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Notes on the Nesting and Breeding of *Delichon urbica* (Linnaeus, 1758) (Aves: Passeriformes) near Köprüköy (Kızılırmak, Turkey)

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Abstract: The migration and some bio-ecological characteristics of a house martin (*Delichon urbica*) population, which has established colonies under bridges over the Kızılırmak River near Köprüköy village (Kırıkkale), were investigated in 2003 and 2004. These house martins were observed from the beginning of April to the first week of September, when they migrated south. According to the specimens examined, mean measurements of total length, wingspan, and weight were recorded as 133.5 mm, 279.5 mm, and 15.5 g, respectively. Mean measurements and weights of the nests were 12.5 mm long × 9 mm wide × 6 mm high, and 425 g. The first clutch was observed in May, the first offspring appeared during the first week of June, and litter size varied from 1 to 4. The mean weight of eggs was 1.6 g; the total body length and weight of a hatchling were 6 mm and 0.83 g. It was also found that the house martin had a maximum of 2 clutches during the breeding season.

Key Words: Migration, breeding, *Delichon urbica*, Turkey

Köprüköy (Kızılırmak, Türkiye) Civarındaki *Delichon urbica* (Linnaeus, 1758) (Aves: Passeriformes)'nın Yuvalanma ve Üreme Biyolojisi Üzerine Notlar

Özet: Kızılırmak'ın Köprüköy mevkiinde bulunan köprülerin altına yuvalanan ev kırlangıçlarının (*Delichon urbica*) göç zamanı ve bazı biyo-ekolojik özellikleri 2003 ve 2004 yıllarında incelendi. Buna göre kuşların çalışmanın yapıldığı alana Nisanın ilk haftasında geldiği, Eylülün ilk haftasında ise güneye göç ettiği saptandı. İncelenen örneklerde ortalama tüm boy uzunluğu, kanat açıklığı ve ağırlık sırasıyla 133,5 mm, 279,5 mm ve 15,5 gr olarak belirlendi. İncelenen yuvaların ortalama boyutları ve ağırlığı; boy: 12,5 mm, en: 9 mm, yükseklik: 6 mm ve ağırlık: 425 gr olarak belirlendi. Üreme biyolojisinin belirlenmesine yönelik çalışmalarda kuluçkaya Mayıs ayında yattıkları ilk yavruların yuvalarda Haziranın ilk haftası içerisinde görülmeye başlandığı ve yuvalardaki yavru sayısının 1-4 arasında değiştiği, incelenen yuvalarda bulunan yumurtaların ortalama ağırlığının 1,6 gr olup, yumurtadan yeni çıkmış bir bireyin 6 mm boyunda ve 0,83 gr ağırlığında olduğu belirlendi. Çalışılan istasyonda bu tür üreme sezonunda en fazla 2 kez kuluçkaya yatmaktadır.

Anahtar Sözcükler: Göç, biyoloji, ekoloji, *Delichon urbica*, Türkiye

Introduction

The house martin, *Delichon urbica* (Linnaeus, 1758), is generally distributed in Europe, Cyprus, Israel, and Turkey, in the Palearctic Region. It is distributed widely across central and northern Asia, southern Iran, the Himalayas, and southern China. It breeds sporadically in northwest Africa and Namibia. According to studies, the number of individuals in a population of house martins is not stable and continuously changes (Kumerloeve, 1964; Steiner, 1970; Barış et al., 1984; Dijksen and Kasparek, 1985; Kiziroğlu, 1989; Kasparek, 1992; Heinzel et al., 1995; Snow and Perrins, 1998; Rhodes and Piper, 2001). Snow and Perrins (1998) suggested that there were 100,000-1,000,000 breeding pairs in Turkey during the breeding season.

House martins are migratory birds that are summer visitors in the Palearctic Region, though they have been reported during the winter in the Mediterranean basin,

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Western Europe, and the north of Britain and Ireland. West Palearctic and west Asian birds winter in the Afrotropics (Snow and Perrins, 1998). Due to a highly aerial lifestyle, with high-altitude foraging, they live within the Afrotropics, in the humid zone north of the equator. They migrate late in autumn because the last broods are still in the nest in late August or September. Southerly movement through Europe occurs in September-October, but rarely in November. The return to breeding colonies in northwest Africa and southern Iberia occurs in January, progressively later further north, and over most of Europe in the second half of April and the first half of May (Snow and Perrins, 1998).

