# BREEDING SUCCESS AND REPRODUCTIVE BEHAVIOR IN A WHITE STORK (*Ciconia ciconia*) COLONY IN ANKARA

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
BIOLOGY

SEPTEMBER 2006

Approval of the Graduate School of Natural and Applied Sciences

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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## ABSTRACT

### BREEDING SUCCESS AND REPRODUCTIVE BEHAVIOR IN A WHITE STORK (*Ciconia ciconia*) COLONY IN ANKARA

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September 2006, 78 pages

White Stork (*Ciconia ciconia,* Linnaeus, 1758) is a summer visitor and passage migrant in Turkey. Although being widespread in summer near wetlands of Turkey, except for the eastern and western parts of the Black Sea Region, there has been no research on this species involving regular monitoring of nests.

In this study, breeding success and survival of nestlings in a population in Kızılcahamam-Ankara as well as behavioral differences among nests and their probable consequences on breeding success were studied. Regular field observations throughout six-month long breeding seasons between 2003 and 2006 were carried out to determine parent and young behavior patterns at nest.

Clutch size, and numbers of chicks hatched and fledged fluctuated throughout 2003-2006 for pairs that bred while fledgling success (average fledgling per successful nests with egg laid) were 2.63 in 2003, 3.82 in 2004, 1.89 in 2005 and 3.13 in 2006. These values are in good agreement with those recorded in northern Europe.

The relationship between beginning date of incubation and both clutch size and brood size were found to be different for 2004 and 2005. Such a relationship may be significant in breeding seasons colder than usual.

For 2004 and 2005, the amount of food brought and caring towards young by parents were compared with breeding success (proportion of hatched young that were fledged), and breeding success was found to increase with increasing amount of food provisioning. However, this result may be suggested to be related with weather conditions. In conclusion, Kızılcahamam White Stork population has been found to be not restricted by food or nest site availability and with a reproductive output above the European average, although annual climatic stochasticity was found to affect reproductive output.

Keywords: White Stork, Survival, Breeding Success, Nest Behaviors, Behavioral Ecology.

# ÖZ

## ANKARA KIZILCAHAMAM'DAKİ BİR LEYLEK POPULASYONUNUN ÜREME BAŞARISI VE YUVA DAVRANIŞLARININ ARAŞTIRILMASI

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Eylül 2006, 78 sayfa

Leylek (*Ciconia ciconia,* Linnaeus, 1758) Türkiye için yaz göçmeni ve geçit yapan bir türdür. Karadeniz Bölgesi'nin doğu ve batı kesimleri dışında, Türkiye'nin çevresinde sulakalan bulunan bölgelerinde yaz boyunca bulunmasına rağmen, daha önce bu tür üzerinde yuvaların düzenli takibini içeren ayrıntılı bir çalışma yapılmamıştır.

Bu çalışmada, Ankara-Kızılcahamam'daki bir Leylek populasyonunun üreme başarısı ve yavruların yaşama gücü saptanmış, yuvalar arasındaki davranış farklılıklarının, üreme başarılarındaki farklılığına olası etkileri araştırılmıştır. Bu amaçla, 2003 ve 2006 yılları arasında yaklaşık altı aylık üreme dönemleri boyunca yapılan düzenli gözlemler sonucu, yuvada ebeveyn ve yavruların davranış kalıpları belirlenmiştir.

Üreyen tüm yuvalardaki toplam yumurta sayıları, yumurtadan çıkan ve uçurulan yavru sayıları 2003-2006 yılları arasında dalgalanma göstermiş, yuvadan yavru uçurma başarısı (yuvadan uçurulan yavruların yumurtadan çıkan yavrulara oranı), 2003'de 2.63, 2004'de 3.82, 2005'de 1.89 ve 2006'da 3.13 olmuştur. Bu değerler kuzey Avrupa'da ölçülen değerlerle benzerlik göstermektedir.

Kuluçkaya başlama zamanı ile yapılan yumurta sayısı ve bir batındaki yavru sayısı arasındaki ilişkiler 2004 ve 2005 yılları için farklı bulunmuştur. Soğuk geçen üreme dönemlerinde bu ilişkilerin önemli olabileceği düşünülmektedir.

Üreme olan yuvalarda besin getirme ve yavruya ebeveyn tarafından gösterilen bakım davranışlarının miktarları ile üreme başarısı (her yuva için yumurtadan çıkan yavru sayısının uçurulan yavru sayısına oranı) 2005 yılı verileri için karşılaştırılmış ve getirilen besin miktarı arttıkça üreme başarısının arttığı kaydedilmiştir. Ancak yuvalar arasındaki üreme başarısı farklarının iklimsel faktörlerle de bağlantılı olduğu düşünülmektedir. Sonuç olarak, Kızılcahamam leylek populasyonunun besin ve yuva yeri sıkıntısı çekmeyen, ancak yıldan yıla değişen mevsimsel farklılıklardan etkilenen, üretkenliği Avrupa ortalamasının üzerinde bir populasyon olduğu bulunmuştur.

Anahtar kelimeler: Leylek, Yaşama Gücü, Üreme Başarısı, Yuva Davranışları, Davranışsal Ekoloji.

To my family

**ACKNOWLEDGEMENT**

I received tremendous support and encouragement from many people.

I thank my advisor, Assoc. Prof. C. Can Bilgin for his acceptance of my demand on behavior studies and for his guidance and support on my study.

I especially want to thank to my mom for encouraging me in every turning and my little sister and at the same time my little psychologist Ezgi for listening to me always, patiently.

I also would like to thank to KAD (Turkish Bird Research Society) to support my thesis and for technical help for both field studies and ringing activities and also to my colleagues Okan Can and Özge Keşaplı Can to direct me working with the White Stork. Bilge Bostan for always being very helpful and supportive.

I would like specially thank to Prof. Dr. Piotr Tryjanowski for supporting me with the articles and his encouragement and Roman Guziak for his truly help.

I thank Didem Çakaroğulları, Arzu Kanaat, İlker Özbahar, Senem Tuğ for their assistance with field works, Banu Kaya for her technical help and Deniz Özüt, Ceran Şekeryapan and Raşit Özkan for their truly help with statistical analyses.

I also want to thank to workers of Kızılcahamam Soğuksu National Park for their help with the field studies.

And to storks... my winged friends...You arrived at every March and brought spring into my life and while leaving in August with the summer on your wings, I stood in bewilderment with admiration. I know we will meet someday soon when you come here again with the spring on your wings…

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# INTRODUCTION

## 1.1 Breeding Biology

The questions related with life-history characteristics and ecology have been studied for more than 50 years. Yet some authors studied breeding biology even earlier. For instance, in his book 'Problemata', Aristotle mentions about the variation in litter size, number of brood per year, and care of offspring (Farner & King 1971). Darwin, in 'The Origin of Species' (1859), relates larger numbers of eggs to fluctuations in food supply, fecundity and population size. In the first third of the last century, there is a development of concepts such as fitness and reproductive value with the valuable contributions of Lotka (1925) and Fisher (1928), particularly.

### 1.1.1 The Ecological Aspects of Reproduction

It is known that if the breeding success of an animal is only related with inherited characteristics, the genetic makeup of individuals that produce the biggest number of mature offspring would eventually predominate in the population. But breeding success is determined not only by genetics itself but also with the other animal and plant species and the non-biological environment. If reproductive commitment is the sum of efforts put directly into the production of offspring, then the distribution of these efforts in relation to the occurrence of variations in weather, food supply, and all other aspects of environment will determine the ultimate or realized reproductive output (Farner & King 1971).

#### 1.1.1.1 Ultimate Control of Reproduction

The environmental factors that control efficiency of breeding have led to the evolution of species-specific breeding periodicities through natural selection. Baker (1938) has introduced the term "ultimate causes" which has been altered by Thomson (1950) into "ultimate factors".

The most important ultimate factors for most bird species are the quality and the quantity of food supply. Great need for food occurs during the whole breeding season, especially after hatching of young since parents need not only finding food for themselves but also for their chicks. Food shortages can reduce or stop egg production, and thus clutch size may be affected by inefficiency of food supply (King 1973, Ricklefs 1974). Therefore, food supply is also important for the female in terms of enabling the production of eggs.

Placement of the nest may affect the nest microclimate and thus breeding success of the pairs due to factors such as being in or out of the sun, shade or wind, or safe from predators (Gill, 1994)

Climate has its greatest influence on bird numbers through indirect effects on changes in vegetation and food supply. It has been suggested that the onset of reproductive activity is governed by results of precipitation (such as green vegetation, improved food supply, etc.) rather than by actual rainfall itself (Baker 1938, Moreau 1950, Disney & Marshall 1956, Marshall & Disney 1957, Morel *et al*. 1957, Brooke 1966, Ridpath 1971).

Climate also has a direct influence on bird survival, especially on tender young, mainly through its extremes in temperature and rainfall. For instance, very high or very low temperatures directly affect the individual. A positive correlation between temperature and egg production has been found in many bird species (Burger 1948, Farner & Mewaldt 1952, Engels & Jenner 1956, Farner & Wilson 1957).

#### 1.1.1.2 Proximate Control of Reproduction

Some of the subsidiary factors that control reproduction are increased sunshine, change in the general appearance of landscape, final attainment of full sexual development, stimuli from the breeding area, establishment of territory, availability and acquisition of a specific nest site, immediate stimuli from the nest and behavioral interactions.

### 1.1.2 The Energetic Cost of Reproduction

According to life history theory, there is a tradeoff on an animal's investment in its young against their own chances to survive and reproduce in the future (Roff 1992, Stearns 1992). If the reproductive effort in one year leads to a loss in future reproductive output (through decreased adult survival or reduced fecundity), then the optimal effort in the current season is less than the effort that would maximize the number of offspring produced in that season (Williams 1966, Charnov & Krebs 1974).

Peak reproductive activities increase total daily energy expenditures by as much as 50% (Ricklefs 1974, Walsberg 1983). At the beginning of the breeding season, courtship, territoriality, and nest building demand significant effort. Incubation can also create energy storage because it limits the amount of time a bird can forage for its own maintenance. The parents then face another surge of demands on their time and energy when the chicks hatch and require food and brooding.

Most of the annual mortality in the House Sparrow (*Passer domesticus*) occurs during its breeding season (54%, Summers-Smith 1956). The same was reported for the European Blackbird (Snow 1958).

### 1.1.3 The Concept of Breeding Success

Breeding success is an important population parameter that provides a measure of the reproductive output by a particular group of animals during a particular season. Breeding success (if defined in a broad way) depends on a number of factors. These include proportion of sexually mature adults in the population, proportion of those adults that manage to find a mate or territory, mating system, number of eggs laid (clutch size), number of broods, proportion of eggs that hatch, and survival of young to independency (fledging in case of birds). In a narrower sense, breeding success is usually defined as the number of young raised per breeding pair.

#### 1.1.3.1 Proportion of Sexually Mature Adults in the Population

In White Stork populations, there are some immature individuals that occupy a nest but do not breed successfully. Therefore they do not contribute to overall breeding success of the population. The proportion of the sexually mature adults as real contributors to reproductive output is important.

#### 1.1.3.2 Proportion of Adults Manage to Find a Mate or Territory

Only after having a mate and territory a bird may be regarded as contributor to its population. White Stork is a territorial birds that defends its nest and surroundings against other individuals. Sometimes, especially if nesting sites are limited, some potential breeders may not nest in a particular year.

#### 1.1.3.3 Mating System

Male and female birds have different reproductive options and different potential reproductive success. These differences result in different mating systems and behavioral differences in birds. According to Oring (1982), both the duration and

number of sexual partners help to define differences among various mating systems. White Storks are generally monogamous, so this is not a crucial factor as in polygamous birds.

#### 1.1.3.4 Number of Broods

Every attempt that results in successful reproduction of a bird during one breeding season can be termed as the number of broods (Farner&King 1971). White Stork has one brood every year.

#### 1.1.3.5 Clutch Size

The number of eggs a bird lays in one set is called as a clutch. The clutch is subject to short-term constraints, such as energy available for egg formation, and long-term considerations of lifetime reproductive success. It varies within a single species depending on age, food availability, population density, habitat, nest site, the time of breeding or genetic differences between individuals. As a general rule, feeding abilities of parents limit the clutch sizes of altricial birds.

Food shortages can reduce or stall egg production and thus affect clutch size (King 1973, Ricklefs 1974). Therefore, year-to-year variations in average clutch size are normal. Also, in their first breeding season, the birds generally produce fewer eggs and offspring than older, more experienced birds.

#### 1.1.3.6 Proportion of Eggs that Hatched

After incubation periods some of the chicks hatch. Most of the variation in proportion of eggs that hatch in a clutch depends on food availability on the territory as well as brooding behavior of parents.

#### 1.1.3.7 Survival of Young to Independency

A fledgling's chance of survival depends on food availability, the quality of parental care, the number of siblings competing for that care; the timing of fledging and mass at fledging (Gill 1994).

In a small brood, there is more chance for every chick to survive then large brood. Because in a small brood, nestlings are better fed and heavier when they fledge; but the number of potential fledglings from small brood is low (Gill 1994).

## 1.2 The Life History of White Stork

### 1.2.1 Importance of The Species

According to IUCN criteria (IUCN 2001), status of the White Stork is Least Concern (LC) due to being widespread and abundant taxa worldwide. However, the White Stork is an indicator species that reflects the quality of the area in which they live together with many of the other animal species such as amphibian, fish, insect or any other bird species. It is relatively at the top of the food chain. Therefore, the study and monitoring of this species will help improve the success in the conservation of entire ecosystems and all species contained therein. Moreoever, the species is easy to detect and is known and liked by most people. Due to the reasons given above, the White Stork is generally considered as an umbrella or flagship species.

### 1.2.2 General Characteristics

The White Stork (*Ciconia ciconia, Linnaeus, 1758*) is a polytypic, large, semi-aquatic bird species. The nominate race *ciconia* ( Linnaeus 1758) occurs in Europe, the Middle East and in North Africa. Its height is 100-115 cm, wingspan is 115-165 cm;

the male averages slightly larger than the female. In plumage, sexes are alike and there is no seasonal difference in plumages.

White Stork belongs to Familiy Ciconiidae which has 17 species within 6 genera (Kahl 1971a). The family is divided into three groups; White Stork is in the second group and belongs to typical storks (Ciconia).

The adult is entirely white except for black primaries, secondaries, greater coverts and long scapulars. The bill, legs and feet are red. Juvenile plumage, worn when the young leaves the nest in July, is generally similar to that of the adult but its coverts and scapulars are tinged brown. Its bill and legs are brownish red but gradually change through orange to red. This color change starts while they are still in the nest and for most individuals is completed before their first summer.

As a result of lacking muscles in the voice box, adults are mostly silent, but can give hissing sounds at nest and during ritualized displays.

### 1.2.3 Worldwide Distribution and Population Trends

They breed in Europe except for Britain and Scandinavia and the northern part of Russia; also in Turkey, north of Algeria and Tunisia, in central Iraq and Armenia (Cramps & Simmons 1977, Schulz 1999). White Stork is summer visitor and passage migrant in Turkey. The species breed throughout the country except for the eastern and the western parts of the Black Sea region. Some individuals may winter in southern and western coastal parts of Turkey (Kasparek & Bilgin 1996). In Europe, the number of breeding pairs of White Stork is monitored since the beginning of the 20th century. Data were collected especially in 1934, 1958, 1974, 1984 and 1994/1995 (Schulz 1994, 1999; Schüz 1936, 1940, 1979; Schüz & Szijj 1962). According to the 94/95 census, the western population is estimated at 112,000 individuals and the eastern at c. 552,000 birds. (Schulz 1999). While in the beginning of the century and even in 1984 populations were declining, an important positive trend in population size was noted in 1994/95 (Schulz 1999). Turkey was

not included in any international censuses but the population is estimated to be around 15.000-35.000 pairs (Parr 1997).

### 1.2.4 Migration

The White Stork is migratory. By the end of breeding season, the majority of the population migrates to tropical Africa, Iran and Indian subcontinent (Haverschmidt 1949, Bauer & Glutz 1966; Moreau 1972). Only a few winter in southern part of the breeding range, exceptionally north to Denmark and Kaliningrad, and some of them in Spain (Ree 1973) and in France. But since the late 1980s, the numbers of White Storks wintering in Europe have increased dramatically (Barbraud & Barbraud 1991, Tortosa *et al.* 1995, Schulz 1998, Chartier 2001, Kayser *et al.* 2003, Schaub *et al.* 2004). Some in the last decade started to winter in the Iberian Peninsula and in Israel (Paz 1987, Schulz 1988).

