

## Diet variability in the White Stork *Ciconia ciconia* in eastern Algeria

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The diet of the White Stork *Ciconia ciconia* was studied at El Merdja, Algeria, from 1997 to 1999 and in 2007 by analysing 240 regurgitated pellets. A total of 12 234 prey types were identified and classified into six categories. Insects dominated during each month and year of the study. Three orders of insects were mainly consumed. Coleoptera species were the most frequently consumed prey during all months and years, followed by Dermaptera species, except in 1998 when Orthoptera were more frequent. The frequency of families of prey insects varied considerably depending on the year: Carabidae were dominant in 2007, Tenebrionidae in 1999 and Carcinophoridae in 1997.

**Keywords:** diet, East Algeria, Tebessa, White Stork

Several studies have shown that the White Stork *Ciconia ciconia* feeds on a great variety of prey types (Cramp and Simmons 1977; del Hoyo et al. 1992). Although some studies identified geographical and seasonal variability in the diet of the White Stork, very few have investigated the between-year variability in diet. Interannual changes in diet were reported at several wintering and breeding localities linked to White Storks feeding on rubbish dumps (e.g. Tortosa et al. 2002; Massemin-Challet et al. 2006; Djerdali et al. 2008; Kruszyk and Ciach 2009; Ciach and Kruszyk 2010), but the interannual diet variability at breeding colonies remains poorly known.

The main objective of this study was to quantify the seasonal and interannual changes that occur in the diet of a White Stork population breeding in the area of El-Merdja, eastern Algeria, located in the extreme south of the species' Palaearctic breeding distribution.

The study area was situated at El-Merdja (35°24'47" N, 8°07'56" E) in the department of Tebessa. The area hosts several foraging habitats for White Storks. In uncultivated areas, vegetation mainly consists of Boraginaceae (*Borago officinalis*), Graminae (*Hordeum* sp.), Umbelliferae (*Daucus carota*) and Compositae (*Carlina* sp.). The cultivated areas are of crop-rotation type with wheat, maize and market gardening. The study area is semi-arid with cold winters and is characterised by a dry period from May to October and a humid period from November to April.

Diet was studied in a White Stork colony of about 50 nests situated in white poplar *Populus alba* and mulberry *Morus nigra* trees. Pellets were collected in 1997, 1998, 1999 and 2007 during regular visits to the colony from February (first occupation of nests) to July (fledging of the chicks and departure from the colony; Sbiki 2008). At

each visit, pellets were collected under the trees supporting nests. After each visit all remaining pellets were removed from the area so as to have a new sample at the following visit. No pellet was found on February 1997.

A sample of 11 pellets was selected among the intact pellets collected and brought to the laboratory. They were soaked in water with alcohol for 10 min so as to make easier the separation of the fragments of indigested prey. Undigested fragments of prey were isolated, identified using a microscope and classified to the nearest taxonomic level using identification keys (Perrier 1927, 1932; Chopard 1951; Perrier 1972; Albouy and Caussanel 1990; Baraud 1992) and reference collections at the National Institute of Agronomy of El-Harrach (Algiers, Algeria) and the National Museum of Natural History (Paris, France). Insects were identified from the remains of the head, legs and thorax, arachnids from the pincers, and birds from the feathers and claws. Prey remains were quantified to calculate relative abundances.

The effects of month and year on the frequency of prey orders and prey families most frequently encountered were tested using log linear tests.

A total of 240 pellets were analysed and 12 548 prey remains were isolated, of which 12 452 (99.24%) belonged to invertebrates and 96 (0.76%) to vertebrates (Table 1). During the study period, six different prey types were found in pellets, including five categories of invertebrates: gastropods, arachnids (including Scorpionidae each year in June), crustaceans and myriapods represented only a small part of the total number of prey, whereas insects were regularly consumed and dominated the diet of the White Stork during all months and years of the study. Vertebrates were not regularly consumed and consisted of bird remains.

