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Breeding ecology and behaviour of the Great Reed Warbler, *Acrocephalus arundinaceus*, in Poyrazlar Lake, Turkey

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Abstract: In this study, the breeding ecology and behaviour of the Great Reed Warbler, *Acrocephalus arundinaceus*, was studied at Poyrazlar Lake, Turkey. The breeding period started in the first week of May. The incubation period lasted 14 days. As clutch size increased, the diameter of the nests became larger ($r = 0.65$). Diameters of nests containing different clutch sizes varied significantly from one another ($P < 0.01$). However, their height did not change ($r = 0.24$). There was no significant height difference between nests containing different clutch sizes ($P > 0.05$). As the nests became farther from the shore, the clutch size and the egg weight increased, because mature adults built their nests on the reeds in deeper areas ($r = 0.59$, $r = 0.73$). On the other hand, young breeders showed no location preference in their choice of nest site. The number of the nests showed a positive correlation with the height of reeds ($r = 0.80$). In all nests, 4 different behaviours (Nest Empty, Sitting, Edge of Nest Waiting, Feeding Nestlings) were observed from the appearance of the first egg until the female left the nest. On average, a given female spent 38.11% of her time away from the nest, 51.84% of her time in incubation, 0.91% of her time around the nest, and 9.24% feeding her nestlings per day.

Key words: Great Reed Warbler, breeding, ecology, Poyrazlar Lake, Turkey

1. Introduction

The Great Reed Warbler, *Acrocephalus arundinaceus*, is the largest of the European warblers (Simms, 1985). This passerine bird generally lives in large reeds, although it also can often be observed in bushes. The Great Reed Warbler spends the winter in tropical Africa. Its breeding area is Europe and westernmost temperate Asia (Traylor and Parelius, 1967). While this species is mostly monogamous, a male may occasionally mate with more than one female (Del Hoyo et al., 2006). The females take the quality of the nesting area, the quantity of food, and predation risk into consideration before determining the territory. The males generally prefer polygamy in high-quality territories. In low-quality territories, however, they prefer monogamy and often fail in mating. The polygamous males show less parental care when compared to the monogamous males. In either case, males warn the females in case of predators (Hasselquist et al., 1996; Hansson et al., 2000).

Since the first quarter of the 20th century, many studies have been carried out on Great Reed Warblers. During the last 20 years, research has been focused intensively on their breeding ecology (Dyrcz and Nagata, 2002). As a result of these studies, populations breeding in different habitats and climates can be compared. The Great Reed Warbler lives in almost every wetland in Turkey and is a summer migrant (Uzun et al., 2010). However, there has been no study on the breeding biology of this species in Turkey. The purpose of our study is to address this deficiency and to compare the data that we gathered with other studies.

2. Materials and methods

The study was carried out in April–October 2011. A total of 27 visits were made to Poyrazlar Lake. Information regarding the arrival time of the Great Reed Warbler to Poyrazlar Lake was provided by Uzun et al. (2010). Field observations at the lake were begun 1 week before the beginning of the breeding season and were continued until the first individual was observed. Individuals were counted by point and transect counting. Counts were carried out by naked eye and with the aid of 8 × 30 magnification Conus binoculars. The nests were searched for around the reed field where birds were observed singing. Shallow areas of the lake were entered with the aid of boots while deeper areas were accessed by boat. Labels showing the visit date and the discovery order were attached to the nests. So that nests could be located again easily, a red ribbon was tied

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to a tall reed nearby. The distance between the nests, the distance to the shore, and the height above water were determined with a Bosch laser meter. The depth of water and height and diameter of nests were measured with a ruler (0–100 cm). The weights of eggs were measured with an electronic scale (Unimaster 1200), and the heights and diameters were measured with a Mitutoyo digital compass. Five randomly chosen nests were observed for 24 h with a Prohex PX-190 camera with night vision. The images were stored in a 2-terabyte GNT 804 4 Realtek recording device and periodically analysed. The acquired data were evaluated with SPSS 20 (t-test, correlation, variance analysis [Pearson]).

2.1. Study area

Poyrazlar Lake is located in the northeast of the Marmara region of Turkey (40°50′N, 30°28′E). The surface of the lake is 60 ha. The lake was formed when the Sakarya River changed its course. Its maximum depth is 3 m. The lake is a popular picnic site for people from nearby cities. The lake is surrounded by forestland to the west and north, and by residential areas to the east and south. The reed vegetation is composed of sea club-rush (*Scirpus maritimus*), common spike-rush (*Eleocharis palustris*), and common reed (*Phragmites australis*). When the field survey started in April 2011, the average *Scirpus maritimus* was 78 cm, *Eleocharis palustris* was 104 cm, and *Phragmites australis* was 42 cm. The aqueous vegetation grew until mid-July. During this period, sea club-rush grew 9.94 cm on daily average and became 237 cm tall, common spike-rush grew 10 cm and became 264 cm tall, and common reed grew 3.25 cm and became 94 cm tall. The maximum temperature recorded around Poyrazlar Lake during the study period was 33 °C and the minimum temperature was 11 °C (average temperature: 26.25 ± 1.24 °C).