The world population is divided into western and eastern sub-populations due to separate migratory routes. The population breeding west of a line from the Harz to Osnabruck in northern Germany and west of $11^0$E in southern Germany and in northern Africa is called the western population; these migrate southwest and pass the Strait of Gibraltar at Spain and winter in West Africa. The birds from east of that line breed in Eastern Europe and the Middle East, is called the eastern population, and migrate through Bosphorus at Istanbul, pass Turkey diagonally and leave at the Belen Pass. This sub-population winters mostly in East Africa. Many birds in their second calendar year do not migrate to the north, instead spend the spring and summer south of the Sahara, with the second, third and fourth-year birds migrating increasingly greater distances towards their breeding area (Hall *et al.* 1987).

### 1.2.5 Habitat and Foraging

The White Stork is basically a gregarious species, often breeding in solitary pairs but commonly feeding in small parties, and also nesting colonially in part of its range (Cramp & Simmons 1977, Haverschmidt 1949).

A historical accident of convergence of habitat requirements with human settlements has long led them to commensalism. Therefore, it may be regard as a normal scene that stork nests and human houses usually coincide.

In general, White Storks prefer open natural or extensively cultivated lowland, wet grassland or farmland and shallow standing waters, for instance lagoons, pools, open ditches, margins of deep lakes and seas. High breeding densities are found near rivers, with regular flooded grassland (Cramp & Simmons 1977, Goriup & Schulz 1991). They avoid chilly and humid habitats or tracts of tall dense vegetation like forests and reed beds.

The species is an opportunist that feeds on a wide variety of prey including insects (locusts), frogs, snakes, toads, tadpoles, fish, lizards, earthworms, mollusks, crustaceans, rodents (as voles *Microtus spp*) (Tryjanowski *et al.*, 2002), and rarely the chicks or eggs of ground-nesting birds. White Stork shifts its attention from fish and frog to rodents during droughts years.

### 1.2.6 Nest Building

Birds built nests in a great variety of forms, from a greater variety of materials, and on a greater variety of sites. White Stork nests are huge (1 meter in diameter), made of branches and sticks and lined with twigs, grasses, sod, rags, and papers. The nests are mostly on man-made structures such as rooftops, chimneys, telephone and electric poles, walls, trees and cliff-edges.

A nest is built by either member of a pair of the White Stork. Nest site selection is accompanied by displays. A new nest can be built in 8 days. New nest materials are added throughout the breeding season.

Like raptors, White Storks imprint on their natal nest sites; consequently, the youngers choose the same area for breeding when they reach maturity. They return to the same site year after year and repair or add to the existing nest. A comparable sexual difference in faithfulness to the natal territory appears in the White Stork.

The average distance between birthplace and the site of the first breeding as an adult is 33 km in males and 61 km in females (Zink 1967).

### 1.2.7 Breeding

#### 1.2.7.1 Mating

White Storks have a monogamous pair-bond that often only lasts for a breeding season. However, polyandrous mating has been reported occasionally in this species**.** The same pair sometimes breeds together more than one breeding season at the same nest site. Usually, the male is the first to return to the site. It often appears to accept the first female to come back to the breeding area, whether it's previous mate or not.

Even if they do not breed, storks in their first four years exhibit some sexual and courtship behaviors even though they never produce a clutch (Bloesch, unpubl. in Hall *et al.* 1986). Sub-adult birds may occupy a nest or construct a new one, and defend nest sites and sometimes form temporary pairs without breeding (Hornberger 1967). This pair formation may last for part of one season or more.

Territory plays an important role in the pair bond of White Stork. They fight viciously for the possession of their nest, and once in possession it forms a stronger bond with the nest than with its mate (Schüz 1938).

#### 1.2.7.2 Egg Laying and Incubation

Mostly, young birds reach sexual maturity in their third or fourth year (range 2-7 years) (Barbraud *et al.* 1999). Some of the white storks may start to breed at the age of 3, and most of them reproduce with the age of 4 (Schnetter&Zink 1960; Siefke 1981). According to Schüz (1936), three year olds often breed, but either raise fewer young than older birds or none at all.

The eggs are variable in shape. They are generally chalky white. The White Stork has one brood a year. The records of clutch replacement is rare (Haas 1963).

The incubation period covers the interval between the laying of the first egg of a clutch and the hatching of the eggs. For this species, as for many other bird species, the incubation period is fixed and lasts 33-34 days (Haverschmidt 1949), and both sexes fulfill the incubation duties. In a clutch, the female may lay some infertile eggs due to immaturity and incubate them together with fertile ones during the breeding season.

Eggs are laid at an interval of 1-4 days (Haverschmidt 1949). Incubation starts with the first egg. Therefore hatchings of chicks occur asynchronously. The first hatched chick has an advantage over their younger siblings. Egg shells are discarded over site of the nest after hatching of the chick.

#### 1.2.7.3 Looking After Hatchlings

Storks show an altricial type of development (Skutch 1976) with hatchlings unable to thermoregulate or locomote, depending completely on their parents for food and shelter, and staying in an open nest throughout the 60-90 days of growth and development (Redondo et al. 1995, Tortosa & Castro 2003). However, as hatchlings show a loose downy plumage and open eyes, depending on the classification, they may be considered as semi-altricial (Nice 1962) or semi-altricial-1 (Starck 1993).

Both parents feed the young on the nest until they fledge at 8-9 weeks of age at the end of 58-64 days of fledging period (Haverschmidt 1949). Due to undeveloped homeothermy ability at the time of hatching, stork nestlings are more sensitive to environmental conditions occurring before 20 days of age (Jovani R. & Tela J.L, 2004). Therefore, nestling mortality concentration occurs within this sensitive period. They are fed by parents' regurgitating onto the floor of nest. Until the tenth day the chicks need to be fed every hour, until the 15th day every two hours, and thereafter less frequently. One of the adults will always stand guard near the nest,

and in rainy or cold weather the adult covers the young and on sunny days it protects them with its shadow.

#### 1.2.7.4 Development of a Chick

Newly hatched young are covered with white down feathers. At day 7, second down feathers are dense, white and woolly, the bill is black, the eyes are grey, and the legs and feet are grayish yellow. By the third week, black scapulars and flight feathers begin to appear and the young is fully feathered by 45 days.

The nestling starts to flaps its wings from 14$^{th}$ days of age and is able to stand at day 22. They are brooded almost continuously up to 10$^{th}$ days, thereafter mainly shaded when necessary. After 45$^{th}$ days, parents may leave the chicks alone in the nest (Brown *et al.*, 1982).

Food at first is dropped into nest and picked up by young. At around the 12$^{th}$ day, the chicks can grab the parent's bill to encourage for the feeding and can feed directly from the adult's bill. The fledglings depend on adults around a month afterwards leaving the nest, prior to their migration (Brown *et al.*, 1982, Hancock *et al.*, 1992).

#### 1.2.7.5 Fledging of Young

Long before they are ready to fly from the nest, young birds develop essential strength through exercises. The nestlings jump up and down and flap their growing wings with increasingly effective strokes. After many flight exercises, the young fledge from the nest. Fledglings may continue to return to the nest site each evening to beg for food from their parents.

## 1.3 Behavioral Studies

Behavior of animals has always attracted human beings for various reasons. The first observations of animal behavior were made in the ancient times. Early hunters needed to learn wild animals' behaviors to survive, and in the meanwhile, to track the game animals, they have begun to domesticate wild dogs.

### 1.3.1 What is Behavior?

Behavior is all observable and measurable muscular and secretory responses (or lack thereof) and related phenomena in response to changes in an animal's internal or external environment and is often directed towards something in the outside world, such as prey, a mate or a nest (Grier & Burk 1992).

Behavior in birds, as in all animals, is largely directed toward self-survival. The way in which an animal behaves depends in large part on its behavior equipment: the sense organs or receptors, the correlating nervous system, and the effectors or muscles and glands. Since all these structures are inherited, a hereditary basis exists for the behavior for any species.

According to ethologist Niko Tinbergen (1907-1988), there are four causes of behavior and these causes can be grouped into two larger classes: ultimate causes and proximate causes. The two causes that contribute to ultimate causation are phylogenetic contingencies and the second is flight adaptive significance. Phylogenetic constraint factors generally might stop development of certain behavioral or morphological traits. Adaptive significance is related with asking whether a trait is good in an evolutionary context. Therefore, the adaptive significance of a behavior in birds might have enabled avian ancestors to escape from predators.

Proximate causation is also divided into ontogenetic factors and mechanistic factors. Ontogenetic factors are the entire sum of experience throughout the lifetime of an

individual from embryo to death. Mechanistic factors, as the name implies, are the processes of the body that give rise to behavior such as the effects of hormones on behavior and neural basis of behavior.

### 1.3.2 Approaches to Behavioral Studies

#### 1.3.2.1 Ethology

Ethology can be defined as the biology of behavior. The exploration of functional and evolutionary questions, and the mechanisms underlying why an animal exhibits certain behavior patterns under certain circumstances. The first step of an animal behavioral study is preparing an ethogram of the animal. An ethogram serves as a basis for posing questions about the adaptive value, ecological importance and regulation of various behavior patterns.

#### 1.3.2.2 Comparative Psychology

This is a discipline devoted to comparative studies of behavior in animals. The primary emphasis has been on "how" questions about the mechanisms that underlie observed behavior patterns. Comparative analyses lead to the discovery of relationships between various types of behavior and species.

In comparative psychology, one line of research is based on defining, identifying and characterizing the classes of behavior pattern in two or more species. Another is the selection of a most appropriate species for investigation of particular problem.

#### 1.3.2.3 Behavioral Ecology and Sociobiology

Behavioral ecology, which emerged from ethology after Tinbergen, deals with habitat selection, feeding and other aspects of a species' ecological niche, with

particular reference to behavior. It is also a search for the role of behavior in enabling animals to adapt to their environments.

Behavioral ecology like other areas of evolutionary biology, has included many techniques that have been borrowed from optimisation theory. Optimisation is a concept that stipulates strategies that offer the highest return to an animal given all the different factors and constraints facing the animal. One way to arrive at an optimal solution is to do a cost/benefit analysis. By considering the advantages of a behavior and the costs of a behavior, it can be seen that if the costs outweigh the benefit,s then a behavior will not evolve and vice versa. (Available on http://en.wikipedia.org/wiki/Behavioral Ecology).

Sociobiology is considered a sub discipline of behavioral ecology by some scientists and is basically concerned with the social system of a species, and how and why their particular social organization evolved. It is the biological basis for animal social behavior and is based on the idea that animals act in ways to improve their own inclusive fitness (kin selection). Therefore, animal behavior can be explained by how they act to preserve their genes in the population. For example, it can be used to explain why a lioness will nurse not only her own young, but the young of her close genetic relatives in the pride. (Available on http://en.wikipedia.org/wiki/Sociobiology).

### 1.3.3 Widespread Methodology in Behavioral Studies

In recent years, field studies of many animals have focused on research strategies and methods of collecting data under field conditions. Many of the techniques for behavioral observation that were first devised for use with primates have found broad application with many other animal species.

#### 1.3.3.1 Sampling Techniques

There are a number of sampling techniques used in the study of animal behavior. These range from very unstructured to very rigorously structured, and each has value in specific situations.

##### 1.3.3.1.1 Focal Animal Sampling

Focal animal sampling (Altmann 1974) involves recording all of the actions and interactions of one particular animal during a prescribed time period. This technique allows observers to watch a few focal animals over a long time period. (e.g., five or ten minutes per animal) (Drickamer *et al.,* 1996 pp: 34). The advantage of this technique is that a good number of samples can be collected with a focus on particular animal.

##### 1.3.3.1.2 Scan Sampling

In scan sampling, the researcher records the instantaneous activity or behavioral state of all animals for a few seconds at periodic intervals (e.g., once per minute). Although it is impossible to record the behavior of all individuals instantaneously, the researcher attempts to do so in as short a time period as possible. In this type of sampling technique, the behaviors are well defined so that scanning is made easier (Goldsmith 2006).

The advantage of this technique is that it allows the observer to sample many animals in a group or population and collect across wide range of behavior patterns. Therefore the technique is useful to understand the frequency with which all animals in the group display certain behaviors or behavioral states. Scan sampling is a common technique used to quantify the activities of animals, including waterfowl.

As an example, scan and focal animal sampling techniques were used in endangered American Wood Stork research to determine at what depth category storks foraged most often, and the data collected were used to identify and save prime habitat of the species (Standora 2006).

#### 1.3.3.1.3 Instantaneous Sampling

This technique is an alternative to scan sampling. As the name implies, an individual is observed repeatedly and behavior that the animal is engaged in is recorded at the instant of the observation. One result of this type of sampling technique is time or activity budget which consist of proportion of instantaneous observations in which an individual is engaged in various activities.

#### 1.3.3.1.4 *Ad libitum* Sampling

The type of observational technique employed by the curious naturalist is called *ad libitum* sampling. As the name implies, there are no constraints on the duration of the observation period, how many individuals are observed, or what data or observations are recorded. It is based on the method to record everything and anything that has been seen during the observation period.

### 1.3.3.2 Time Budget

Time budget studies focus on the amount of time individual animals spend on exclusive activities. These activities might be feeding, scanning for predators, grooming, caring for offspring or sleeping (Gill 1994). The time given to a particular activity may change during the lifetime of an individual; for instance, young mammals spend a lot of time sleeping and adults spend much less.

## 1.4 Aims and Scope of the Study

This study is a first attempt in Turkey to document and monitor a population of White Stork, over breeding seasons of multiple years in terms of breeding success, ecology and nest behavior of the species**.**

The aims of this study are:

- To find out the breeding success of a White Stork colony in Kızılcahamam and its fluctuations over several years.
- To find out probable behavioral differences between nests.
- To determine the effects of behavioural differences on breeding success of the nests.

# CHAPTER 2

# MATERIALS & METHODS

## 2.1 The Study Area

The study was carried out in Kızılcahamam (40º 28' 23.1 N - 32º 39' 25.3 E) (Figure 2.1). Kızılcahamam is 78 km north of Ankara and lies next to the Ankara-İstanbul highway (formerly known as E-5). The Soğuksu National Park borders the settlements of the town to the west.

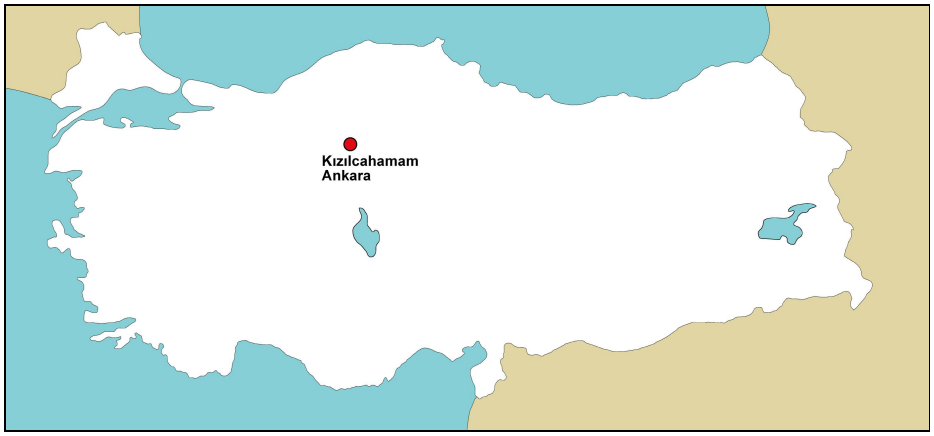


**Figure 2.1** Location of the study area on the map of Turkey.

The study area lies at about 950 m asl and is mainly covered with open land and scattered trees. The Kirmir Stream passes through the whole district diagonally. This river is a basic foraging area not only for White Storks but also for Black Storks (*Ciconia nigra*) and Grey Herons (*Ardea cinerea*) which breed around Kızılcahamam. Along the river, there are willow (*Salix* spp.) and poplar (*Populus* spp.) trees, and some small grassland. Along the southern part of the study area, both sides of the

stream are occupied by industrial estate and gas stations while the northern part of the river is covered by human settlement.