The bio-ecological characteristics of the house martin have been studied by Bryant (1975, 1979), Bryant and Westerterp (1983), and Møller (1984); however, there are only a few observational records of the house martin population in Turkey (Beaman et al., 1975; Kaya et al., 1999; Gündoğdu, 2002; Aslan and Kiziroğlu, 2003; Kılıç and Eken, 2004). The current study aimed to examine the migration, nest building, and breeding biology of the house martin, as well as support conservation activities for this species, which is listed in Appendix-2 of the Bern Convention and evaluated as VU (Vulnerable) in the Red Book of Turkish Birds in IUCN (2001).

Materials and Methods

The study included house martins that had established a colony under 2 bridges near Köprüköy village (lat 39°34'37.44"N, long 33°25'44.83"E) between 2003 and 2004 (Köprüköy village is located near the Kızılırmak River, 110 km southeast of Ankara). The bridges are parallel to each other and approximately 250 m apart. House martins established a breeding colony and built nests under these bridges (Figures 1a,b, and 2a,b). The habitat around the bridges is characteristic Anatolian steppe, with a semi-arid cold-type Mediterranean climate. Climatic data, such as temperature and humidity, of the nearest town (Keskin) were obtained from the Turkish State Meteorological Service.

The study area was visited periodically at weekly intervals in order to determine the migration dates during the study period. The nests were also periodically observed and closely investigated to collect reproduction biology data. Some individuals were captured by mist-nets and butterfly nets. The observations, which started in early morning and ended at sunset, were made using a field scope, binoculars, and video camera. We captured a total of 20 specimens, consisting of 10 adults, 3 juveniles, 4 fledglings, 2 hatchlings, and 1 embryo. Some measurements of specimens were taken using calipers sensitive to 0.1 mm. The weights of nests and birds were also recorded. The house martins were divided into 4 age groups (Figure 3a-e), and morphological and biometrical characteristics were examined. In addition to this, relative fledgling mass (mass at fledgling/adult body mass) was calculated according to Remes and Martin (2002).

Measurements taken from birds

Total body length (TBL): Distance between the tips of the beak and tail;

Wingspan (WS): Distance between the tips of both wings;

Wing length (WL): Distance between the shoulder girdle and the longest primary feather;

Tail length (TL): Distance between the posterior margin of the cloak and the tip of tail;

Head width (HW): Distance between the widest points of the head;

Beak length (BL): Distance between the anterior margin of forehead feathers and the tip of the beak;

Humerus length (HL): Distance between the shoulder girdle and the posterior tip of the ulna;

Tarsometatarsus length (TaL): Distance between the digits and the tibiatarsus;

Mid toe length (MT): Distance between the joint of the tarsometatarsus and the tip of the mid toe;

Weight (W).

Results

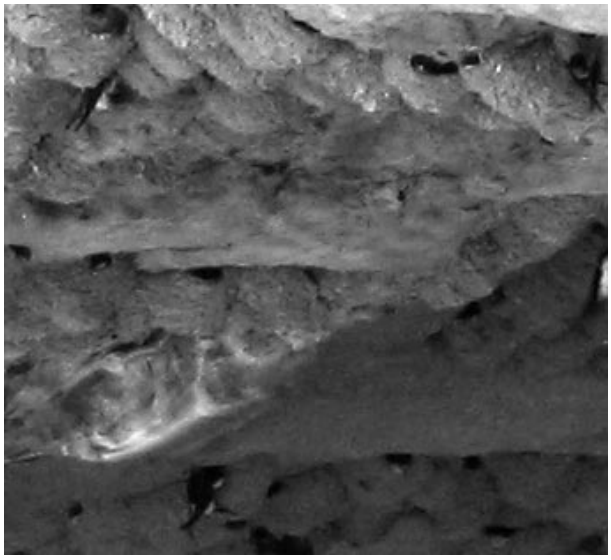
External characteristics and nesting

According to our examinations, with respect to morphological and biometrical characteristics, the specimens did not show sexual dimorphism. An adult specimen typically has a short neck, slender and pointed wings, a forked tail, glossy blue-black dorsal parts, and pure white ventral parts. The rump is white, tail feathers are black, and white feathers cover its legs and toes (Figure 3e). In adults, mean TBL is 133.5 mm, WS is 279.53 mm, WL is 126.6 mm, and W is 15.50 g (Table).

a

b

Figure 1. Two bridges were used by house martins for nesting in the study area. a) Old bridge, b) new bridge.