3. Results

The first Great Reed Warbler individuals at Poyrazlar Lake were observed on 1 May. Migration lasted 1 month. The Great Reed Warbler population left Poyrazlar Lake in September. During the study, the average number of individuals was lowest in May (22.20 ± 0.58) and highest in August (87.25 ± 3.27). During August, the individual count included the season's new young, leading to a much higher count for this month (Figure 1).

The first nest was recorded on 3 May and the last nest was recorded on 10 August. In total, 33 nests were found: 14 of the nests were recorded in June, 13 in July, 3 in August, and 3 in May. Building the nests and mating were completed within 2–3 days. There were no nests found in the reeds prior to the studied breeding season. Hence, the nests are rebuilt in every breeding period by males and females together. The first 27 nests were found

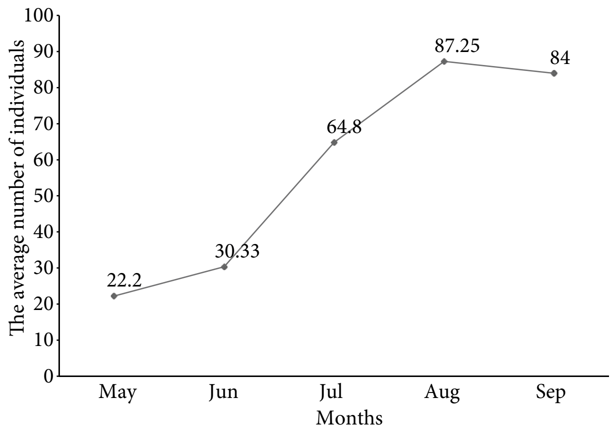

Figure 1. The average number of individuals during each month observed.

on dead sea club-rush and the last 6 nests were found on fresh common spike-rush. The number of reed stems used to support the nests in the form of a cup varied from reed species to species. In the nests built on sea club-rush, 2–4 (2.96 ± 0.10, N = 27) reed stems were used, while 3 reed stems were used in the nests built on common spike-rush. The distance between the nests varied between 4.20 m and 8.50 m (6.37 ± 0.26, N = 33). In the deeper areas towards the interior of the lake, the birds built their nests higher up on the reeds (Table 1). As the length of the nests increased, the diameters of the nests increased, too. There was no statistical relationship between the number of the nests and their distances to the shore's edge ($r = -0.34$, N = 33).

The clutch size varied from 3 to 5 (Table 1). The mean clutch size was 4.40 ± 0.27 (N = 33). A positive correlation among egg length, weight, and diameter was observed. Egg weight and size were positively correlated ($r = 0.50$). However, there was no statistical difference among the egg sizes ($P > 0.05$). A similar relationship between diameter and weight was observed ($r = 0.92$). The eggs showed a significant difference in the diameters of different weights ($P < 0.05$). The egg diameter became larger along with the length, as expected. The diameter of the nest showed a positive correlation with the clutch size ($r = 0.65$). Nests of different diameters had significantly different clutch sizes ($P < 0.01$). However, there was no statistical relationship between the nest height and the clutch size ($r = 0.24$). Clutch size showed no significant difference depending on nest height ($P > 0.05$). To summarise, as a Great Reed Warbler expanded its nest, it increased the nest's diameter in order to fit more eggs into it but did not change its height. Clutch size did not change depending on the height of the nest from the water ($r = -0.19$). In other words, the clutch sizes of nests at different heights from the water did

Table 1. Morphology of nests and eggs.

Characteristics	N	Min–Max	Average ± SD
Height of nest from water (cm)	33	32–64	47.80 ± 3.93
Water depth (cm)	33	43–100	62.90 ± 5.37
Nest diameter (cm)	33	7–10	8.90 ± 0.35
Nest length (cm)	33	9–13	11.10 ± 0.46
Nest distance from shore (m)	33	5–25	11.25 ± 2.16
Clutch size	33	3–5	4.40 ± 0.27
Egg weight (g)	145	2.1–3.8	2.87 ± 0.06
Egg length (mm)	145	19.70–23.90	22.02 ± 0.18
Egg diameter (mm)	145	13.40–17.50	15.51 ± 0.16

not differ significantly (P > 0.05). In contrast, clutch size increased with increasing water depth (r = 0.70). Nests located in different water depths differed significantly in their clutch sizes (P < 0.01). Similarly, there was a positive correlation between clutch size and distance to the shore (r = 0.59). Nests located at different distances from the shore showed significantly different clutch sizes (P < 0.05). More eggs were laid in the nests built in deeper waters. Similarly, as the distance to the shore increased, the egg weight increased, as well (r = 0.73). Egg weights showed significant differences depending on the distance to the shore (P < 0.05).