**Figure 2.2** A part of study area, Kirmir Stream, some of the nests and and Kızılcahamam industrial estate.

## 2.2 Methods

This study was carried out during three years' (2004, 2005 and 2006) breeding seasons. For 2003, data were obtained through personal communication with Özge Keşaplı Can. During the breeding season (which lasts 5-5.5 months), the study area next to the industrial estate was visited two days a week (Figure 2.2). In 2004, the first observation date was 3rd of April and the last was on 9th of September and between these dates, totally 21 field observation visits were made. In 2005, the first observation was made on 8th of March and the last was on 26th of August. Totally 37 field observation visits were made.

In 2006, first field trip was made at the end of March and last observation was made 30th August and totally 10 field study were made.

Transportation to study area was basically by local minibus and rarely by private car. While collecting data during the field observations, a Nikon telescope with a zoom lens 20-25x and Nikon 8x40 binoculars were used.

In the beginning of the 2004 breeding season, to differentiate them from each other, nests that had been found until that date were numbered from 1 to 13 based on their localities. During the late breeding season of 2004, two new nests, numbered as 14th and 15th were constructed on the same roof between May 16-23 and May 30-June 13, respectively. However, both nests were destroyed in the winter of 2004 due to harsh winter conditions, but were built again on the same roof in the following breeding season between May 17-22 and July 17-21 2005. Besides, two old nests were found during field trips and numbered as nest 16 and nest 17, respectively. One of those nests was on the roof of the sports hall. The other nest was on the chimney of an old ruined house. Both were old and abandoned.

On May 17, 2005 during the work of local TEDAŞ authority, the location of the nest 6, which was on an electric mast, was changed with its mast (moved from 40º 27' 59-32º 39' 01 to 40º 28' 06.1-32º 39' 12.2). And since it was not known whether there were any eggs in the nest, the probable effect of this change of nest place is unknown.

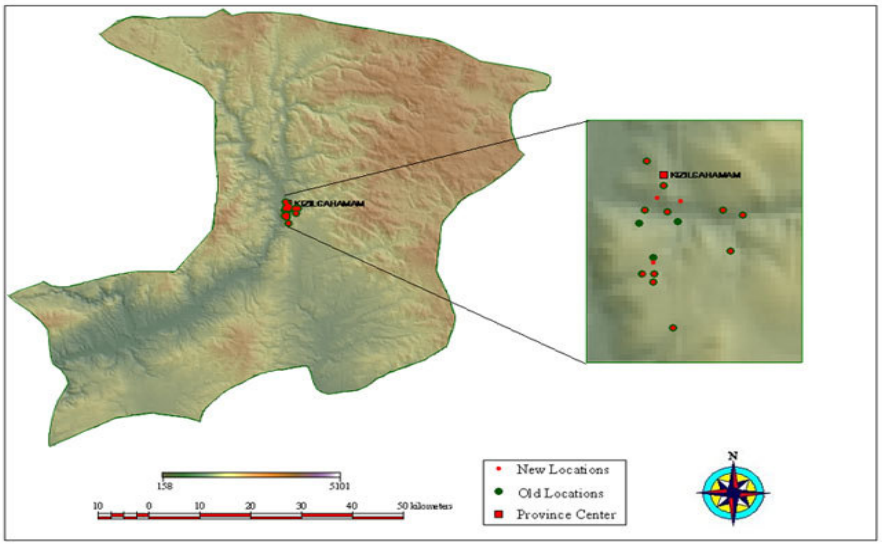


**Figure 2.3** Nest locations.
* Red dots reflect new locations and green dots reflect old locations of the nests.

In the beginning of 2006, nest 14 was at the same location and intact. On June 23, an attempt for a new nest construction was observed on the electric mast ( 40º 27' 34.4-32º 39' 09.0). This nest was numbered as nest 15 since there wasn't any nest present with this id number.

At the end of March 2006, on the first field observation day of the breeding season, it was observed that the nest 1 which had been located on the chimney in 2005 was not on its place, destroyed by the owner of the roof and the storks were prevented from constructing a new platform. A couple that was apparently searching for the former place of the nest made a new nest on a nearby telephone mast (nest location was moved from 40º 27' 98.0 -32º 39' 24.9 to 40º 28' 02.6 -32º 39' 25.3). This new nest was numbered as nest 1.

In the beginning of the 2006 breeding season, a shop owner in Kızılcahamam industrial estate demanded from the Municipality of Kızılcahamam to change the place of a white stork nest on top of a ventilation chimney above his. Therefore, a platform located higher than the chimney was constructed in suitable shape for the roof and the nest was placed on the platform in one piece. In half an hour, a pair of white storks arrived at the nest and occupied it.

**Figure 2.4** Nest 5 in 2005

**Figure 2.5** Nest 5 in 2006 (on the platform)

To show dates as numbers, during 2004 and 2005 breeding seasons field study dates were shown as pentads by dividing a whole year by 5 day-long periods. Since field work was not carried out every day, nearly each date corresponded to a pentad number.

On 7$^{th}$ of July 2005 (the first observation day after ringing), the nestling of nest 12 were not on the nest. This nest was the most successful one in terms of number of nestlings (four nestlings). Although they were one of the biggest nestlings in the breeding area, still it was early for these birds to fly from the nest. Since there were similar events in previous years, it was assumed that the nestlings were kidnapped from their nest. However, they were accepted as successfully fledged from the nest.

### 2.2.1 Data Collecting on Breeding Parameters

Arrival and departure dates for each nest and numbers of eggs, hatchlings and fledglings were recorded. To obtain these data, 5 observation points were chosen. In some years, information on clutch sizes for nests 2, 4, 5, 6, 11 and 14 could not be obtained due to these nests' unsuitable locations, the excessive distance to all

five observation points or the nest's height. Also on the first few days after hatching, the chicks may be impossible to see from outside due to their small body size and since parents generally continued to brood over them. In addition, storks used some materials from the rubbish dump located on the upper part of the industrial estate, which sometimes might seem as if they are chicks. Therefore, from a far distance – either with a telescope or not– it was not always possible to tell the presence of stork chicks with certainty.

### 2.2.2 Data Collecting on Nest Behaviors

In 2004 and 2005, behavioral observations of most of the nests were also carried out. For the year 2006, only 8 observations have been made to obtain egg, hatchling and fledgling numbers for each nest.

There are some differences between 2004 and 2005 study years in terms of the number of visits and the method used to collect behavior data**.** In 2004, 14 nests were observed for behavioral studies. Three observation points were chosen in the area due to visibility of these 14 nests from the points. From each point different nests were observed. Therefore, all the nests were not able to be watched in the same time periods and from the same observation points, yet some of them which were seen from the same point were observed together.

The nest 13 was located 1 km away from the other nests and was not possible to observe from the observation points, therefore only a few special observations were made for it and those were not included in the behavioral analyses.

In the very beginning of 2005 breeding season, to collect nest behavior data, another observation point from where all 14 the nests can be seen was found and so all nests were observed from the same point and in the same time intervals during the whole breeding season. For both years, from each points, observations were basically made throughout a two hour-long interval. On some days some extra information were collected on behaviors performed at the nests and these were

included into behavior analyses. Due to some restrictions such as harsh weather conditions, on some days the observation duration was shorter.

Nest 17 was abandoned in all three breeding seasons (2004-2006) although on 21st of July 2006, an individual was on the nest and new nest materials brought to the nest were observed. This nest was excluded from analyses.

**Table 2.1** Number of 10-minute observations in 2004 breeding seasons

| 2004 | IN A SEASON | | |
|---|---|---|---|
| NEST NO | Morning | Midday | Afternoon |
| 1 | 56 | 63 | 43 |
| 2 | 48 | 63 | 40 |
| 3 | 15 | 66 | 51 |
| 4 | 12 | 66 | 48 |
| 5 | 13 | 67 | 62 |
| 6 | 13 | 62 | 70 |
| 7 | 12 | 64 | 55 |
| 8 | 24 | 61 | 74 |
| 9 | 22 | 53 | 70 |
| 10 | 20 | 52 | 69 |
| 11 | 23 | 56 | 80 |
| 12 | 21 | 54 | 74 |
| 13 | 5 | 0 | 6 |
| 14 | 16 | 50 | 67 |
| 15 | 11 | 49 | 63 |
| 16 | 0 | 0 | 4 |

**Table 2.2** Number of 10-minute observations in 2005 breeding seasons

| 2005 | IN A SEASON | | |
|---|---|---|---|
| NEST NO | Morning | Midday | Afternoon |
| 1 | 104 | 216 | 121 |
| 2 | 105 | 215 | 117 |
| 3 | 107 | 243 | 107 |
| 4 | 107 | 247 | 123 |
| 5 | 105 | 244 | 116 |
| 6 | 107 | 221 | 107 |
| 7 | 107 | 247 | 119 |
| 8 | 109 | 252 | 121 |
| 9 | 109 | 240 | 121 |
| 10 | 107 | 238 | 122 |
| 11 | 107 | 246 | 120 |
| 12 | 106 | 257 | 123 |
| 13 | 9 | 25 | 30 |
| 14 | 77 | 139 | 59 |
| 15 | 21 | 15 | 3 |
| 16 | 0 | 5 | 13 |

Scan sampling was used as the main method. Within two-hour intervals each nest were scanned every ten minutes through binocular and/or telescope and behavior types were noted. Each nest observation was followed immediately by an observation at the next nest. By this way, the number of observations of these ten-

minute intervals was equal to each other and there were 12 observations for each nest within a two-hour interval.

Results were analyzed and all graphs were obtained mainly in Microsoft Excel. The probable correlation between fledgling success, years and nest locations was tested with general linear model (GLM) and to analyze the effects of different behaviors on breeding success of the nests, behavioral dataset was tested by multiple regression. ANOVA for Windows version 14.0 was used for both analyses.

In 2003, nest occupancy and numbers of eggs, chicks and fledglings for some nests were determined during field work on May 25, June 1 and 7. In the same year, on 12th of July the first ringing of White Stork nestlings was conducted in Turkey by Turkish Bird Research Society (KAD) and Kızılcahamam were chosen as a pilot area. As a result, 17 nestlings were ringed from 7 nests in the study area. On 20$^{th}$ June 2004, a second ringing study and on 2$^{nd}$ July 2005 a third ringing study were conducted and 20, 13 nestlings were ringed respectively.

During the ringing, wing, bill and tarsus lengths were measured with a ruler. Body mass was measured by using a 10 kg pesola balance. The White Stork rings were put on each nestling's right tarsus when the nestlings were 6-7 weeks old, just before they fledged from the nests.

The ring was green colored and made of aluminum with a unique serial number on each of them. Besides the code, there was a standard address of "ODTÜ-KAD ANKARA TURKEY" on the ring. Therefore, it was possible to identify the ringed birds not only during breeding season but also for the lifetime when it would be seen. Unfortunately, due to the use of inappropriate dyes during their production, writings on some rings that were used in 2005 became indelible after a year.


**Figure 2.6** National White Stork ring

## 2.3 Periods of Breeding Seasons

Breeding seasons of the years 2004 and 2005 were divided into four parts based on stages of breeding by White Storks. These are mating, incubation, fledging and post-fledging. Since there was no observations for each day of the breeding period, to determine the pentad number of the periods I made some assumptions.

The mating period starts with the arrival of both adults at the nest, and lasts until the start of incubation. To determine the beginning of the mating period, the first date of seeing a second individual on the nest was searched. If there were two individuals, it is accepted as this is a proven occupation and the first day of the mating period of that nest. To calculate the duration, the number of days between the date after the last observation date without two individuals and the first day with both individuals were computed, and the median date was found, and if there were two dates as median date the first is accepted as the beginning of this period and then the equivalent number from the pentad list was found (Appendix B).

The incubation period starts with the first day of incubation. In the study this period is accepted as lasts 34 days according to Haverschmidt (1949) and involves the incubation of eggs. To determine the approximate dates for the start of the incubation period (probable earliest and the latest days), analyzing was started with the day before the first observation of a chick at the nest and then counted

backwards 34 days to reach to the possible latest limit of the beginning of incubation. To find the earliest date, firstly one day after the last observation date that no chick was seen on the nest prior to hatching was found and 34 days were counted down and a new date was found as the date of beginning to incubation. Then the days were counted between the earliest and latest dates and a median date was found and was accepted as the starting date of incubation period.

The raising young period lasts 58-64 days. It starts with the hatching of the first young and lasts until the first young fledged from the nest. To determine the pentad number of beginning of this period, two dates were searched (earliest and latest). To find the latest date of incubation, the first observation date of the chick on the nest was assumed as the first day of hatching and for the earliest date, the day after the last observation date with no hatchling was assumed as the day of hatching. The median day between these two dates was calculated and its pentad number was used as the beginning of hatching.

The post-fledging period starts with fledging of young and lasts until departure date of migration. To calculate the beginning of this period, the earliest and latest days were searched. To determine the latest date of the period, the first observation date of first fledgling's flight was taken and the earliest date was assumed as the day after the last observation with no hatchling flied.

## 2.4 Behavioral Categories

The nest site is the center of social activities during the breeding season. For this reason and because foraging may take place far from the nest site, only behaviors at the nests was recorded.

Five main categories of behavior types, namely Antagonistic Behavior, Heterosexual Behavior, Parental Care, Other Behavior and Behavior of Young, were considered. The first four categories include adult's behavior; the behavior of young category includes all young behavior that was performed at the nest by nestlings.

Even if an adult was not on the nest, if it was still near the nest (for instance on the next chimney or just outside of the nest, or even it was seen landing nearby the nest), it is accepted as an adult on the nest.

Sometimes it could be see an adult was in between position, while finishing one behavior and starting to a new one, in such cases, always the first behavior was taken into account.

### 2.4.1 Antagonistic Behaviors

#### 2.4.1.1 Threat

Vigorously defends site against other adults and juveniles, giving Up-down display in threat, with wings partly open. This type of behavior includes threat up-down display and defensive nest covering display in case an intruder tries to land in the nest. These are direct responses to intruding or neighboring storks flying over the site or even towards a juvenile alighting in the territory. Male and Female together drop their wings and cock the tails and clatter their bills towards more persistent intruders. Male is more aggressive with rhythmically pumped wings and lowering body than female while there is a strange bird nearby. Since some part of this behavior is similar with the greeting display, to differentiate bill clattering in greeting and threat, it is assumed that if one foreign individual was around that nest, then this behavior would be threat toward that bird.

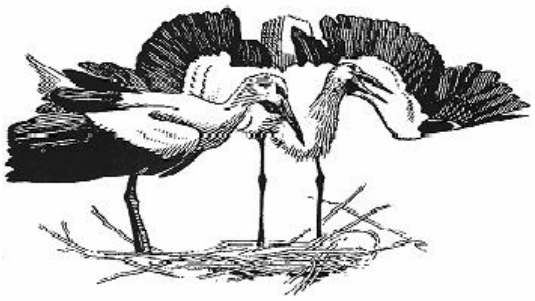

**Figure 2.7** Threat behavior by both adult**.**

#### 2.4.1.2 Fight

It is exhibited when an intruder manages to land on the nest. Behavior consists of pecking with bill, beating with wings and attempts to push intruder over the rim of the nest. Adults may fight so vehemently over nest territory that eggs are crushed and sometimes one of the combatants is killed (Schüz 1944).

### 2.4.2 Heterosexual Behaviors

#### 2.4.2.1 Greeting Display

Expressed by series of up-down displays and bill-clattering given repeatedly by both sexes when one or both partner arrives at nest; returning bird starts in air, few meter from the nest, and guard or incubating bird may join immediately or sometimes not, often while incubating. Greeting Display may be performed by one individual after its arrival at the nest.

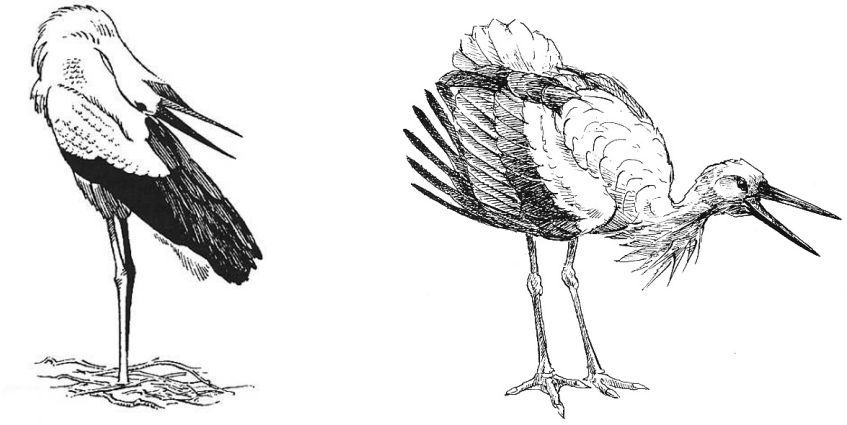

**Figure 2.8** Different postures of Greeting display behavior.

#### 2.4.2.2 Copulation

Male walks slowly to female, both of them usually move for short time in circle or semicircle until she eventually stops. When she stands in a suitable position, male

lays bill and neck sideways over her back and mounts by gently stepping on, adjusting balance with slowly flapping wings, and bending legs to lower body into position. Copulation can also occur when female is sitting or lying down on nest.