**Table 1:** Categories of prey consumed by White Storks in the region of El Merdja, Algeria and found in the pellets by month and year. Relative abundances (%) were calculated from the total prey number of each year. *N* = sample size

Class	Order	Year																	
		1997			1998			1999			2007								
		II	III	IV	V	VI	VII	II	III	IV	V	VI	VII	II	III	IV	V	VI	VII
Vertebrata	Aves	-	-	-	0.2	-	0.3	1.4	-	-	-	-	-	1.0	4.3	8.3	2.6	2.4	1.6
	Dermaptera	-	-	-	46.9	5.6	2.8	26.4	20.1	41.4	54.2	3.5	4.0	5.1	39.4	24.5	-	-	-
	Coleoptera	-	94.5	94.9	51.9	54.2	76.9	71.6	55.3	53.3	42.7	39.7	-	94.9	57.8	64.2	98.1	94.9	94.9
Insecta	Orthoptera	-	5.5	5.1	0.6	37.4	16.4	0.6	23.9	2.4	2.3	52.5	93.4	-	0.6	0.5	1.9	5.1	3.2
	Nevroptera	-	-	-	0.2	1.4	0.8	-	-	-	-	-	-	-	0.4	0.7	-	-	0.5
	Hymenoptera	-	-	-	0.1	0.8	1.1	-	0.4	1.0	0.1	1.6	1.3	-	0.2	0.1	-	-	1.2
	Hemiptera	-	-	-	0.1	0.3	-	-	0.1	0.2	0.1	-	0.3	-	-	-	-	-	0.2
Arachnida		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gasteropods		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crustacea		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myriapoda		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		-	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
<i>N</i>		0	109	158	872	358	282	836	1 262	801	804	634	705	237	535	1 536	519	237	413
														199	253	216	427	574	581

Among insects, Coleoptera were the most frequently consumed in all months of all years, except in May 1998 (Dermaptera) and June and July 1998 (Orthoptera) (Table 1). Five insect families were mainly found with varying degrees of importance: Carcinophoridae (Dermaptera) were highly consumed in 1997, Tenebrionidae (Coleoptera) and Forficulidae (Dermaptera) in 1998, Tenebrionidae in 1999 and Carabidae in 2007 (Figure 1). Results obtained from the statistical analyses indicated highly significant effects of month ( $p < 0.001$ ) and year ( $p < 0.001$ ) on orders and families of prey insect frequencies in pellets.

White Storks in the Tebessa region feed mainly on invertebrates, whereas vertebrates are rarely caught. Coleoptera, Dermaptera and Orthoptera were the most frequently consumed, confirming results obtained in several regions in Algeria and in the world (Table 3).

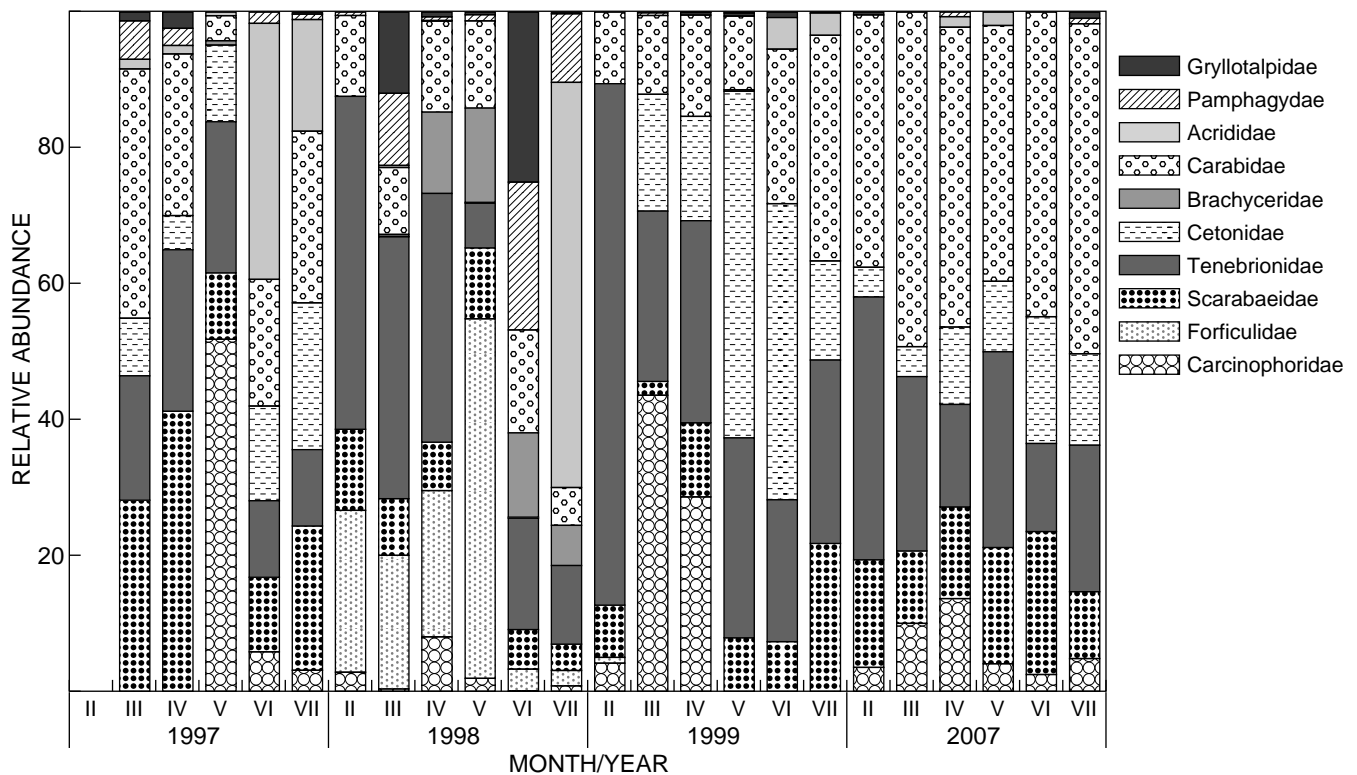
The relative abundance of ingested prey identified in rejection pellets was low during the first months of each year (except in February 1998). This may reflect lower energy demands than during the breeding period, during which chicks are fed, and/or that adults fed on prey that leave no remains in pellets, such as amphibians and annelids (Barbraud and Barbraud 1997).

