## Breeding ecology of the White Stork Ciconia ciconia in two localities of Turkey

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The White Stork *Ciconia ciconia* is a summer visitor and passage migrant in Turkey. Although widespread in the breeding season near wetlands, there has been no tradition of research involving regular monitoring of their nests in Turkey. Here we present data on the breeding ecology of White Storks from central and western Turkey, carried out over several years. About 15 pairs were observed annually near Ankara and between 15 and 36 pairs near Izmir and their breeding success was examined. No significant difference was noted in mean brood size between the two localities over three common study years. The mean reproductive output, given as mean number of young fledged per occupied nest, was 2.57 for Ankara (5 years), and 2.38 for Izmir (3 years). Significant differences in brood size between nest locations (roof, chimney, electricity and telephone poles) were found. Contrary to previous studies outside Turkey, in Ankara the mortality rate was higher in nests with smaller brood sizes. Also in Ankara, early breeders had significantly higher breeding success than late breeders, confirming previous research elsewhere.

## INTRODUCTION

The White Stork *Ciconia ciconia* is a summer visitor and passage migrant in Turkey. The country provides important feeding and resting areas not only for Turkish White Storks but also for the eastern European White Stork population. The latter population has been estimated at 552 000 individuals (Schulz 1999) and, according to the results of the last International White Stork Census, *c*74% of the world population migrates south through the Bosphorus at Istanbul (NABU 2006, Kai-Michael Thompsen pers comm), then passes diagonally across Turkey and leaves at the Belen pass in the south. As many as 315 000 White Storks have been counted over the Bosphorus in one migration season (Kasparek & Kilic 1989) and Can (2001) counted 13 000 individuals during a single day in March at the Belen pass in Hatay.



Plate I. ÇG observing a White Stork Ciconia ciconia nest, Kizilcahamam, Ankara, Turkey, May 2006. © Ezgi Göcek

Between 1970 and 1990 the breeding population of the White Stork in Turkey was estimated to be between 15 000 and 35 000 pairs and apparently declined by over 50% (Parr *et al* 1997, IUCN 2006). According to the results of the last International White Stork Census in 2004/2005, the Turkish breeding population was estimated to be *c*6195 pairs (NABU 2006), though the results may not adequately reflect the actual number of White Storks breeding in Turkey.

It is well known that several factors affect White Stork breeding success, such as age of breeders, time of breeding, habitat,



Plate 2. A White Stork *Ciconia ciconia* nest platform constructed above a chimney, Kizilcahamam, Ankara, Turkey. © *Osman Erdem* 

year and even where the nest is sited (Schulz 1998). However, the breeding ecology of the Turkish population is poorly known. The main purpose of the present paper is to provide information on breeding success of the White Stork in relation to year, nest placement and phenology at two localites in Turkey, near Ankara (40° 28' N, 32° 39' E, central Turkey) and Izmir (38° 44' N, 27° 05' E, coastal western Turkey).

## STUDY AREAS AND METHODS

Ankara: the study area is in the Kizilcahamam district. The White Stork population there is principally located at the Kizilcahamam industrial estate, partially in the vicinity of human settlement (Plates 1–3). The study area is mainly open with scattered trees, covering *c*1580 km<sup>2</sup>. The Kirmir stream is the main foraging area for the storks (Göcek 2006). At the study area there were 15 nests, most of which were occupied every year. The study was carried out for five breeding seasons, 2003–2007. During 2004 and 2005, the study area was visited principally two days per week; for the rest of the study period, field observations were conducted one or two times a month.

Since the male and female storks of the same nest could not be distinguished and different pairs could not be recognized individually, nest-based identification was used by numbering the nests from 1 to 15, based on location. In the breeding seasons 2004 and 2005, the number of breeding and non-breeding pairs, occupation dates of each nest, numbers of eggs, hatchlings and fledglings were recorded but during the years 2003, 2006 and 2007 only data on numbers of hatchlings and fledglings were collected. The nest occupation date was defined as the first day on which the second bird (presumably mainly females, Tryjanowski *et al* 2004) was seen on the nest. The presence of two individuals was accepted as proven occupation.

For 2004 and 2005, besides breeding success of the nests, the behaviour of the pairs and chicks was recorded and will be published separately. Clutch size and brood size were established sometimes using a telescope and binoculars from a distance (*eg* Plate 1) and sometimes by climbing directly to the nest. In some cases, data on clutch and brood size could not be obtained.