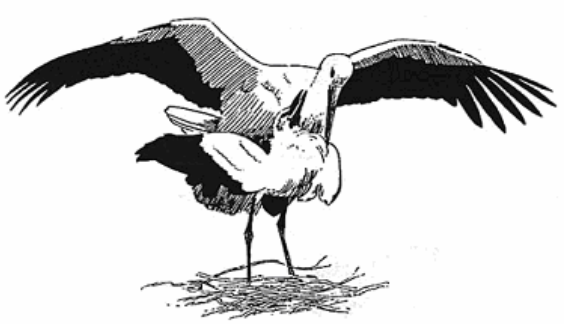

**Figure 2.9** Copulation behavior.

#### 2.4.2.3 Allo-preening

Occurs in both sexes, generally the female nibbles crown feathers of the male as he sits or lies down.

### 2.4.3 Parental Care

#### 2.4.3.1 Incubation Behavior

It is shown in the incubation period for about 33-34 days. In order to keep eggs warm, both sexes lay down on the eggs without any movement for regular time intervals. Female mostly lies down on the eggs at night. (Haverschmidt 1949) And after incubation period the parents continued performing incubation behavior to help protecting the body heat of the chicks. And since before 20 day of age the nestling are especially sensitive to environmental conditions and are incapable of self- thermoregulation (Jovani & Tella 2004), behavior includes sitting on the chicks to cover them were thought as another type of incubation behavior and called as brooding.

It is accepted that an individual cannot perform more then one behavior on the nests. Therefore, following assumptions were made: While incubating if an individual preened or arranged nests materials then this individual was accepted as performing the latter behaviors.

#### 2.4.3.2 Turning Eggs

It is performed during incubation by both sexes. While turning eggs, the adult shows a specific posture and thus this behavior could be regard as a clue on probability of the existence of an egg in the nest.

#### 2.4.3.3 Bringing Food or Water

Hatchlings are fed by both parents by regurgitating on to the floor of nest. If regurgitation of the adult was not observed but nestlings where observed while eating food soon after a new coming adult, or if the adult was dividing the food into pieces then it is regarded it as bringing food behavior. Food delivery rates vary according to the age of young. Fledglings require more than younger aged chicks.

#### 2.4.3.4 Shadowing

Due to protect the nestlings from the direct sun or in bad weather from rain or even snow, shadowing behavior is shown by both sexes. An adult standing above the nestlings (even though it did not spread wings) were assumed to be performing shadowing behavior. Even in shadowing position, an adult bird could arrange nest material or preened. This individual was not accepted as performing shadowing behavior.

#### 2.4.3.5 Preening Young

Both obvious preening of young and simply touching a chick's wing or head feathers by an adult (beginning of proper preening) were considered under this category.

### 2.4.4 Other Behaviors

#### 2.4.4.1 Self-preening

This behavior may occur while an adult is standing up or lying down at the nest floor. Preening with using bills or leg as a comb was accepted as such.

**Figure 2.10** Different types of preening behavior.

#### 2.4.4.2 Resting

An adult standing on the nest (but not directly over the young), not moving and not feeding is considered to be resting. Sometimes it rests standing on one leg, with/without bill buried in ruff of foreneck; this posture is useful to minimize heat loss.

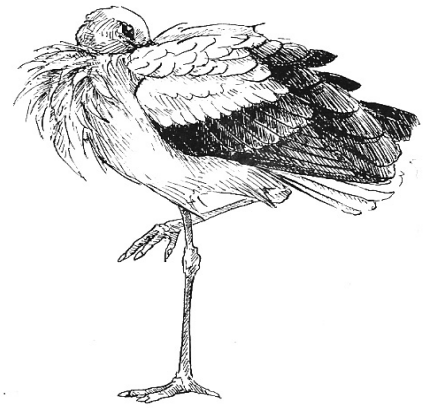

**Figure 2.11** Resting behavior.

#### 2.4.4.3 Nest Maintenance

This category includes bringing nest materials such as grass, small branches of trees, etc. to the nest or arranging the materials that are already on the nest.

### 2.4.5 Behavior of Young

#### 2.4.5.1 Begging Food

Starting with lowering the body, partially opening the wings and flapping, a sound that resembles the mewing of a cat may follow this behavior. It is observed in the older aged young before leaving the nest and continues to be performed in post-fledgling period. Begging cries of nestlings stimulate parents to deliver food and to regurgitate instantly to the ground of the nest.

#### 2.4.5.2 Preening

It may occur when a young is either standing up or lying down on the nest floor. Preening with using both bill and leg as a comb was accepted as preening.

#### 2.4.5.3 Resting

Standing on the nest or laying down, not moving forward or feeding is defined as resting. For the first 20 days of nestlings, adult's resting behavior was assumed as grooming while lying down on the chicks and shadowing while standing above the nestlings.

#### 2.4.5.4 Flight Practice

It is shown among nestlings from 3-4 weeks onwards until first departure from the nest. They jump up and down the nests and flap their growing wings with increasingly effective strokes. This category includes all wing movements related with flight.

# CHAPTER 3

# RESULTS AND DISCUSSION

## 3.1 Arrival and Nest Activity

In 2004, because of a late start to field work (in the very beginning of April), arrival of the individuals to the breeding area in March could not be observed. The first nests which were found to be occupied on April 3 were 1, 3, 5, 7, 9, 11, 12 and 13. But for the first two field observations, the duration of the observation time was too short to understand whether the rest of the nests were occupied or not.

In 2005, in the first two field observations, there were no individuals in the breeding area and the first stork was seen by a local worker on March 18 on nest 12 and it is learnt that the individual stayed there until midnight (pers.comm). But during the observation made on March 19, there was no individual in the area. Since two individuals on the nest gives more reliable information on the occupation of the nest, the date of the first occupation by both individuals were accepted as the occupation of nests. Nest 3 and nest 12 were the first occupied nests, which were followed by the nest 11.

In 2005 and 2006 with the help of the Ministry of Environment and Forestry and the Municipality of Kızılcahamam, two nest platforms for white storks were constructed and erected in suitable and safe areas away from the industrial estate, next to the Kirmir Stream in Kızılcahamam. In both years the platforms were used by White Storks as a resting place and were not occupied.

## 3.2 Breeding Success and Causes of Mortality

Between years 2004-2006 there were the same numbers of nests observed in the area but in 2003, since not all the nests were visible, the real numbers in each column for this year may be different in Table 3.1. For instance there might have been more nests in the area than shown in the first column of the table. However, the values for this year were shown to compare with other years.

**Table 3.1** Breeding values for the years.

| Year | Total number of nests | (A) Number of occupied nests (by a pair) | (B) Number of occupied nests with eggs laid | (C) Number of nests with successful breeding (young fledged) | (D) Total number of fledged young (sum of all nests) | (D/A)Average fledgling per nest attempt | (D/B) Average fledgling per nest with eggs | (D/C)Average fledgling per successful nests |
|---|---|---|---|---|---|---|---|---|
| **2003** | **16** | **10** | **8** | **7** | **21** | **2.10** | **2.63** | **3.00** |
| **2004** | **17** | **14** | **11** | **10** | **42** | **3.00** | **3.82** | **4.20** |
| **2005** | **17** | **14** | **9** | **7** | **17** | **1.21** | **1.89** | **2.43** |
| **2006** | **17** | **16** | **15** | **14** | **47** | **2.94** | **3.13** | **3.36** |

The mean reproductive output (average of four years' values in columns D/B in table 3.1) for the Kızılcahamam population was 2.95 for an average of 4 years. In comparison, a much larger sample size (n=42, 407 breeding attempts, 1983-2001) for Poland and eastern Germany yielded the values 2.08 and 1.91 fledglings per breeding attempt, respectively (Schaub 2005). This difference may be due to cooler conditions occurring in Northern Europe during the breeding season compared to the general climatic conditions of Kızılcahamam district. Therefore, chick mortality could be higher in those areas with a short warm season.

In general, it can be said that each year's total number of fledged young changed sharply throughout 4 years. The year 2005 was the year with the least number of fledged young among all years. According to Schulz (1998), years with adverse

weather conditions and food supply, a large proportion of storks do not breed or start to breed very late resulting in very low breeding success, death of many of the chicks and a high proportion of non-breeding individuals.

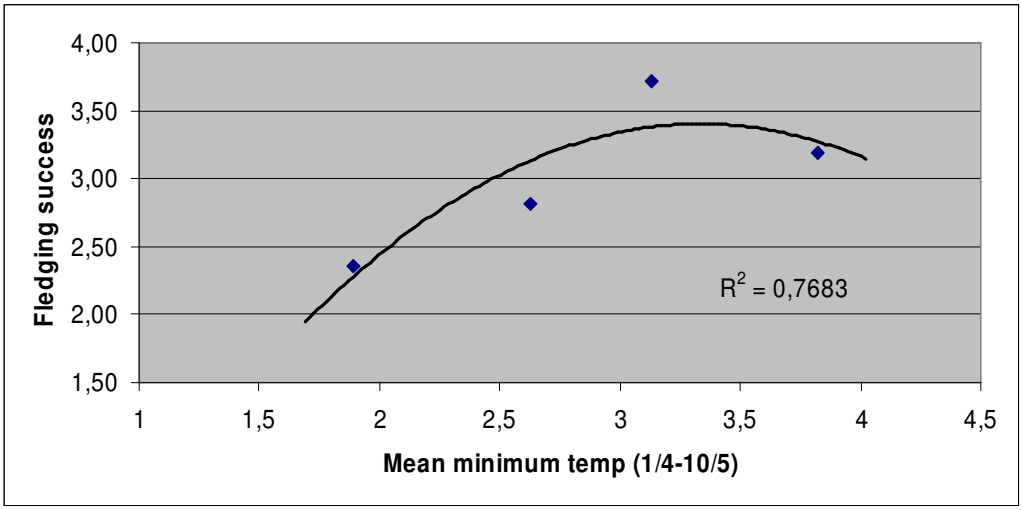


**Figure 3.1** Relation between temperature and fledgling success.

**Table 3.2** Breeding success and air temperature values for four years.

| WEATHER/FLEDLING SUCCESS | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|
| Fledging success | 2,63 | 3,82 | 1,89 | 3,13 |
| 1 Apr-10 May mean min C | 2,81 | 3,19 | 2,36 | 3,71 |

Daily temperature values for four years were obtained from General Directorate of State Meteorological Works, and mean minimum air temperature between 1 April-10 May were calculated for each year. This duration between dates includes the critical incubation period, hatching and the first few days of chicks after hatching in which they may get easily affected by cold weather conditions. It is easily seen from both the Figure 3.1 and the Table 3.2 that there is a positive correlation between minimum temperature and breeding success (i.e. average number of fledglings per nests with eggs).

The fluctuation in reproductive output can be reflected by four related parameters: the total number of fledged young, average fledgling per occupied nest, average fledgling per nest with eggs, and per successful nest (i.e. those having fledged young) in different years. The year 2005 had the smallest values for almost all parameters. Although the number of occupied nests were the same in 2004, both the number of breeding pairs and the average number of fledged young per breeding pair were negatively affected by late arrival to breeding grounds in 2005 and these values were relatively of a smaller quantity. In other words, although many of the nests were occupied, several such pairs could not establish themselves as reproductive parents.

**Table 3.3** Fledgling numbers per nest per year.

| NEST NO | 2003 | 2004 | 2005 | 2006 | Mean±SE |
|---|---|---|---|---|---|
| 1 | 3 | 2 | 0 | 4 | 2.25±0.85 |
| 2 | ND | 4 | | 3 | 3.50±0.50 |
| 3 | 2 | 5 | 2 | 3 | 3.00±0.71 |
| 4 | 2 | 4 | 1 | 4 | 2.75±0.75 |
| 5 | 4 | 4 | 3 | 5 | 4.00±0.41 |
| 6 | ND | | | 3 | 3.00 |
| 7 | 0 | 3 | 0 | 3 | 1.50±0.87 |
| 8 | 1 | 0 | | 4 | 1.67±1.20 |
| 9 | 5 | 5 | 0 | 3 | 3.25±1.18 |
| 10 | | | 2 | 3 | 2.50±0.50 |
| 11 | | 5 | 3 | 2 | 3.33±0.88 |
| 12 | 4 | 5 | 4 | 5 | 4.50±0.29 |
| 13 | ND | 5 | | 0 | 2.50±2.50 |
| 14 | | | | 3 | 3.00 |
| 16 | ND | | 2 | 2 | 2.00±0.00 |
| Mean±SE | 2.62±0.60 | 3.82±0.48 | 1.70±0.45 | 3.13±0.32 | |

∗ ND means No Data for the related cell, the empty cell reflects no fledgling for those nests even if breeding attempt was observed, " 0 " in the cell means breeding attempt with no successfully fledged young.

During four breeding seasons, nests 5 and 12 were the most stable nests in terms of high breeding success during all four years. The averages and standard errors for fledged birds for these nests were 4.00±0.41 and 4.50±0.29**,** respectively (Table 3.3). Nest 13 showed the biggest fluctuation (0 vs. 5) in number of fledged young throughout 2004-2006. Nest 9 and 8 followed nest 13 with higher standard errors than 1.00.

The average number of nestlings per nest was highest in 2004 (3.82) while the fluctuation in number of nestlings was highest in 2003 (Table 3.3). The year with the lowest number of fledglings and largest number of nests that no breeding occurred was 2005. In this year no fledglings were seen in 50% of the nests (see Table 3.3). There were fluctuations between these four years as can be seen from Figure 3.2. 2004 and 2006 were the years with highest fledged numbers (i.e. breeding success).

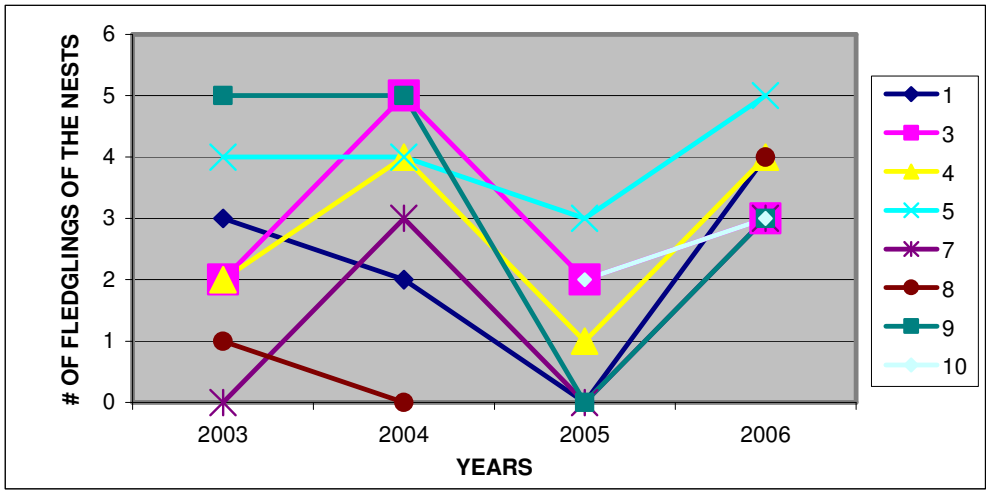


**Figure 3.2** Fluctuation in fledged young numbers of some nest.

The figure 3.2 does not contain all nests with fledglings but only the nests that at least one young was fledged in all 4 years. In 2005, there was a sharp decrease in numbers of fledged young for all nests. This could be partly due to smaller number of breeders which had returned from wintering quarters. The winter of 2004-2005 in

Africa was drier then the year before (Roman Guziak, pers.comm.) and the storks of Kızılcahamam may have started to migrate late due to insufficient food supply than that they needed to start migration. In addition, the year 2005 had a harsh winter in Turkey compared to other three years of the study (see Figure 3.1 and Table 3.2). Unfavorable weather conditions on the migration route and also in breeding grounds can effect entire populations (Tryjanowski et al., 2004). While traveling on their migration route in March, many of the storks had died due to cold weather conditions and lack of sufficient food supply (unpubl. data). The following year (2006) there was an increase in the number of young that fledged successfully from the nest.