a

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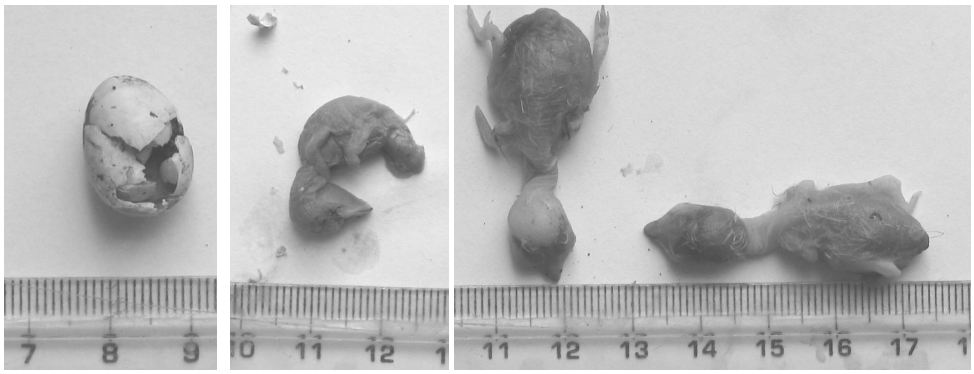
Figure 2. Nest distribution under the bridges. a) Old bridge, b) new bridge.



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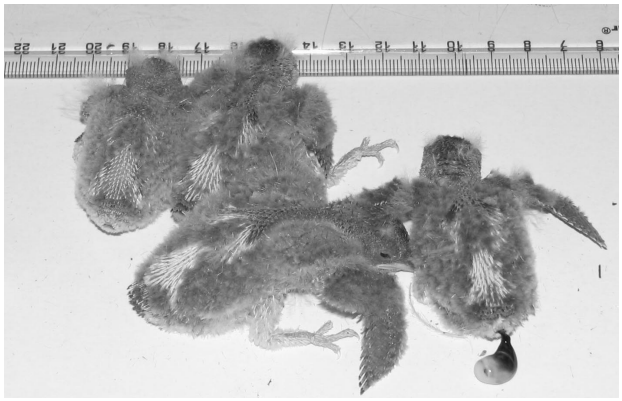

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Figure 3. Age groups of the house martins; a) an egg and its embryo, b) hatchlings, c) fledglings, d) a sub-adult, e) an adult.

Table. External measurements (mm) and weights (W, g) of adult house martins specimens.

Specimens	Measurements									
	TBL	WS	WL	TL	HW	BL	HL	TaL	MT	W
1	134	274	125	57	14	6.9	16	10.3	9	14.28
2	136	277.4	125	60	15	6.9	15.5	10.4	10	15.28
3	135	281	125.8	60	14.5	5	16.7	10.3	12	15.47
4	145	282	128	62	14.2	6.5	16.2	11.2	11.2	16.45
5	136	277.5	125	59	14.5	6.4	17.6	10.2	10.3	16.63
6	125	278.4	125	58	14.1	6.9	16.2	9	9	16.20
7	124	269	122	51	14.5	6.7	17.2	10	12	13.77
8	139	287	130	62	14.6	6.5	17.5	11.2	11	15.11
9	129	284	130	56	14.8	6.6	16.3	11.6	12.4	15.82
10	132	285	130	55	14.5	6.0	16.5	11.5	11.7	16.02
Means	133.5	279.53	126.58	58	14.47	6.44	16.57	10.57	10.86	15.50
Standard Deviations	± 6.35	± 5.43	± 2.76	± 3.40	± 0.31	± 0.58	± 0.68	± 0.80	± 1.24	± 0.93

We determined that the juveniles were different from adults in their biometric characteristics, having a pale color and white flecks on their wings (Figure 3d). The morphological characteristics of other age groups, such as fledglings and hatchlings, are shown in Figure 3a-c.