The high frequency of Coleoptera in the pellets might be related to their high availability in the study area (Sbiki 2008), as also reported by Boukhamza et al. (1995) for Kabylie, northern Algeria. The regular consumption of beetles may be linked to the succession of prey families belonging to this group of insects that become available during the year. According to Ouchtati and Doumandji (2011) most carabic species are active in winter and spring at El-Merdja, although species richness and diversity may vary from year to year. The arrival and the prereproductive period of the White Stork at El-Merdja coincide with a peak of abundance of Tenebrionidae, Scarabaeidae and Carabidae. Scarabaeidae also represented the most important prey of the White Stork in Kabylie (Boukhamza 2000).

Dermaptera were rarely found in pellets in February and July because these preys are more available in spring at El-Merdja (Sbiki 2008). According to Boukhamza (2000), Dermaptera were mainly captured by White Storks from March to July in Kabylie, Algeria, where they represented 34.17% of the total number of prey in 1992, and from February to July at Oum El Bouaghi, north-eastern Algeria, (Belghit and Rebiai 2011).

Orthoptera were mainly found during the nesting period (May to July) at El-Merdja, as found by other authors (Boukhamza et al. 1995; Boukhamza 2000). Orthoptera represented the prey that was mostly consumed in February and July in Merouana, Algeria (Boukhtache and Si Bachir 2010). Grasshoppers and locusts seem to be the most important food items on the African wintering grounds for the White Stork (Brouwer et al. 2003).

Alternatively, the size of the available prey species may also explain diet variability between months and years because large prey species may be more beneficial in terms of energy compared to smaller prey (Groner and Ayal 2001). Large and profitable species reported in the diet of White Storks include Tenebrionidae, Carabidae,



**Figure 1:** Monthly frequencies of the main insect families consumed by White Storks in the region of El Merdja, Algeria

Scarabaeidae (Boukhamza et al. 1995; Tschalidis and Goutner 2002), Hydrophilidae (Barbraud and Barbraud 1997) and Silphidae (Schierer 1962).

This study confirmed the findings from earlier studies, showing the White Stork as a highly insectivorous bird during the breeding season, which may choose prey based on relative availability in the breeding area. Our four-year study showed that, although always dominated by insects, the diet of the White Stork showed important variations and suggests an increasing importance of Coleoptera. However, longer time series are needed to infer whether this corresponds to a shift in diet or only to interannual variations in prey availability.

**Acknowledgements** — We thank Mr and Mrs Voisin (MNHN, Paris) and Mrs Amara K. for their invaluable help, Dr. Si Bachir A. (University of Batna, Algeria) for his advice and to those who helped improving the manuscript.

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