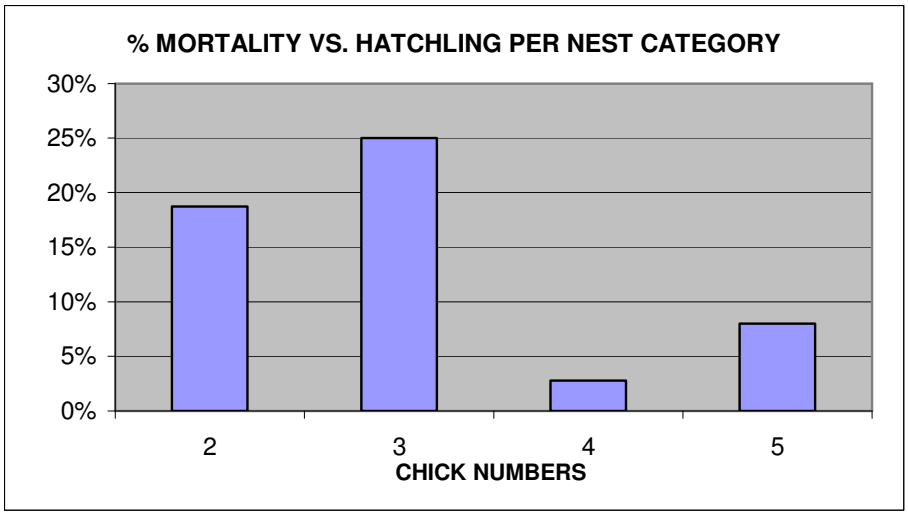


**Figure 3.3** Percent Mortality of chicks of the nests with 2,3,4 and 5 brood sizes.

During four years (2003-2006) totally 39 pairs were assessed for mortality of nestlings in relation to the number of hatchlings in the nests. The nests with one and six hatchlings were not observed; therefore four categories are shown on the Figure 3.3. Interestingly, nests with 2 or 3 nestlings had higher chick mortality than those with 4 or 5 nestlings. This finding contradicted with Massemin-Challet *et al.* (2006) in which the highest chick mortality in nests with five chicks was found in Alsace (France). The results of this study indicate that, unlike in Alsace, chick mortality is not due to limited food supplies. One explanation could be that those

females that lay 2 or 3 eggs (and their mates) are inexperienced adults and they may not have been able to look after their young as well as more experienced pairs.

### 3.3 Phenological Differences Between Two Breeding Seasons

During the whole breeding seasons in both 2004 and 2005, different phenological aspects of the White Stork pairs were recorded in terms of dates of nest occupation, breeding, fledging of young from the nest and departure for migration.

Compared to 2005, breeding started earlier in 2004 and thus chicks were hatched earlier (in 27$^{th}$ and 28$^{th}$ pentads in Figure 3.4). However in 2005, hatching was delayed until the 28$^{th}$ pentad (Figure 3.5), with some eggs hatching as late as the 35$^{th}$ pentad. Fledging of young from the nests was similarly delayed.

In 2004, due to lack of information for some important dates such as the beginning of incubation or hatching dates for the chicks, for some nests these dates were not determined and question marks were used in Figure 3.4. Although the occupation dates were unknown, it is clear from the figures that the beginning and last dates of these periods were similar in this year.

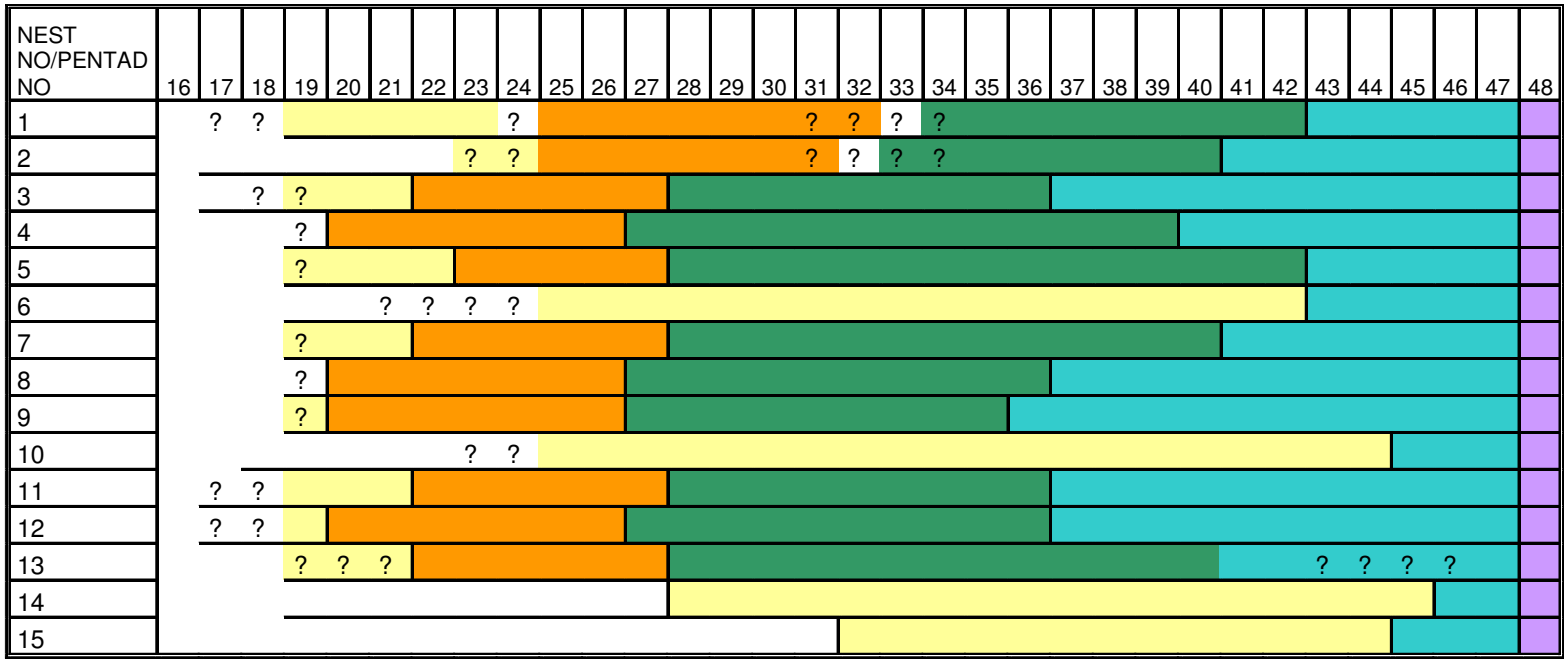


**Figure 3.4** Phenology of the nests in 2004 ("?" reflects unknown data on starting or last date of related pentads.)

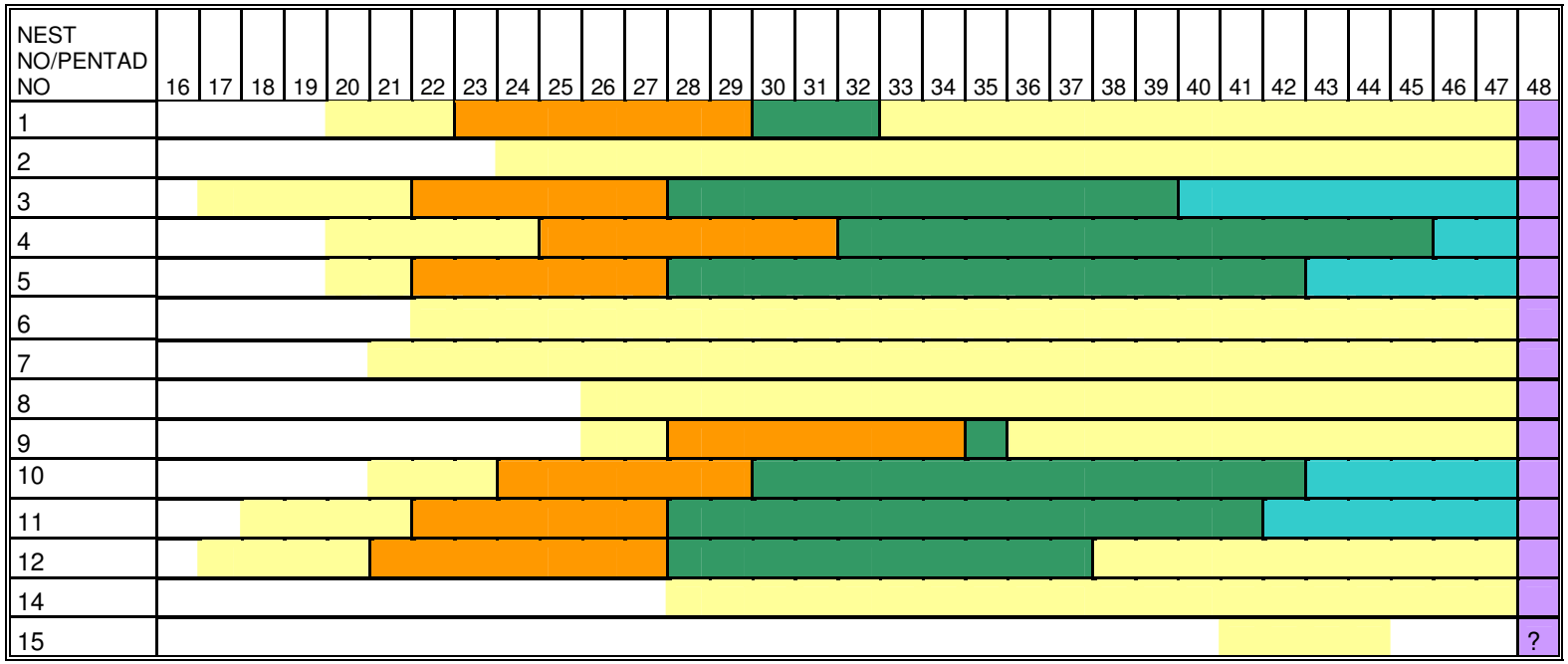


**Figure 3.5** Phenology of the nests in 2005

Nest occupation by both adults
Incubation period
Raising young period
Post-fledging period
Migration

Observations of 13 in 2005 and for both years observations of nest 16 were insufficient. Therefore, the four periods for these nests were not determined (Figure 3.5).

In 2005, although the exact location of nest 15 had changed, nests 14 and 15 were situated on the same roof. As in 2004, there was no breeding attempt in these nests in 2005. These birds might have been sub-adults that constructed a nest late in the season to obtain experience without breeding; for instance, nests 2, 6, 7 and 8 were occupied throughout the breeding season but no breeding occurred (Figure 3.5). In 2005, there were five nests with fledged young.

On 7$^{th}$ July 2005, the first observation date after ringing at the site, four nestlings of the nest 12 disappeared from the nest and could not be seen anywhere in the area afterwards. There was some evidence that they have been stolen from their nest. The reason for this is apparently to set up a private zoo to attract ecotourists since White Storks are an important addition to such a venture. Therefore, the last part of raising young period for the nest 12 could not be observed.

### 3.4 Differences Among Nests (Pairs) and Years

To understand the variation in fledgling success between different years and at different nest locations, the General Linear Model (GLM) approach was used for years 2004 and 2005. According to Table 3.4, there is a significant annual variation in breeding success (P=0,002) but no significant relation was found between nest site and fledgling success (P=0,206).

There is also no significant interaction between these two factors (years and nest locations, P=0,812). However, since R-Sq value could explain only a part (41.72%) of the differences in fledgling success at different nests and in different years, there might have been some other possible factors (like behavioral differences between the owners of the nests) that may affect outcome.

**Table 3.4** Results of general linear model

**General Linear Model: fledged versus nest locations; year**

| Factor | Type | Levels | Values |
|---|---|---|---|
| Nest loc | fixed | 4 | 1; 2; 3; 4 |
| Year | fixed | 3 | 2004; 2005; 2006 |

**Analysis of Variance for fledged, using Adjusted SS for Tests**

| Source | DF | Seq SS | Adj SS | Adj MS | F | P |
|---|---|---|---|---|---|---|
| Nest loc | 3 | 11,214 | 12,930 | 4,310 | 1,61 | 0,206 |
| Year | 2 | 42,133 | 41,954 | 20,977 | 7,85 | 0,002 |
| Nest loc*year | 6 | 7,822 | 7,822 | 1,304 | 0,49 | 0,812 |
| Error | 32 | 85,467 | 85,467 | 2,671 | | |
| Total | 43 | 146,636 | | | | |

S = 1,63427 R-Sq = 41,72% R-Sq(adj) = 21,68%

### 3.4.1 Nest Site or Position

A new nest built by June was accepted as an occupied nest for that year. Both the nests 10 and 11 were constructed in 2003 and they were added to Table 3.5 above as "occupied nests". Due to lack of information on some nests the number of occupied nests might have been underestimated.

**Table 3.5** 2003 Breeding values of nests on different locations.

| 2003 place of the nest | total # of nests | occupied nests (A) | # of nests with breeding (B) | % nests with breeding (B/A) | Av. # of fledged young in different locations (divided by A) | Av. # of fledged young in different locations (divided by B) |
|---|---|---|---|---|---|---|
| **Telephone mast** | 2 | 1 | 1 | 100% | 4.00 | 4.00 |
| **Electricity mast** | 4 | 4 | 2 | 50% | 1.00 | 1.34 |
| **Chimney** | 6 | 3 | 3 | 100% | 2.34 | 3.50 |
| **Roof** | 4 | 2 | 2 | 100% | 3.00 | 3.00 |

A new nest built by June was accepted as an occupied nest for that year. Both the nests 10 and 11 were constructed in 2003 and they were added to Table 3.5 above as "occupied nests". Due to lack of information on some nests the number of occupied nests might have been underestimated.

**Table 3.6** 2004 Breeding values of nests on different locations.

| 2004 place of the nest | total # of nests | occupied nests (A) | # of nests with breeding (B) | % nests with breeding (B/A) | Av. # of fledged young in different locations (divided by A) | Av. # of fledged young in different locations (divided by B) |
|---|---|---|---|---|---|---|
| **Telephone mast** | 2 | 2 | 2 | 100% | 5.00 | 5.00 |
| **Electricity mast** | 5 | 5 | 3 | 60% | 2.40 | 4.00 |
| **Chimney** | 5 | 4 | 3 | 75% | 2.20 | 3.67 |
| **Roof** | 4 | 3 | 3 | 100% | 3.00 | 3.00 |

**Table 3.7** 2005 Breeding values of nests on different locations.

| 2005 place of the nest | total # of nests | occupied nests (A) | # of nests with breeding (B) | % nests with breeding (B/A) | Av. # of fledged young in different locations (divided by A) | Av. # of fledged young in different locations (divided by B) |
|---|---|---|---|---|---|---|
| **Telephone mast** | 2 | 1 | 1 | 100% | 2.00 | 4.00 |
| **Electricity mast** | 5 | 5 | 3 | 60% | 1.00 | 1.67 |
| **Chimney** | 6 | 5 | 4 | 80% | 1.60 | 2.67 |
| **Roof** | 3 | 3 | 2 | 67% | 0.00 | 0.00 |

In 2006, breeding occurred in all the nests that were constructed on chimneys or roofs, but the average number of fledged young on nests at different locations was

similar (Table 3.8). On 23rd of July 2006, an egg was seen attached to the sticks of nest 13, but as there was no fledged young for that nest, these nest was not included into the Table 3.8.

**Table 3.8** 2006 Breeding values of nests on different locations.

| 2006 place of the nest | 2005 place of the nest | total # of nests | occupied nests (A) | # of nests with breeding (B) | % nests with breeding (B/A) | Av. # of fledged young in different locations (divided by A) |
|---|---|---|---|---|---|---|
| **Telephone mast** | 3 | 3 | 2 | 67% | 3.00 | 4.50 |
| **Electricity mast** | 6 | 6 | 5 | 83% | 3.20 | 3.20 |
| **Chimney** | 4 | 4 | 4 | 100% | 3.00 | 3.00 |
| **Roof** | 3 | 3 | 3 | 100% | 3.34 | 3.34 |

In all breeding seasons, the least fluctuation in fledgling success was at the nests that were located on chimneys (see Tables 3.4, 3.5, 3.6, 3.7). On the other hand, for all years the most successful nests were the nests that located on telephone masts. It can be suggested that the most dangerous nests (i.e. those with higher mortality risks) were the ones located on electricity masts due to risk of electrocution or collusion of birds with cables. In addition to adults, some young birds during their flight practices died of this reason in particular (unpubl. data).