The nests that were built under the 2 bridges showed specific spatial distributions in accordance with the shape of the bridges. The nests were built as a cluster of 12-16 under the old bridge, but were in a linear formation under the edges of the new bridge. Under both bridges some nests were found to not share a wall with other nests. We counted 160 nests under the old bridge and 200 nests under the new bridge. It was also observed that the house martins built their nests by carrying small mud pellets and other nest materials in their beaks. They collected the mud and other materials from relatively near places (about 150 m away), within a flight distance of 13 s; however, some individuals used old nests after repairing them. House martins spent a relatively long time in the air; they perched on the ground only to collect mud and other nest materials. When they perched on the ground they flapped their wings while walking. The nesting materials were composed of sheep and goat wool, bird feathers, and various plant materials. The shapes of the nests were usually spherical and had an entrance hole about 3 cm in diameter. The mean measurements of the nests were 12.5 cm long × 9 cm wide × 5.6 cm high, weighing 425 g. The thickness of the nest walls ranged from 0.45 to 1.90 cm. It was also determined that some of the nests under the bridges were used by house sparrows (*Passer domesticus*) and European starlings (*Sturnus vulgaris*).

Migration period and daily activity

House martins were first observed around Köprüköy during the first week of April (April 2, 2003 and April 5, 2004). During this period the temperature and relative humidity were 19 °C and 49%, respectively. The first migration south was recorded from the new bridge at the end of July, and the last individuals left Köprüköy the first week of September, when the temperature was 22 °C and the relative humidity was 63.7%. During the study period, the minimum recorded temperature was 17.8 °C in the first week of May and the maximum was 25.2 °C in the second week of July. The minimum relative humidity was 35.7% at the beginning of April and the maximum was 63.7% in the second week of July.

According to our daily observations, the house martins began flight between 0530 and 0600 hours, just before local sunrise time. Flying started with irregular wing beats while rising. When an individual reached a certain altitude it then started gliding. They continuously

repeated this flight pattern and also flew by turning sharply in a zigzag pattern. They had very little gliding ability due to their wing morphology, and so when the house martins were gliding they lost altitude very quickly. They responded to this by flapping their wings to rise again. The number of wing beats varied among the individuals in the colony, with a mean of 9-10 per second according to video recordings. Parents spent most of their time foraging and returning to the nest to feed nestlings. After the house martins fed the nestlings, they usually left immediately, but they sometimes returned only for perching and guarding the nest. We also observed that all the house martins in the colony left the nesting area a few times by rising up as a group for 5-10 min. The altitude during this flight, about 20 m, was higher than flight for foraging. During this flight, some members of the colony came back to guard the nest and tried to remove any intruders.

Breeding and Growth

The first eggs were found in the nests on April 29, 2003 and on April 30, 2004. The incubation period started at the same time and the young of the first brood were seen in the first week of June. The size of clutches usually varied from 1 to 3 eggs (1 egg in 3 nests, 2 eggs in 14 nests, and 3 eggs in 12 nests), but 4 eggs were also recorded from 1 nest. The eggs were oval, pointed, and white; some of them had some little brownish speckles. The mean length and width of the eggs were 20.4 mm and 13.8 mm, respectively; the mean weight of eggs (n = 27) was 1.59 g. We did not observe copulation in or out of the nest, or during flight. The nestlings of the house martins were divided into 4 age groups based on stage of development as follows:

Group 1: Hatchlings that just emerged from eggs after 14 days of incubation. We examined 2 hatchlings with a mean length and weight of 40 mm and 2.3 g. We also examined an embryo just ready for emergence that was 20 mm long and weighed 0.83 g. The hatchlings were naked and their eyes were closed (Figure 3a,b).

Group 2: Nestlings with down feathers. They were fed at the nest entrance. The weights of this age group were greater than those of the adults. We observed 4 nestlings in 2 nests and recorded their feeding behavior. Time intervals between feedings ranged from 1 to 11 min and the nestlings waited for food at the nest entrance during these intervals. When their parents approached the nest, the young birds readily opened their mouths (Figure 3c).

Group 3: Sub-adult fledged nestlings. We first saw the sub-adults in the second week of July. The bodies of these birds were covered by flight feathers. These sub-adults were also waiting for food at the nest entrance and they were almost ready to fly (Figure 3d).

Group 4: House martins that built breeding nests (adults). These individuals were also parents of the nestlings and fed the nestlings; the manner of feeding depended on the age of the nestlings. If the nestlings were just hatched, parents fed them in the nest, but when they were fledged, the parents fed them at the nest entrance (Figure 3e, Table).

The weights of nestlings changed in an interesting manner (Figure 4). According to the graph in Figure 4, the weights of hatchlings increased quickly as they became nestlings and then decreased in the sub-adult and adult stages. Relative fledgling mass (mass at fledgling/adult body mass) was 1.21 g.