Izmir: the study plot is located in the Gediz delta (*c*20 400 ha) and includes 13 villages of the Menemen, Cigli and Foca districts. The delta has various habitats such as brackish and freshwater marshes and arable fields. It is one of the most important wetlands in the Mediterranean region, becoming a RAMSAR site in 1998. The number of White Stork pairs under observation changed from 15 to 36 due to extending the area of interest by adding new villages to the analysis each year. The White Storks preferred to forage close to corn and cotton fields (relatively less disturbed habitats near the settlements), which provided a

Table I. Variation in breeding success of White Storks Ciconia ciconia among study years in Ankara, Turkey. See
Study Areas and Methods for explanation of symbols. HPm% = HPm as % of HPa. SD = standard deviation of
breeding success (IZm). Min/Max, minimum and maximum number of fledged chicks.

Year	HPa	HPm%	JZG	JZa	JZm	SD	Min/Max
2003	9	77.8	21	2.33	3.00	1.80	0–5
2004	14	71.4	42	3.00	4.20	2.15	0–5
2005	15	46.7	17	1.13	2.43	1.41	0-4
2006	15	86.7	47	3.13	3.62	1.25	0–5
2007	15	100	48	3.20	3.20	1.01	I5
Mean				2.57	2.43	1.70	
Total	68		175				

large variety of food (Ciftci 2006). The data on the nestling and chick counts in the villages were obtained from the beginning of March till the end of August, 2005–2007.

White Stork nestlings fledge at 58–64 days old (Haverschmidt 1949 in Cramp & Simmons 1977). The date of fledging per nest used in our study was the midpoint between the last observation of no flight and the first observation of chick flight.

Population data: the following statistics were calculated for the Ankara (Table 1) and Izmir (Table 2) populations. Their abbreviations are conventional ones introduced by Schüz (1952) based on definitions in German.

- The number of nests occupied by a pair for longer than one month, between 14 April and 15 June (HPa).
- The number of pairs that fledged young (HPm).
- Total number of young fledged in a local population in a given year (JZG).
- The mean number of young fledged per HPa nest (JZa = JZG/HPa).



Plate 3. White Stork Ciconia ciconia nest on platform close to cables, Kizilcahamam, Ankara, Turkey. © Dorota Szulc-Guziak

Total	73		174				
Mean				2.38	2.71	1.21	
2007	36	88.9	79	2.19	2.47	1.19	04
2006	22	90.9	61	2.77	3.05	1.23	04
2005	15	86.7	34	2.27	2.62	1.16	0-4
Year	HPa	HPm%	JZG	JZa	JZm	SD	Min/Max

**Table 2.** Variation in breeding success of White Storks *Ciconia ciconia* among study years in Izmir, Turkey. See Study Areas and Methods and Table I for explanation of symbols.

The mean number of young fledged per nest with breeding success (JZm = JZG/HPm).

Data for egg and hatchling numbers per pair were obtained for the Ankara population allowing additional analysis.

Nest site (Table 3) was categorized as: chimney, roof, electricity pole, telephone pole. We included nests located on the top of mosques (two cases) in the second category and excluded the one nest on a tree from the analysis.

All statistical analyses followed Zar (1999) using SPSS/PC version 12.0.

### RESULTS

#### Number of breeding pairs and breeding success

In the Ankara study area (Table 1) in 2004–2007 the number of breeding pairs was almost stable (14–15 pairs). In Izmir (Table 2), extended monitoring added additional pairs to the study each year.

In contrast to the stable number of breeding pairs, HPm% (HPm as % of HPa) changed sharply between years in Ankara (Table 1). The year 2005 had the lowest percentage of successful breeders (HPm%), both for the Ankara and Izmir localities (46.7% and 86.7%, respectively, Tables 1 & 2). White Storks breeding in the Ankara and Izmir study areas did not differ significantly in brood size (JZm) (data available for three common years 2005–2007; mean  $\pm$  SD = 2.49  $\pm$  1.55 *vs* 2.38  $\pm$  1.21, Ankara and Izmir respectively, Mann-Whitney U-test, *Z* = -0.665, P = 0.506). In Ankara, 2004 had the highest variation in the number of fledglings per nest, this occurred in Izmir in 2006 (Tables 1 & 2).

#### Nest site and year effects

We tested the importance of nest site and the effect of year on breeding success for both localities. The total number fledging (JZG) and the mean number of fledglings per occupied nest (JZa) varied annually in Ankara: 2005 had the lowest JZG (17, Table 1). A similar variation was seen for the Izmir locality in JZa values (Table 2). There was a

Table 3. Percentage	(%) of	White	Stork	Ciconia	ciconia	nests i	n differe	ent loca	tions,	at Ankara	and I	zmir	study	sites,
Turkey.														