### 3.4.2 Clutch Size and Breeding Success

For four years, there were some consistently successful nests in the study area. For these nests clutch size might have been small, but percentage breeding success may reflect better the suitability of nests in terms of location or behavioral differences that might have resulted from having or lack of experience of adults. Although it was a poor season, in 2005 nests 3, 5, 10 and 16 had 100% breeding success (chick success) (Table 3.9).

**Table 3.9** Percent Breeding values of nests for four years

| Years/Nest no | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2003** | 60% | UN | 100% | UN | 100% | UN | 0% | UN | 100% | UN | UN | 100% | UN | NN | NN | UN | UN |
| **2004** | 100% | 100% | 100% | 100% | 100% | NS | 100% | 0% | 100% | NB | 100% | 100% | 100% | NB | NB | NB | NB |
| **2005** | 0% | NS | 100% | 50% | 100% | NS | NS | NB | 0% | 100% | 75% | 80% | NB | NB | NB | 100% | NB |
| **2006** | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 0% | 100% | NB | 100% | NB |

*NS No Success **UN Unknown *** NB No Breeding ****NN No Nest constructed

**Table 3.10** Breeding parameters of the nests for four years.

| | 2003 | | | 2004 | | | 2005 | | | 2006 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nest Number | Egg number | Chick number | Fledged number | Egg number | Chick number | Fledged number | Egg number | Chick number | Fledged number | Egg number | Chick number | Fledged number |
| 1 | UN | 5 | 3 | 4 | 2 | 2 | 4 | 3 | 0 | UN | 4 | 4 |
| 2 | UN | UN | UN | ? | 4 | 4 | 0 | | | UN | 3 | 3 |
| 3 | 2+ | 2 | 2 | 5 | 5 | 5 | 2 | 2 | 2 | UN | 3 | 3 |
| 4 | UN | UN | 2 | 4 | 4 | 4 | 2 | 2 | 1 | UN | 4 | 4 |
| 5 | UN | 4 | 4 | 5 | 4 | 4 | 3+ | 3 | 3 | UN | 5 | 5 |
| 6 | UN | UN | 0 | 0 | | | 0 | | | UN | 3 | 3 |
| 7 | 4+ | 2 | 0 | 4 | 3 | 3 | 0 | | | UN | 3 | 3 |
| 8 | UN | 1+ | 1 | 4 | 3 | 0 | 0 | | | 4 | 4 | 4 |
| 9 | UN | 5 | 5 | 5 | 5 | 5 | 3 | 3 | 0 | 5 | 3 | 3 |
| 10 | NB | | | 0 | | | 2 | 2 | 2 | UN | 3 | 3 |
| 11 | UN | UN | UN | 5 | 5 | 5 | 5 | 4 | 3 | UN | 2 | 2 |
| 12 | UN | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 4 | UN | 5 | 5 |
| 13 | UN | UN | UN | 6 | 5 | 5 | UN | UN | 0 | UN | 0 | |
| 14 | NN | | | NB | | | NB | | | UN | 3 | 3 |
| 15 | NN | | | NB | | | NB | | | NB | | |
| 16 | UN | UN | UN | NB | | | 2+ | 2+ | 2 | UN | 2 | 2 |

*UN- UNknown, NN-No Nest constructed, NB-No Breeding

The pairs at Nests 1 and 9 had laid eggs and the chicks have hatched, but the nestlings did not get fledged (Table 3.10). In nest 1, each chick died one by one in consecutive observations during the period of the first 20 days following hatching. The reason for their deaths might have been harsh weather conditions which was mostly rainy and windy on those days. Such young chicks are not always able to balance their thermoregulation and the parents' brooding may not have been enough to protect them from cold weather.

Nest 9 was occupied late in the breeding season. They were the latest breeders in the population and the female laid 3 eggs and three chicks hatched (Table 3.10). However, all chicks died within 10 days following their hatching. Since the weather conditions in the second part of June when they hatched was warm, the cause of mortality may not be cold weather but could be lack of experience as parents or human disturbance, since it is an easily accessible nest on a low building.

### 3.4.3 Behavioral Differences and Their Consequences

For two years, nest behaviors of both adult and young white storks were observed. Since much more field trips were made in 2005 compared to 2004, most of the behavioral analysis were made by using 2005 field data.

The differences in chick success between nests were also searched in terms of behavioral investments like caring young, bringing food or water behavior. In Figure 3.6, for eight nests, the food provisioned per nestling and the breeding success values (as the proportion of fledged young to hatchlings) were compared. To make the analysis more comparable, the number of observations (the number of 10 minute periods) that were made during the fledgling stage were summed for each nest, and the values showing how many times adults brought food to nest per young were divided by these numbers. As can be seen from the graph below, breeding success increased with increasing value of the bringing food index.

In the Figure 3.6, two year (2004-2005) observations of food provisioning behavior versus chick success are shown where increasing number of food provision behavior results in an increase in chick success.

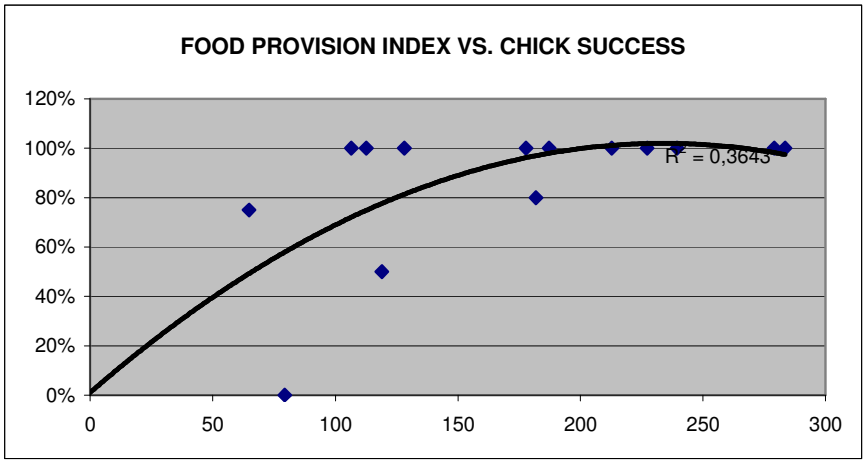


**Figure 3.6** Relation between Food provisioning behavior and chick success (corrected for observation effort).

A caring young index (including standing guard at nest, shading and preening young) was computed with the same approach that was used for bringing food index for nine nests for which this behavior was observed. The probable relationship between performing this behavior and chick success (as the proportion of hatchlings to fledged young) were assessed.

The breeding success decreased with increasing care per young (Figure 3.7). This is an unexpected result since increased chick care should lead to higher, not lower, survival of young. The only explanations were either the effect of an extreme outlier value distorting the relationship, or a trade off between feeding and care behavior of adults.

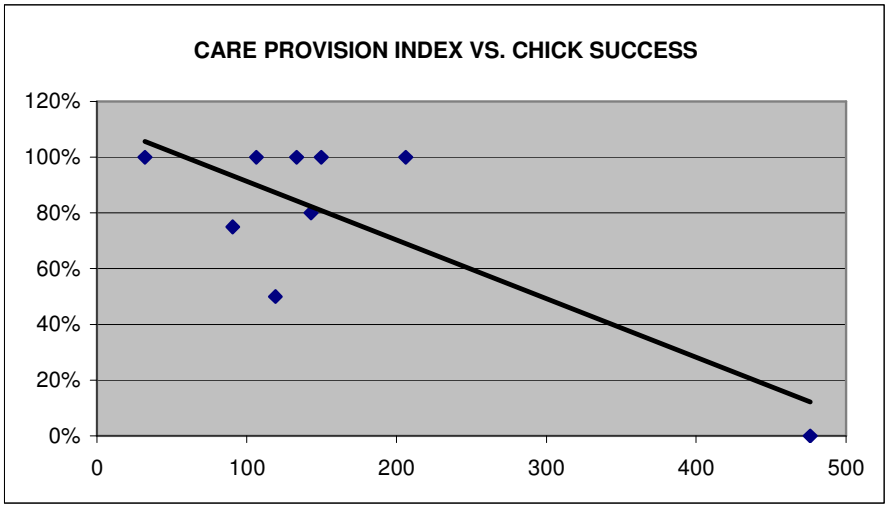


**Figure 3.7** Relation between care provisioning behavior and chick success (corrected for observation effort).

### 3.4.4 Phenological Differences and Their Consequences

According to a common phenomenon in birds, smaller clutch sizes of migrant birds would be associated with a seasonal decline in clutch size (Drent & Daan 1980, Murphy & Haukioja 1986, Daan *et al.* 1989). This situation is generally related with food supply (Verhulst *et al.* 1995; Siikamäki 1998, Tortosa *et al.* 2003). The relationship between clutch size and the date when incubation starts in 2005 is rather complex, with early starters having clutch sizes ranging from 2 to 5. On the other hand, a particular late starter (nest 9) laid 3 eggs. Therefore, there did not seem to be a clear trend of reduced clutch size as the season progressed (Figure 3.9).

However, the smaller clutch sizes observed for nests 3 and 10 may not reflect the original number of eggs laid as the parents might have removed infertile and/or damaged eggs prior to the observation (Figure 3.9).

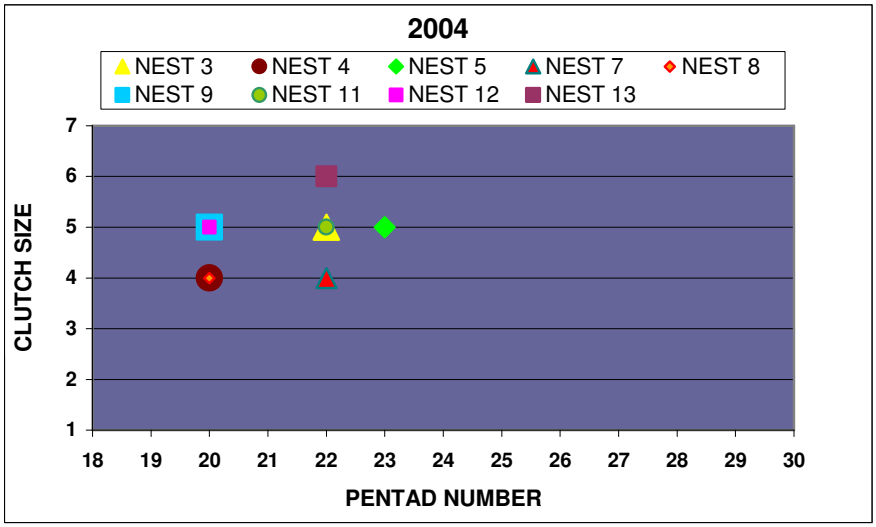


**Figure 3.8** Date of beginning to incubation versus clutch size in 2004.

For 2004, there is no clear relation between clutch size and date of beginning to incubation since no decrease was observed in clutch size in late breeders compared to earlier breeders (Table 3.8).

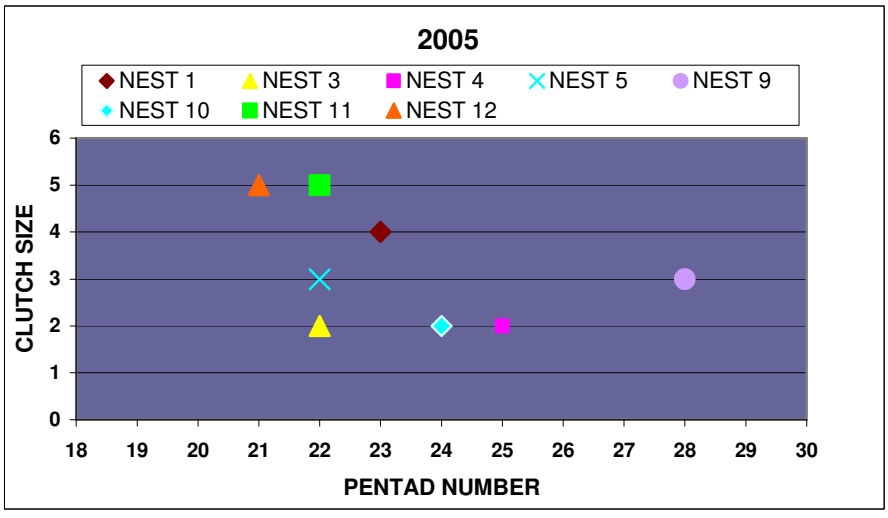


**Figure 3.9** Date of beginning to incubation versus clutch size in 2005.

Starting to breed earlier has some possible effects on the reproductive output (Massemin-Challet *et al.*, 2006). In temperate bird populations, as the breeding season progresses, reproductive success declines (reviewed in Svensson 1997, including the White stork, Profus 1991, Goutner & Tsahlidis 1995). It is shown in the Figure 3.8 that late breeders (nests) had smaller clutch sizes.

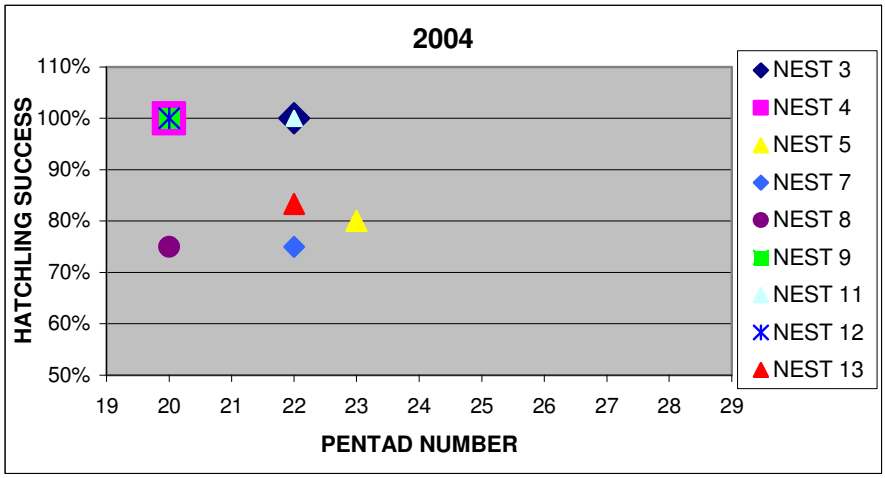


**Figure 3.10** Hatching date versus starting date of incubation in 2004.

In 2004, the proportion of chicks hatching from eggs (hatching success) decreased as the breeding season progressed (Figure 3.10). However, this trend is not clear since Nests 3 and 11 had 100% hatchling success although they were late breeders. One possible reason for this result may have been that year 2004 was a normal year in terms of early arrival to the breeding grounds. Therefore, even late breeders were not affected much by changes associated with late arrival, such as physiological changes in their biological rhythm and natural environmental changes.

In 2005, storks arrived in spring approximately 10 days later and several nests started incubation late. However, this fact was not reflected in a clear decrease in hatchling success. Even late breeders had 100% hatchling success in 2005 (Table 3.11).

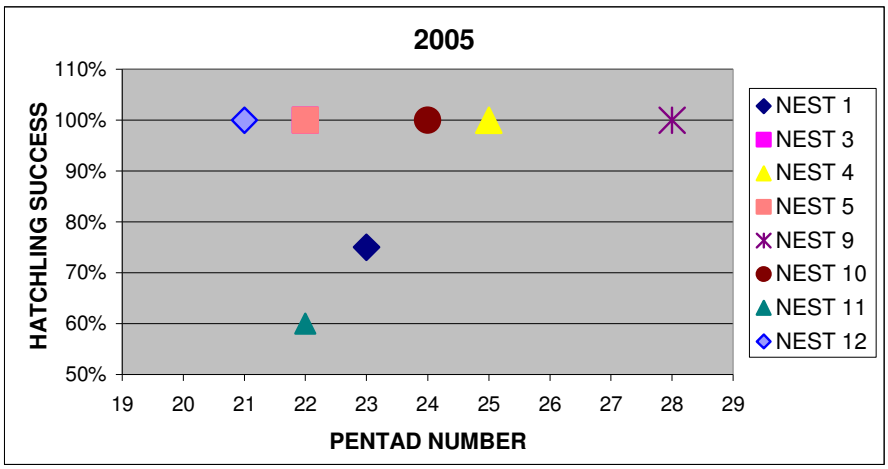


**Figure 3.11** Hatching success versus starting date of incubation in 2005.

As in clutch size, chick success did not change much between late and early breeders in 2004 (Figure 3.12).