Discussion

Although there were many buildings in the rural study area, the house martins preferred to nest under the 2 bridges and these were usually built on the southern side. This data is consistent with Ptaszyk (2001), who reported that the preferred nesting sites were on the southern (35.2%), northern (26.1%), western (25.4%) and eastern (13.3%) sides of buildings. According to Oelke (2003), house martins prefer wet areas; their favorite nest sites in Germany are next to rivers so they can get food easily. It can be said that the observed

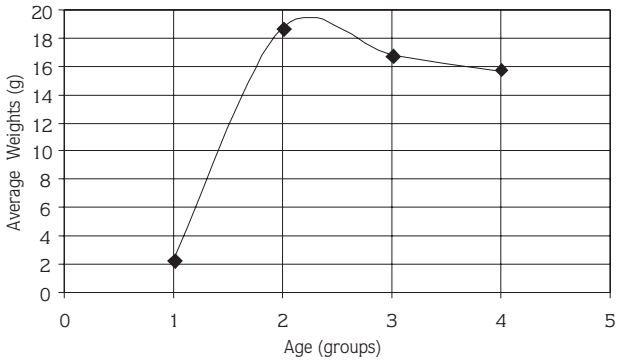

Figure 4. Changes in the weight of age groups (1 = hatchlings, 2 = fledglings, 3 = sub-adults, and 4 = adults).

preference for nesting under bridges, instead of on rural buildings, was most probably related to the abundance of food. Oelke (2003) also reported that there was an inverse relationship between the number of houses per human settlement and the number of breeding swallows.

We determined that house martins arrived in Köprüköy village in the first week of April and left in the first week of September. Our findings are generally consistent with the reports by Beaman et al. (1975), Kaya et al. (1999), Gündoğdu (2002), and Aslan and Kiziroğlu (2003), who studied the avian fauna of central and western Anatolia. Gündoğdu (2002) also noted that house martins were still present around Isparta and its environs on September 12. Oelke (2003) recorded that the first arrival of house martins in Germany was the middle of April, while Hubálek (2003) reported that house martins arrived in southern Moravia, in the Czech Republic, on April 21. Rhodes and Piper (2001) defined the house martin as a Palearctic migrant and observed that they left their habitat in KwaZulu-Natal (South Africa) until returning in May. Our data also supported the idea that migration of the house martin to the north showed consistency with bioclimatic rules.

The mating behavior of house martins was studied by Lifjeld and Marstein (1994), Riley et al. (1995), and Whittingham and Lifjeld (1995). According to their studies, the males had a complex breeding strategy and they continually entered neighboring nests to mate with females. Males usually entered a foreign nest when the female was alone. They also observed that if a male was present the foreign visitor fought with the male to enter the nest. Similar behavior was observed in this study, and we also observed that sometimes these fights were so violent that the birds fell into the water.

Snow and Perrins (1998) published the following mean measurements and weights for house martins: TBL: 125 mm; WL: 105-116 mm; WS: 260-290 mm; W: 13.77-16.63 g. These figures are generally in agreement with our measurements, but the TBL we recorded (133.5 mm) was markedly higher.

Bryant (1973) stated that the eggs of house martins were 20.3 mm × 13.6 mm, and weighed 1.68 g in the first clutch and 1.64 g in the second clutch. Our data on egg size and weight are consistent with Bryant's (1973).

Bryant (1973) also determined that nestlings that were only 4 days old could approach the nest entrance and drop out of the nest, which is consistent with our observations of 4-day-old nestlings in the first week of June 2003. Snow and Perrins (1998) reported that the brooding period for house martins was between 14 and 16 days and that the fledgling period lasted 32 days. Based on this report, we surmised that the house martins near Köprüköy should be able to produce 2 broods during the breeding season.

Bryant (1975) suggested that the breeding success of house martins is related directly to the density of insects. He also found that in England the first clutch size was 3.9 and the second was 2.95. In the present study, the maximum number of nestlings per nest was 4 (n = 1), but there were usually 3 in a nest. As a rule, clutch size is expected to decrease towards more northern latitudes, but our data showed that there was not a significant difference in clutch size between Turkey and England. However, Møller (1984) showed that clutch size increases as one moves westward, and that as clutch size increases the hatching success rate decreases. They also noted that the brood number decreases with latitude. According to these data, the breeding strategy of house martins is consistent with the rules of Hopkins and the bioclimatic rule. Bryant (1975) also suggested that the major reason for deaths in the nest was inadequate food availability. We found many dead house martins in the nests we examined, all of which were from the previous year. These dead birds might have belonged to the last brood, possibly abandoned by parents due to a sudden decline in climatic conditions. According to Bryant (1975), if food was scarce, the egg-laying period lasted longer, causing deaths in the nest. According to Remes and Martin (2002), the relative fledgling mass of house martins was 0.819 g. This value was below our measurements of 1.21 g for 15-day-old nestlings and 1.08 for sub-adults.

