949) On the dates of arrival and departure of the White Stork (Ciconia ciconia L.) in Algeria. Bull. Soc. His. Nat. from Afr. North, 40 (5-6), p.138-159.
15. Lazaro E (1986) Contribution to the nutritional biology of the white stork in Spain. Beith. Publ. Lands. Bad. -Württ, 43: 235-242.
16. Lazaro M.E, Fernandez B.V (1991) The feeding of the white Cigüeña in Spain. Influence of ciertos parámetros in su alimentary conducta. In: Mériaux J.L. & al. (Eds.), Proceedings of the International Colloquium, The Storks of Europe. European Institute of Ecology / Multidisciplinary Association of Environmental Biologists, Metz (France), pp. 37
17. Moali-Grine N (1994) Ecology and population biology of the white stork Ciconia ciconia in Algeria: population, distribution and reproduction. Thesis of Magisterium, University of Tizi-Ouzou, 78 p.
18. Musinic J, Rasajski J (1992) On food and feeding habits of the White stork, Ciconia ciconia, in the central Balkans.Ökol. Vögel (Ecol. Birds), 14, p. 211-223.
19. Pinowska B, Pinowski J (1989) Feeding ecology and diet of the White Stork Ciconia ciconia in Poland. In: Rheinwald G.J, Ogden H. (Hrsg.), Weiβstorch. Proc. I. Int. Stork Conserv. Sympo. Schriflenreihe des DDA, 10: 381-396.
20. Pinowski V.J, Pinowska B, De Graaf R, Visser J, Dziurdzik B (1991) Influence of feeding habitat on prey capture rate and diet composition of White Stork Ciconia ciconia (L.). Studia naturae – Seria A, 37: 59-58.
21. Saker H (2010) Trophic and behavioral ecology of the white stork Ciconia ciconia nesting in northeastern Algeria. Magister Thesis, University of Annaba, 59 pp.
22. Salmi R, Doumandji S, Si Bachir A (2002) Variations in the diet of the Cattail Heron (Bubulcus ibis) in the region of Bejaia. 6th Ornitholigie Day, March 11, 2002, Dep. Zool. Agro. for. Inst. Nat. Agro., El Harrach, p. 32.
23. Sbiki M (2008) Contribution to the comparative study of the trophic niches of two waders in the Tebessa region: The White Stork (Ciconia ciconia) and the Cattle Egret (Ardea ibis). Same. Magister, Uni. Tebessa, 193 p.
24. Schierer A (1962) 23. Schierer A (1962) On the diet of the white stork (Ciconia ciconia) in Alsace. (First contribution: analysis of 24 balls of rejection). Bird and R.F.O., 32 (3/4), p. 265-268.
25. Setbel S, Doumandji S, Boukhemza M (2004 (Contribution to the study of the diet of the Barn Heron Bubulcus ibis in a new nesting site in Boudouaou. Alauda 72 (3), 2004: 193-200.
26. Si Bachir A, Hafner H, Touren Q.J.N, Doumindj S.E, Lek S (2001) Diet of the adult Cattle egret (Bubulcus ibis L.) in a new North African colony (Petite Kabylie, Algérie): taxonomic composition and variability. Ardeola 48 (2): 217-223.
27. Skov H (1991) The ecology of the white stork (Ciconia ciconia) in Denmark. In Meriaux J.L. et al (eds), Proceedings of the international conference, The storks of Europe. European Institute of Ecology / Multidisciplinary Association of Environmental Biologists, Metz (France), pp. 33-36.
28. Villiers A (1978) Fauna of Coleoptera of France - Cerambycidae. Lechevalier, Paris, 611 p.
29. Zennouche O (2002) Contribution to the bioecology of the white stork Ciconia ciconia L. 1775 in the region of Bejaia. Thesis Magister, Bio. Con. Ecodevelopment, Uni. Bejaia, 100 p.