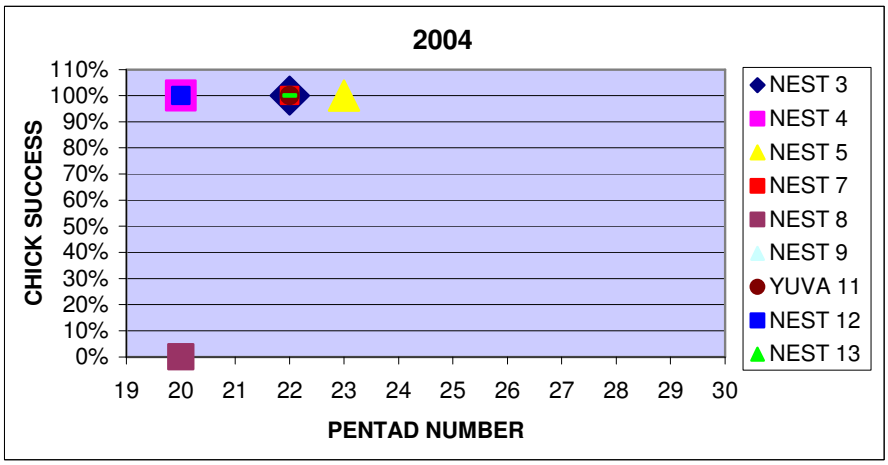


**Figure 3.12** Chick successes versus starting date of incubation in 2004.

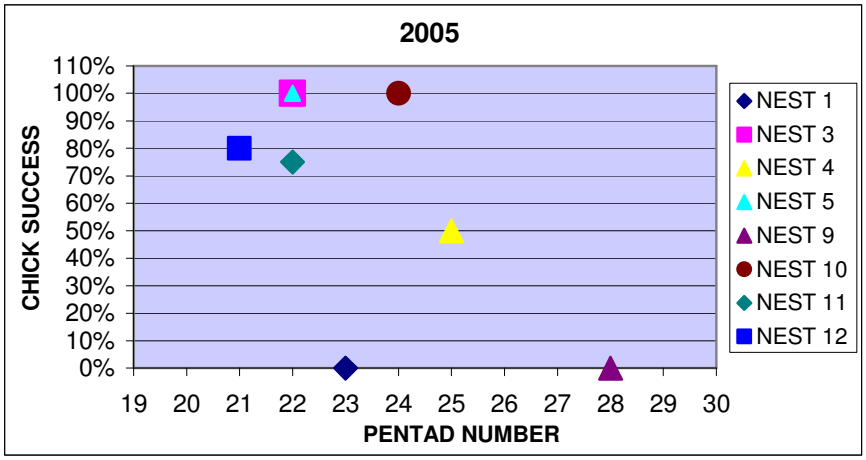


**Figure 3.13** Chick successes versus starting date of incubation in 2005.

Contrary to 2004, in 2005 there were some decreases in chick success of late breeding nests as the season proceeded (Figure 3.13). However, it is difficult to explain this trend by a single factor, since inexperienced pairs at particular nests may be the reason of this observation as much as any effects due to advanced breeding season.

**Table 3.11** Results of regression analysis.

**The regression equation;**
Fledged = 0,699 - 2,19 care + 6,59 food

| Predictor | Coef | SE Coef | T | P |
|---|---|---|---|---|
| Constant | 0,6988 | 0,1116 | 6,26 | 0,000 |
| Care | -2,1916 | 0,5915 | -3,70 | 0,003 |
| Food | 6,594 | 1,928 | 3,42 | 0,005 |

S = 0,255558 R-Sq = 64,3% R-Sq(adj) = 58,8%

To analyze the effects of caring young and food provisioning behavior on breeding success of the nests, multiple regression was carried out (Table 3.11). The caring young behavior was extended by adding the observation of shadowing and brooding behaviors into the analysis.

Caring young and food provisioning behaviors correlated significantly with breeding success (p=0.003 and p=0.005, respectively). The regression equation showed that the food provisioning behavior made a positive effect while caring young decreased this effect on the fledging success. Additional factors effecting breeding success or interaction between parameters used may include weather conditions (Table 3.11).

## 3.5 Different Calculations on Nestling's Date of Birth

Some calculations were made to estimate the first day of hatching for the chicks to determine the first day of raising young period. Wing chord and bill length measurements that were taken during ringing studies were used for the computations. Two different equations that are used to determine the age of nestlings in two different countries (Spanish and Polish) were used.

**Table 3.12** Age of nestlings.

| 2005 AGE OF NESTLINGS | | | | |
|---|---|---|---|---|
| **NEST NUMBER** | | **Based on Kania's (Polish) formula** | **Based on to Spanish wingcord formula** | **Based on field observation data (min-max)** |
| **NEST 3** | Chick 1 | 38 | 51 | 45-49 |
| | Chick 2 | 39 | 55 | |
| **NEST 4** | Chick | 18 | 19 | 24-28 |
| **NEST 5** | Chick 1 | 33 | 43 | 43-46 |
| | Chick 2 | 36 | 48 | |
| | Chick 3 | 31 | 44 | |
| **NEST 11** | Chick 1 | 38 | 47 | 43-47 |
| | Chick 2 | 41 | 52 | |
| | Chick 3 | 36 | 52 | |
| **NEST 12** | Chick 1 | 48 | 58 | 48-51 |
| | Chick 2 | 36 | 54 | |
| | Chick 3 | 36 | 57 | |
| | Chick 4 | 41 | 58 | |

In addition, another estimate of the probable age of nestlings in some nests were made based on individual field observations. It could be seen from Table 3.12 that the estimates are not in accordance with the approximate field observations. Therefore, neither Spanish nor Polish formulas were used for the estimation of first day of hatchings at different nests and different chicks. However, according to the formula for Spanish population, nestling age estimates were made based on wing chord (age=5.068+0.117x wing chord, r=0.99, N=12, P<0.01) (Blas *et al.,* 2006) while estimates for the Polish population were based on bill measurements (Kania 1982). Table 3.12 implies that although having the same wing chord measurements, the chicks from Spanish populations could be older than the chicks at Kızılcahamam, and even though having the same bill length, nestlings at Kızılcahamam could be older than Polish population. Therefore, in general, it can be said that chicks of Spanish population grow slower than Turkish and Polish chicks and the fastest growing chicks are the ones from Poland. One probable reason for this is better feeding conditions for the chicks and the shorter available breeding season in Poland than in Turkey or Spain.

## 3.6 Critique of the Methodology

Since an insufficient number of observations on nest behavior were taken in 2004, only 2005 behavior data was used for the behavioral analysis (except data on bringing food and caring young behaviors used in the regression analysis).

Although the same method (scan sampling) was used in both years, there were differences between the years in terms of implementation of the method and in 2004 every nest was not observed at the same time. Because, the best observation point on where all the nests can be observed was not located due to lack of experience prior to this study.

Due to short observation time of scan sampling, some behaviors were observed while finishing or starting. Therefore, sometimes it was difficult to assign an observation and put into one of the categories previously defined, since some of the behaviors have similar postures in the beginning or at the end. Therefore, some

assumptions were needed to be taken. If all behavioral patterns were defined precisely and exclusively before fieldworks, then analyses of behavior patterns would have been easier.

In 2004, due to late start to field studies, some dates on arrivals and for some nests dates of beginning to incubation could not observed.

It was important to use scan sampling method to understand the situations and main behavior types of nestlings and adults on the nests. Yet, it is usually restricted to broad categories of behaviors such as "preening", "greeting", or "resting". Therefore, if there would be enough observers, making focal animal sampling together with scan sampling, that approach would provide more precise and accurate data on behavior types, and thus potential biases could have been avoided.

# CHAPTER 4

# CONCLUSIONS

This study has for the first time monitored breeding of a White Stork colony in Turkey for three years. Average reproductive parameters per breeding attempt were respectively 3.91 (n=18), 3.40 (n=21) and 3.02 (n=22) for clutch size, brood size, and number fledged for data based on 2003-2006 observations. The latter parameter is considerably higher than that recorded for both Germany and Poland (1.91 and 2.08 respectively).

There is significant annual variation in breeding success, ranging up to two fold between the best and worst years. This is probably caused by changes in temperature and rainfall.

In 2005, clutch size is reduced when breeding is delayed (from 5 to 2) while chick mortality has increased when breeding was delayed (from 0% to 100%). 2005 differed from 2004 in that the adults arrived and started incubation about 10 days later.

Unlike the results reported by, for example Massemin-Challet (2006), the highest chick mortality occured in clutches with 2 or 3 hatchlings and were about four times higher than nests with 4 or 5 young. Probable reasons could be poor parentage by inexperienced adults or reduced thermoregulation of smaller broods.

The frequency of food provision by adults seems to be an important factor in determining chick success. However, nest location or position did not effect overal success. The growth rate of Kızılcahamam stork chicks seems to be intermediate between these from Poland and Spain.

Breeding success of the studied population dose not seem to be restricted by food availability, extraordinary levels of adult or chick mortality, or nest site availability. Therefore, factors related to mortality during migration or at the winter quarters may play a more important role in the observed decline in nesting pairs in Turkey.

Main threats for the White Stork population of Kızılcahamam that stem from the breeding site can be listed as:

- Nest disturbance by inhabitants (of nests on the roofs and chimneys in particular)
- Collisions with vehicles, and electrocution by or collision with electricity cables
- Pollution of nearby wetlands (although no negative effects were detected on breeding success a reduction in water quality is probable in the near future).
- Abduction of some nestling before fledging

Suggestions for conservation of this colony for the future are:

1) Setting up a sheltered nesting area for the White Stork population in Kızılcahamam, with the following precautions:
   - New nesting platforms should be constructed especially for nests on electric masts or on top of buildings, and/or the sites of risky nests should be changed to more sheltered and suitable areas with nesting platforms.
   - Above-ground electricity and telephone cables should be moved to underground.
   - Traffic posts should be placed along the highway to warn the drivers to go at a slower speed while they pass near the colony site.

2) Stopping and even reversing attempts to drain nearby wetlands or straighten the river, and monitoring the water quality in the future.

3) Making inhabitants of Kızılcahamam more aware of the importance of White Storks and the importance of their town for this species.

## REFERENCES


Altmann, J. 1974. Observational Study of Behavior: sampling methods. Behavior. 49: 227-267 (Cited in Bradley, 1984).

Baker, J.R. 1938. The evolution of the breeding seasons. In 'Evolution: Essays on Aspects of the Evolutionary Biology.' (G.R. de Beer, ed.), pp: 161-177. Oxford University Press. London and New York (Cited in Farner & King, 1971).

Barbraud, J.-C. & Barbraud, C. 1991. La Cicogne blanche *Ciconia ciconia* en Charente-Maritime France. Alauda 59: 169-176 (Cited in Archayx *et al.*, 2004).

Bauer, K.M.& Glutz Von Blotzheim, U.N. 1966. Handbuch der Vögel Mitteleuropas I (Cited in Snow&Perrins, 1998).

Blas, J., Baos, R., Bortolotti, G.R., Marchant, T.A. & Hiraldo, F. 2006. Age-releated variation in the adrenocotical repsonse to stres in nestling white stork (*Ciconia ciconia*) supports the development hypothesis. General and Comparative Endocrinology. (article was in press, available on www.sciencedirect.com).

Brooke, R.K. 1966. Nuptial moult, breedind season, and clutch size of Rhodesian Red Bishops *Euplectes orix* and congeners in relation to rainfall. Ostrich Suppl. 6: 223-235. (Cited in Farner&King, 1971).

Brown, L.H., Urban, E.K. & Newman, K. 1982. The Birds of Africa. Vol. 1. Academiz Press, London, UK.

Burger, J.M. 1948. The relation of external temperature to spermatogenesis in the male starling. J. Exp. Zool. 109. 259-266 (cited in Cited in Farner&King, 1971).

Busse, P. 2000. Bird Station Manual. SE Bird Migration Network. University of Gdansk, Gdansk 2000.

Charnov, E. L., and J. R. Krebs. 1974. On clutch-size and fitness. Ibis 116:217-219 (Cited in Erikstad *et al.*, 1998).

Chartier, A. 2001. White Stork *Ciconia ciconia* in Normandy in the 20th century. Alauda *69:* 43-52 (Cited in Archayx *et al.*, 2004).

Cramp S. and & Simmons, K.E.L. (Eds).1977. The Birds the Western Palearctic. Vol 1.Oxford. Oxford Universty Press pp: 320-335 (Cited in Hall *et al.*,1987).

Daan, S., Dijkstra, C., Drenth, R.H. & Meijer, T. 1989. Food supply and the annual timing of avian reproduction. Acta Int. Congr. Ornithol. 19: 392-407 (Cited in Massemin-Challet *et al.*, 2006).

Drickamer, L.C., Vessey, S.H & Meickle, D. 1996. Animal Behavior; mechanisms, ecology and evolution. W. G. Brown Publisher.

Drent, R.H. & Daan S. 1980. The prudent parent: energetic adjustment in avian breeding. Ardea 68: 225-252 (Cited in Massemin-Challet *et al.*, 2006).

Drickamer, L.C., Vessey, S.H. and Meickle, D. 1996. Animal Behavior; mechanisms, ecology and evolution. W.G. Brown Publishers.

Darwin, C. 1859. The Origin of Species by Means of Natural Selection. London. (Cited in Farner&King, 1971).

Disney, H.J. de S. & Marshall, A.J. 1956. A contribution to the breeding biology of the Weaver-Finch *Quelea quelea* in East Africa. Proc. Zool. Soc. London. 127: 379-387. (Cited in Farner&King, 1971).

Engels W.L. & Jenner C.E. 1956. The effect of temperature on testicular recrudscence in Juncos at different photoperiiods. Biol. Bull. 110: 129-137 (Cited in Farner&King, 1971).

Farner, D.S., King J.R. and Parker K.C.1971. Avian Biology Vol. 1, pp: 342-366, 463, 471, 491. Academic Press, inc.

Farner, D.S & Mewaldt, L.R. 1952. The relative roles of photoperiod and temperature in gonad recrudscence in male *Zonotrichia leucophrys gambelii*. Anat. Rec. 113: 612-613 (Cited in Farner&King, 1971).

Farner D.S.& Wilson A.C. 1957. A quantitative examination of testicular growth in the White-crowned sparrow. Biol. Bull. 113: 254-267 (Cited in Farner&King, 1971).

Fisher, R.A.1928. Genetical Theory of Natural Selection. Oxford Univ. Press, London and New York. (Cited in Farner&King, 1971).

Gill, F.B. 1994. Ornithology. Second Edition. W.H. Freeman and Company. New York, PP: 143, 365, 390, 404, 441, 442, 454.

Goldsmith, S. 2006. Animal Behavior. http://artemis.austincollege.edu/acad/bio/sgoldsmith/abhandouts/sampling_techniques.html) 13.09.2006.

Grier J.W., & Burk, T. (1992). Biology of animal behaviour. Dubuque, IO: W.C. Brown.

Goriup, P.D. & Schulz, H. 1991. Conservation management of the White Stork. In: Salathé, T. (eds.). Conserving Migratory Birds. ICBP techn. Publ. 12, Cambridge 393 pp. (Cited in Van den Bossche, 2002).

Goutner, V. & Tsahlidis, E.P. 1995. The time of breeding and brood size of White Storks (*Ciconia ciconia*) in North-eastern Greece. Vogelwarte 38:89-95. (Cited in Tryjanowski *et al.*, 2004).

Haas, W. 1963. Alauda 37:28-36 (Cited in Cramp&Simmons 1977).

Hall, M.R., Gwinner, E. and Bloesch, M. 1987. Annual cycles in moult, body mass, luteinizing hormone, prolactin and gonadal steroids during the development of sexual maturity in the white stork Ciconia ciconia. J. Zool.,Lond. 211: 467-486.

Hancock, J.A. & Kushan, J. A. 1992. Storks, Ibises and Spoonbills of the World Princeton University Press.

Haverschmidt, F. 1949. The life of the White Storks. (Cited in Cramp&Simmons, 1977).