Study area	# nests	Chimney	Roof	Electricity Pole	Telephone Pole
Ankara	69	30.4	21.7	36.2	11.6
Izmir	74	1.4	5.4	91.9	1.4
Mean		15.4	13.3	65.0	6.3
Total	143				

significant difference in chick production among years (two-way ANOVA, F = 27.14, P < 0.002).

The number of fledged young (JZm) in both study areas was affected by nest site (F = 2.75, P < 0.003) and year (F = 5.63, P < 0.001) with no significant interaction between these parameters. Although there were some changes in nest site in Ankara by year, nests were mostly built on electricity poles and chimneys; less often on roofs and telephone poles (Table 3). Nests of White Storks in Izmir were principally built on electricity poles, with far fewer on roofs (Table 3). During the study years, nest platforms on poles were gradually exchanged for safer platforms mounted higher above exposed cables, on the same poles (Plate 4).

# Relation between date of nest occupation and breeding success

The date of nest occupation (generally the end of March to the middle of May) and breeding success (JZm) were examined for the Ankara locality. A significant negative correlation (partial correlation to control



**Plate 4.** A White Stork *Ciconia ciconia* nest platform in Sasali, Izmir, Turkey, re-mounted higher above cables. © *Ömer Döndüren* 

effect of year, r = -0.505, P < 0.007) between date of nest occupation and number of fledglings was found *ie* storks that commenced nesting earlier reared more chicks.

## Chick mortality

Chick mortality in relation to initial number of hatchlings was assessed for the Ankara locality over 5 years of the study. There were four classes: nests with two (n = 8), three (14), four (12) and five (10) initial hatchlings. Chick mortality refers to deaths from hatching to fledging of chicks from the nest (percentage of hatchlings that failed to fledge). Nests with two and three chicks had higher chick mortality than those with four and five chicks, 18.8, 21.4, 6.2 and 8.0% respectively. However, these differences were not statistically significant, presumably due to small sample size ( $\chi^2$  = 4.88, df = 3, P = 0.181).

## DISCUSSION

## Number of breeding pairs and breeding success

These local populations of the White Stork seemed to be stable during the study period. However, the number of pairs without breeding success changed, which is quite typical for this species, presumably mainly due to weather conditions in different breeding seasons (Tryjanowski *et al* 2004). This is also confirmed by the variability in the number of fledglings. Moreover, changes in local chick productivity may be also affected by changes in habitat structure (Tryjanowski *et al* 2005), and/or ageing structure of the local population (Medina *et al* 1998, Vergara *et al* 2006). A good example of year differences is 2005 which, according to Schulz (1998), may be named 'a disturbance year', *ie* with adverse weather conditions and a lack of food supply when a large proportion of the storks do not establish themselves as breeders or they start to breed very late with a reduced number of

fledglings and a very low per pair breeding success. In contrast to 2005, in the following year (2006) there was a remarkable increase in the number of young that were fledged successfully from the nests.

Interestingly, the mean breeding success (JZa) of the studied populations in Turkey was higher than some European White Stork populations. For example, in Poland and eastern Germany (n = 407 breeding attempts, 1983–2001), the heartland of the eastern European population of the White Stork, there was a mean of 2.08 and 1.91 chicks per breeding pair respectively (Schaub *et al* 2005).

#### Relation between nest occupation time and breeding success

It is well known that natural selection favours early arrival and higher breeding success in the White Stork (Tryjanowski *et al* 2004). Starting to breed earlier influences reproductive output (Massemin-Challet *et al* 2006). As the season progresses migrant birds produce smaller clutch sizes (Drent & Daan 1980) and their reproductive success declines (Profus 1991, Goutner & Tsahlidis 1995) as a result of decreasing amount of food supply and/or the quality of the parents (Drent & Daan 1980, Tortosa *et al* 2003). In terms of 'quality' the age of parents may also play an important role. It is known that younger individuals are more likely to arrive later than the older ones (Barbraud & Barbraud 1999) and the older and more experienced adults have a higher breeding success.

The studied local populations of White Stork in Turkey seemed to be performing healthily and are not of urgent conservation concern. However, we believe that this study does not reflect the situation of the Turkish population as a whole. Observations revealing large numbers of old unoccupied nests and interviews with local people living nearby suggest that the number of breeding White Storks in Turkey is still in decline. Probable reasons are: decrease in quality and quantity of wetlands, abandonment of traditional agricultural practices, electrocution and collision with cables, less potential nest sites and less favourable attitudes of man. Urgent countrywide research is needed.

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