House martins come from Africa to Central Anatolia in the beginning of April and return to Africa the first week of September. The house martins that established a breeding colony near Köprüköy village had a maximum of 2 broods and the number of nestlings in each brood ranged from 1 to 4. It was also determined that the people in this village had no concept of conservation for the house martin, as the old bridge was illuminated by the local authorities to promote tourism. This practice can adversely affect the house martin population. Considering that the success of house martins has a positive

correlation with insect density, house martins are thought to be an important factor in the control of harmful insects.

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References

Aslan, A. and Kiziroğlu, İ. 2003. Sakaryabaşı/Eminekin Göleti ve Çevresinin Ornithofaunası üzerine araştırmalar. Turk. J. Zool. 27: 19-26.

Baran, İ. and Yılmaz, İ. 1984. Ornitoloji Dersleri, Ege Üniversitesi Fen Fakültesi Yayınları, İzmir.

Beaman, M., Porter, R.F. and Vittery, A. 1975. Bird Report No. 319, 1970-1973, Ornithological Society of Turkey, London.

Barış, S., Akçakaya, R. and Bilgin, C. 1984. The Birds of Kızılcahamam, Birds of Turkey, Heidelberg.

Bruderer, L., Liechti, F. and Bilo, D. 2001. Flexibility in flight behaviour of Barn Swallows *(Hirundo rustica)* and House Martins *(Delichon urbica)* tested in a wind tunnel. The Journal of Experimental Biology 204: 1473-1484.

Bryant, D.M. 1973. The factors influencing the selection of food by the house martin (Delichon urbica (L.)). The Journal of Animal Ecology 42: 539-564.

Bryant, D.M. 1975. Breeding biology of House Martins *Delichon urbica* in relation to aerial insect abundance. Ibis 117: 180-216.

Bryant, D.M. 1979. Reproductive costs in the house martin (*Delichon urbica*). Journal of Animal Ecology 48: 655-675.

Bryant, D.M. and Westerterp, K.R. 1983. Short-term variability in energy turnover by breeding house martins *Delichon urbica*: A study using doubly-labelled water ($D_2{}^{18}O$). Journal of Animal Ecology 52: 525-543.

Demirsoy, A. 2001. Yaşamın Temel Kuralları, Omurgasızlar/Böcekler (Cilt II/Kısım II), Ankara.

Dijksen, L. and Kasparek, M. 1985. The birds of the Kızılırmak delta, Birds of Turkey, Heidelberg.

Gündoğdu, E. 2002. Isparta çevresindeki bazı korunan alanlarda orman kuşları üzerine gözlemler I. Süleyman Demirel Üniversitesi Orman Fakültesi Dergisi 1: 83-100.

Heeb, P., Kölliker, M. and Richner, H. 2000. Bird-ectoparasite interactions, nest humidity and ectoparsite community structure. Ecology. 81: 958-968.

Heinzel, H., Fitter, R. and Parslow, J. 1995. Türkiye ve Avrupa'nın Kuşları, DHKD, İstanbul.

Hubálek, Z. 2003. Spring migration of birds in relation to North Atlantic Oscillation. Folia Zoologica. 52: 287-298.

Kasparek, M. 1992. Die Vögel der Türkei, Max kasparex Verlag, Heidelberg.

Kaya, M., Yurtsever, S. and Kurtonur, C. 1999. Trakya Ornitofaunası üzerine araştırmalar I. Tr. J. of Zoology. 23: 781-790.

Kılıç, T.D. and Eken, G. 2004. Türkiye'nin Önemli Kuş Alanları 2004 Güncellemesi, Doğa Derneği, Ankara.

Kiziroğlu, İ. 1989. Türkiye Kuşları, T.C. Orman Gen. Müd. Basımevi, Ankara.

Kumerloeve, H. 1964. Knospen- und Jungtriebfilz von Pappeln als Nestmaterial von Mehlschwalben *(Delichon urbica)* (oberen Euphrat). Vogelwelt. 85: 125.