Hornberger, F.W. 1967. Der Weissstorch (*Ciconia ciconia*), neue Brembueherei No. 375. Wittenberg Lutherstadt: Verl. Ziemsen. (Cited in Hall *et al.*,1987).

IUCN, 2001. International Union for Conservation of Nature and Natural Resources. 2006. The IUCN Red List of Threatened Species: IUCN Red List Categories and Criteria Ver. 3.1. http://www.redlist.org/info/categories_criteria2001.html. 24.4.2006.

Jovani, R. and Tella, J.L. 2004. Age-related environmental sensitivity and weather mediated nestling mortality in white storks *Ciconia ciconia*. Ecography 27: 611-618.

Kahl, M.P. 1971a. Living Birds 10: 151-70 ; 1972b. Jour. Zool. London 148: 289-311 (Cited in Crampand &Simmons,1977).

Kania, W. 1982. Investigations of the White Stork *Ciconia ciconia* hatching phenology based on bill measurements of nestlings. The Ring 1988: 134-135.

Kasparek, M. & Bilgin, C.C. 1996. Birds. *In:* Species List of Vertabates in Turkey. (*eds:* A. Kence and C.C. Bilgin). TUBİTAK. Ankara. (In *Turkish*). (Cited in Can, 2001).

Kayser, Y., Girard, C., Massez, G, Chérain, Y., Cohez, D., Hafner, H., Jhonson, A., Sadoul, N., Tamisier, A. & Isenmann, P. 2003. Compte-rendu Ornithologique camarguais pour les années 1995-2000. Revue d'Ecologue (Terre vie) 58:20-21 (Cited in Archayx *et al*., 2004).

King, J.R. 1973. Energetics of reproduction in birds, pp: 78-107. *In* Breeding Biology of Birds(D.S. Farner, Ed.). Washington D.C.: National Academy of Science. (Cited in Gill, 1994).

Lotka, A.J. 1925. Elements of Physical Biology. Williams&Wilkins, Baltimore Maryland (reprinted as 'Elements of Mathematical Biology".Dover, New York, 1956). (Cited in Farner&King, 1971).

Marshall, A.J. & Disney, H.J de S. 1957. Experimental induction of the breeding season in a xerophilous bird. Nature (London). 177: 647-649. (Cited in Farner&King, 1971).

Massemin-Challet, S., Gendner, J.P., Samtmann S., Pichegru, L., Wulgué, A., Maho Y. L., (2006). The effect of migration strategy and food availability on White Stork *Ciconia ciconia* breeding success. Ibis 148: 503-508.

Moreau, R.E. 1950. The breeding seasons of African birds. Ibis 92: 223-267 and 419-433. (Cited in Farner&King, 1971).

Moreau, R.E. 1972. The Palaearctic-African Bird Migration System, London (Cited in Cramp and & Simmons, 1977).

Morel, G., Morel, M.-Y. & Bourliere, F. 1957. The Blackfaced Weaver Bird or Dioch in West Africa. J. Bombay Natur. Hist. Soc. 54, 811-825. (Cited in Farner&King, 1971).

Murphy, E.C. & Haukioja, E. 1986. Clutch size in nidicolous birds. Current Ornithol. 4: 141-210 (Cited in Massemin-Challet *et al*., 2006).

Nice, M.M. 1962. Development of behavior in precocial birds. Trans. Linn. Soc. 8: 1-211 (Cited in Blas J. *et al.*, 2006).

Oring, L.W. 1982. Avian mating system. Avian Biology, 6: 1-91 (Cited in Gill, 1994).

Parr, S.J., Collin, P., Silk, S., Wilbraham, J., Williams, N.P. and Yarar, M. 1997. A baseline survey of white storks Ciconia ciconia in central Turkey. Sandgrouse 18(2): 46-51.

Paz, U. 1987. The Birds of Israel. Christopher Helm LTD.,London (Cited in Van den Bossche, 2002).

PPTP ` pro Natura' Society bulletin 'Program Ochrony Bociana Białego I Jego Siedlisk. 50-449 Wrocław, ul. Podwale 75 tel. (0-71) 44-50-55 w. 36, fax (0-71) 44-61-35.

Profus, P. 1991. The breeding biology of White Stork *Ciconia ciconia* (L.) in the selected area Southern Poland. Stud. Natur. 37A: 11-57. (Cited in Tryjanowski *et al.*, 2004).

Redondo, T., Tortosa, F.S., Arias de la Reina, L., 1995; . Nest-switching and Alloparental Care in A Colonial White Stork. Anim. Behav, 49: 197-1110.

Ree, V. 1973. Sterna 12: 225-68 (Cited in Cramp and & Simmons 1977).

Ricklefs, R.E. 1974. Energetics of reproduction in birds, pp: 152-292. *In* Avian Energetics. (R.A. Paynter Ed.). Publ. Nuttall Ornithol. Soc. No. 15. (Cited in Gill, 1994).

Ridpath, M.G. 1971. The Tasmanian Native Hen Tribonyx mortieri. III. Ecology. CSIRO Wildl. Res. (Cited in Farner&King, 1971).

Roff, D. A. 1992. The evolution of life histories. Chapman and Hall, New York, New York, USA (Cited in Erikstad *et al.*, 1998).

Schaub, M., Kania W. & Köppen U. 2005. Variation of primary production during winter induce synchrony in survival rates in migratory white storks *Ciconia ciconia.* Journal og Animal Ecology 74: 656-666.

Schaub, M., Pradel, R. & Lebreton, J.-D. 2004. Is the reintroduced White stork *Ciconia ciconia* population in Switzerland is self-sustainable? Biological conservation. 119: 105-114.

Schulz, H. 1988. Weißstorchzug. Ökologie, Gefährdung und Schutz des Weibstorchs in Afrika und Nahost. Weikersheim, pp: 459. (Cited in Van den Bossche, 2002).

Schulz, H. 1994. Zur Bestandssituation des Weißstorchs *Ciconia ciconia*- Neue Perspektiven für den " Vogel des Jahres 1994 " Berichte zum Vogelschutz 32. (Cited in Van den Bossche, 2002).

Schulz, H. 1998. *Ciconia ciconia* White Stork. BWP Update 2: 69-105. (Cited in Archayx *et al*., 2004).

Schulz, H. 1999. Der Welbestand des Weißstorch im Aufwind?-White Storks on the up?- Proceedings, Internat. Symp. On the White Stork, Hamburg 1996-NABU (Naturschutzbund Deutschland e. V.), Bonn: 351-365. (Cited in Van den Bossche, 2002).

Schüz, E. 1936. Internationale Bestands-Aufname am Weiben Storch 1934. Orn. Mber. 44:33-41. (Cited in Van den Bossche, 2002).

Schüz, E. 1938. Über Biologie und Ökologie des WeiszenStorches (*Ciconia ciconia*). Proceedings of the VIIIth International Ornithological Congress, Oxford, July 1934: 557-591. Oxford University Press. London (Cited in Welty & Baptista, 1988).

Schüz, E. 1940. Bewegnungen im Bestand des Weißen Storches seit 1934. Orn. Mber, 48: 1-14. (Cited in Van den Bossche, 2002).

Schüz, E. 1944. Nest-Erwerb und Nest-Besitz beim Weiszen Storch (*Ciconia ciconia*). Zeitschrift für Tierpsychologie, 6:1-25 (Cited in Welty & Baptista, 1988).

Schüz, E. & Szijj, j. 1962. Report on the International Census (1974) of the White Stork 1958. Bull. Int. Counc. Bird Preserv, 8:86-98. (Cited in Van den Bossche, 2002).

Schnetter, W. & Zink, G. 1960. Zur Frage des Brutreifealters südwestdeutscher Weißstörche (*Ciconia ciconia*). Proceedings of the International Ornithological Congress, XII, 662-666 (Cited in Schaum et al., 2005).

Siefke, A. 1981. Dismigration und Ortstreue beim Weißstorch (*Ciconia ciconia*) nach Beringungsergebnissen aus der DDR. Zooogische Jahrbücher Abteilung Systematik, Ökologie und Geographyraphie der Tiere, 108:15-35 (Cited in Schaum et al., 2005).

Siikamäki, P. 1998. Limitation of reproductie success by food availability and breeding time in pied flycathchers. Ecology 79: 1789-1796 (Cited in Massemin-Challet *et al.*, 2006).

Skutch, A.F. 1976. Parent Birds and Their Young. Austin. Universty of Texas Press (Cited in Gill, 1994).

Snow, D. 1958. The Breeding of the Blackbird, *Turdus merula* at Oxford. Ibis 100: 1-30 (Cited in Farner&King, 1971).

Standora, M. 2006. The effects of water depth on Woood Stork Mycteria americana foraging. (http://www.uga.edu/srel/REU/MichelleStandora.htm) 13.09.2006.

Starck, J.M. 1993. Evolution of avian ontogenies. In: Power, D.M. (Ed.) Current Ornithology, Vol. 10, pp: 275-366. Plenum Pres, New York (Cited in Blas J. *et al.*, 2006).

Stearns, S.C. 1992. The evolution of life histories Oxford University Press, Oxford, UK (Cited in Erikstad *et al.*, 1998).

Summers-Smith, D. 1956. Mortality of the House Sparrow. Bird Study 3: 265-270 (Cited in Farner&King, 1971).

Svensson, E. 1997. Natural Selection on avian breeding time: causality, fecundity-dependent, and fecundity-independent Selection. Evolution 51: 1276-1283 (Cited in Tryjanowski *et al.*, 2004).

Szymonski, P. & Jakubiec, Z. 2001. Bociany I Bocki ' Stork and Storkies' . 'pro Natura', ul. Podwale 75, 50-449 Wroclaw, Poland.

Verhulst, S., van Balen, J.H & Tinbergen, J.M. 1995. Seasonal decline in eproductive successof the great tit: variation in time or quality? Ecology 76: 2392-2403 (Cited in Massemin-Challet *et al.*, 2006).

Walsberg, G.E. 1983. Avian ecological energetics. Avian Biology. 7:161-220 (Cited in Gill, 1994).

Williams, G.C. 1966. Natural selection the cost of reproduction, and a refinement of Lack's principle. Am. Nat. 100: 687-690 (Cited in Gill, 1994).

Wikimedia Fundation. 2006. Behavioral ecology. (http://en.wikipedia.org/wiki/Ethology).13.09.2006.

Wikimedia Fundation. 2006. Sociobiology. (http://en.wikipedia.org/wiki/Sociobiology). 13.09.2006.

Thomson, A.L. 1950. Factors determining the breeding seasons of birds: an introductory review. Ibis 92: 173-184. (Cited in Farner&King, 1971).

Tortosa, F.S. and & Castro, F., 2003. Development of Thermoregulatory ability During Ontogeny in the White Stork (*Ciconia ciconia*). Ardea, 50:39-45.

Tortosa, F.S., Manez, M. & Barcell, M. 1995. Wintering White Stork *Ciconia ciconia* in SW Spain in the years 1991 and 1992. Die Vogelwarte 38: 41-42 (Cited in Archayx *et al*., 2004).

Tortosa, F.S., Pérez, L. & Hillström, L. 2003. Effect of food abundance on laying date and clutch size in the White Stork *Ciconia ciconia.* Bird Study 50: 112-115 (Cited in Massemin-Challet *et al*., 2006).

Tryjanowski, P. & Kuzniak, S. 2002. Population Size and Productivity of the White Stork (*Ciconia ciconia*) in Relation to Common Vole (*Microtus arvalis*) Density. Ardea 90(2): 213-217.

Tryjanowski, P., Sparks, T.H., Ptaszyk, J. and Kosicki, J. 2004. Do white storks *Ciconia ciconia* always profit from an early return to their breeding grounds? Bird Study 51: 222-227.

Zink, G. 1967. Population Dynamik des Weissen-Storchs, *Ciconia ciconia,* in Mitteleuropa. Proc. Int. Orn. Congr. XIV: 191-215 (Cited in Kanyamibwa *et al*., 1989).

## APPENDIX A

## PHOTOGRAPHS SHOWING BEHAVIOR TYPES PERFORMED ON THE NEST BY WHITE STORK (*Ciconia ciconia*)

**Photo A.1** Fight behavior (a) (*)

**Photo A.2** Fight Behavior (b) (*) (peforming by the nest owner towards intruders)

**Photo A.3** Greeting display (a) (*)

**Photo A.4** Greeting display (b) (*)

**Photo A.5** Copulation (*)

**Photo A.6** Food and water regurtitating (*)

**Photo A.7** Begging food behavior performing by nestlings (*)

**Photo A.8** Self-preening (a) (*)

**Photo A.9** Self-preening (b) (**)

**Photo A.10** Flight practices by nestlings(*)

**Photo A.11** Adult resting behavior (*)

**Photo A.12** Nest maintenance (bringing materials) (*)


**Photo A.13** Nest maintenance (arranging nest material) (**)

**Photo A.14** Shadowing (a) (***)

**Photo A.15** Shadowing (b) (***)


**Photo A.16** Incubating (a) (**)

**Photo A.17** Incubating (b) (****)


**Photo A.18** Field observation of the nest 12 (**)

**Photo A.19** Kirmir Stream (*****)

(*) Photos by Prezmysław Szymonski (from the Szymonski, P. & Jakubiec, Z. 2001. Bociany I Bocki)

(**) Photos by Çağrı Göcek

(***) Photos by Okan Can

(****) Photos by Osman Erdem

(*****) Photos by Krzysztof Konieczny

## APPENDIX B

## NUMBERS OF PENTADS IN FULL YEAR SYSTEM

**Table B.1** The numbers of pentads in full year system (Busse 2000).

| Pentad | Days | Pentad | Days | Pentad | Days |
|---|---|---|---|---|---|
| 1 | 1-5 Jan. | 26 | 6-10 May | 51 | 8-12 Sept. |
| 2 | 6-10 Jan. | 27 | 11-15 May | 52 | 13-17 Sept. |
| 3 | 11-15 Jan. | 28 | 16-20 May | 53 | 18-22 Sept. |
| 4 | 16-20 Jan. | 29 | 21-25 May | 54 | 23-27 Sept. |
| 5 | 21-25 Jan. | 30 | 26-30 May | 55 | 28 Sept. - 2 Oct. |
| 6 | 26-30 Jan. | 31 | 31 May - 4 Jun. | 56 | 3-7 Oct. |
| 7 | 31 Jan. - 4 Feb. | 32 | 5-9 Jun. | 57 | 8-12 Oct. |
| 8 | 5-9 Feb. | 33 | 10-14 Jun. | 58 | 13-17 Oct. |
| 9 | 10-14 Feb. | 34 | 15-19 Jun. | 59 | 18-22 Oct. |
| 10 | 15-19 Feb. | 35 | 20-24 Jun. | 60 | 23-27 Oct. |
| 11 | 20-24 Feb. | 36 | 25-29 Jun. | 61 | 28 Oct. - 1 Nov. |
| 12 | 25 Feb. - 1 Mar. (!) | 37 | 30 Jun. - 4 Jul. | 62 | 2-6 Nov. |
| 13 | 2-6 Mar. | 38 | 5-9 Jul. | 63 | 7-11 Nov. |
| 14 | 7-11 Mar. | 39 | 10-14 Jul. | 64 | 12-16 Nov. |
| 15 | 12-16 Mar. | 40 | 15-19 Jul. | 65 | 17-21 Nov. |
| 16 | 17-21 Mar. | 41 | 20-24 Jul. | 66 | 22-26 Nov. |
| 17 | 22-26 Mar. | 42 | 25-29 Jul. | 67 | 27 Nov. - 1 Dec. |
| 18 | 27-31 Mar. | 43 | 30 Jul. - 3 Aug. | 68 | 2-6 Dec. |
| 19 | 1-5 Apr. | 44 | 4-8 Aug. | 69 | 7-11 Dec. |
| 20 | 6-10 Apr. | 45 | 9-13 Aug. | 70 | 12-16 Dec. |
| 21 | 11-15 Apr. | 46 | 14-18 Aug. | 71 | 17-21 Dec. |
| 22 | 16-20 Apr. | 47 | 19-23 Aug. | 72 | 22-26 Dec. |
| 23 | 21-25 Apr. | 48 | 24-28 Aug. | 73 | 27-31 Dec. |
| 24 | 26-30 Apr. | 49 | 29 Aug. - 2 Sept. | | |
| 25 | 1-5 May | 50 | 3-7 Sept. | | |