Liechti, F. and Bruderer, L. 2002. Wingbeat frequency of barn swallows and house martins: A comparison between free flight and wind tunnel experiments. The Journal of Experimental Biology. 205: 2461-2467.

Lifjeld, J.T. and Marstein, B. 1994. Paternity assurance behaviour in the house martin *Delichon urbica*. Journal of Avian Biology. 25: 231-238

Lope de, F., González, G., Pérez, J.J. and Møller, A.P. 1993. Increased detrimental effects of ectoparasites on their bird hosts during adverse environmental conditions. Oecologia 95: 234-240.

Lope de, F., Møller, A.P. and de la Cruz, C. 1998. Parasitism, immune response and reproductive success in the house martin *Delichon urbica*. Oecologia. 114: 188-193

Merino, S., Martínez, J., Barbosa, A., Møller, A. P., de Lope, F., Pérez, J. and Rodríguez-Caaberio, F. 1998. Increase in a heat-shock protein from blood cells in response of nestling house martins *(Delichon urbica)* to parasitism: an experimental approach. Oecologia. 116: 343-347.

Møller, A.P. 1984. Geographical trends in breeding parameters of Swallow Hirundo rustica and House Martins Delichon urbica. Ornis Scandinavica. 15: 43-54.

Møller, A.P., de Lope, F., Moreno, J., González, G. and Pérez, J. 1994. Ectoparasites and host energetics: House martin bugs and house martin nestlings. Oecologia. 98: 263-268.

Møller, A.P., Merino, S., Brown, C.R. and Robertson, R.J. 2001. Immune defense and host sociality: A comparative study of Swallows and Martins. The American Naturalist. 158: 136-145.

Müller, J. and Seelig, K.J. 1973. *Stenopteryx hirundinis* L. (Dipt., Pupipara) auf Uferschwalben, *Riparia riparia* (L.), im Kreis Staßfurt. Entomol. Nachr. 17: 174-175.

Oelke, H. 2003. Swallow censuses in Northwest Germany (1986, 1991 and 1996). Ornis Hungarica 12-13: 183-190.

Orzságh, I., Krumpal, M.V. and Cyprich, D. 1990. Contribution to the knowledge of the martin bug *Oeciacus hirundinis* (Heteroptera, Cimicidae) in Czecholovakia. Zb. Slov Nár Múz Prir Vedy. 36: 43-60.

Ptaszyk, J. 2001. Nesting of the house martin *Delichon urbica* in the city of Poznan (1976-1978 and 1982-1989). Acta Ornithologica. 36: 135-142.

Pilgrim, R.L.C. and Galloway, T.D. 2003. Descriptions of flea larvae (Siphonaptera: Ceratophyllidae, Leptosyllidae) found in nests of the house martin, *Delichon urbica* (Aves: Hirundinidae), in Great Britain. Journal of Natural History. 37: 473-502.

Remes, V. and Martin, E.T. 2002. Environmental influences on the evolution of growth and developmental rates in Passerines. Evolution.56: 2505-2518.

Rhodes, G.E. and Piper S.E. 2001. Spatio-temporal patterns of abundance *Hirundinidae* in the province of Kwazulu-Natal South Africa. The Ring. 23: 81-97.

Riley, H.T., Bryant, D.M., Carter, R.E. and Parkin, D.T. 1995. Extra-pair fertilizations and paternity defence in house martins, *(Delichon urbica)*. Animal Behavior. 49: 495-509.

Snow, D.W. and Perrins, C.M. 1998. The Birds of the Western Palearctic, Passerines, New York.

Steiner, H.M. 1970. Eine Beobachtung der Rötelschwalbe *(Hirundo daurica)* im östlichen Schwarzmeergebiet. İbid. 13: 57-58.

Tripet, F. and Richner, H. 1997. The coevolutionary potential of a 'generalist' parasite, the hen flea *Ceratophyllus gallinae*. Parasitology. 115: 419-427.

Tripet, F., Christe, P. and Møller, A.P. 2002. The importance of host spatial distribution for parasite specialization and speciation: A comparative study of bird fleas (Siphonaptera : Ceratophyllidae). Journal of Animal Ecology. 71: 735-748.

Whittingham, L.A. and Lifjeld, J.T. 1995. High paternal investment in unrelated young: extra-pair paternity and male parental care in house martins. Behav. Ecol. Sociobiol. 37: 103-108.