During the laying period, the female laid 1 egg every day. Laying took place at around 0500–0600 hours (average: 0523 hours ± 3 minutes, N = 20). Even though the clutch size varied, the females incubated after the third egg in the 5 nests recorded by camera. During the first 3 days, the female spent most of her time out of the nest. From the fourth day on, sitting time rose significantly and empty nest time decreased (Figure 2). This situation lasted until the nestlings hatched. However, there was statistically no difference between the time spent out and sitting time (P > 0.05, t-test, Table 2). The times spent out of and in the nest by the female were significantly higher than the lengths of time spent waiting at the edge of the nest and feeding nestlings (P < 0.05, t-test, Table 2). This was the same in all of the 5 nests observed by camera. In all of the nests, the female usually left the nest empty during daytime, especially during midday, around 0100–0400 hours. When it got dark, the female preferred to stay in the nest. When she did not incubate at night, she waited at the nest edge. The incubation lasted 14 days. The nestlings in the nests with 3 eggs hatched on the same day and the ones

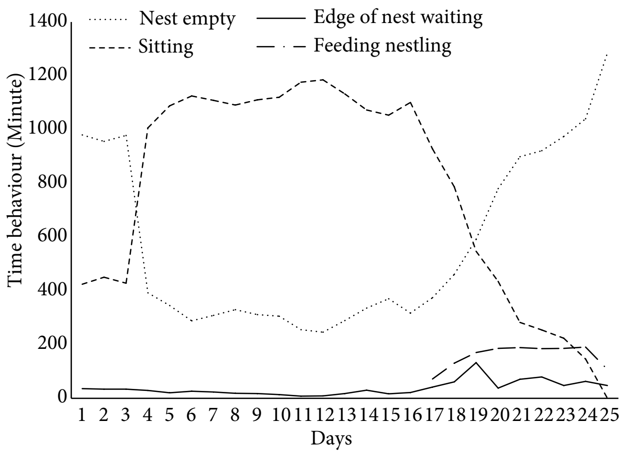

Figure 2. Times spent engaged in indicated behaviours over the days under observation.

in nests with 4 or 5 eggs hatched over 2 days. The nestlings left the nest 8–9 days after hatching. The female left the nest 1–2 days before the nestlings. Therefore, the breeding period in total (from the first egg on) lasted 25–26 days (Figure 2).

Sitting time and edge of nest waiting time were close to equal in all 5 nests, showing no significant differences from one another (P > 0.05, t-test). Empty nest and nestling feeding times were different among nests (P < 0.05, Table 2). The female left the nest empty longer in the nests with fewer eggs. That is to say, as the clutch size decreased, empty nest time increased (r = –0.49). Nestling feeding time showed a positive correlation with the clutch size (r = 0.55). The female spent more time feeding the nestlings as their number increased (P < 0.05, Table 2).

Table 2. Time spent engaged in different behaviours in the 5 observed nests.

Nest no.	Clutch size	Nest empty/day (min ± SD)	Sitting/day (min ± SD)	Edge of nest waiting/ day (min ± SD)	Feeding nestling day (min ± SD)
1	5	560.60 ± 61.19[a]	775.56 ± 76.66[abc]	11.48 ± 6.76[d]	210.44 ± 17.65[e]
2	3	596.32 ± 69.71[b]	768.92 ± 79.21[abc]	20.76 ± 8.16[d]	109.68 ± 18.33[f]
3	4	563.20 ± 63.85[ac]	775.20 ± 81.58[abc]	24.98 ± 9.21[d]	150.05 ± 22.25[g]
4	5	551.80 ± 65.46[a]	766.20 ± 83.33[abc]	21.20 ± 8.39[d]	213.88 ± 16.78[e]
5	3	594.80 ± 69.72[bc]	769.20 ± 78.45[abc]	20.78 ± 8.06[d]	115.62 ± 11.85[fg]
Average ± SD		573.34 ± 65.42[k]	771.01 ± 79.58[k]	37.73 ± 5.49[m]	157.57 ± 14.51[n]

There are statistically significant differences between data points labelled with different letters ($P < 0.05$, t-test).

4. Discussion

Great Reed Warblers are summer visitors in Asia and Europe (Dyrcz and Nagata, 2002). However, they reach different breeding areas at different times. In our study, the first individuals were observed on 1 May and the first egg was recorded on 3 May. On the other hand, the first individuals in Japan were observed on 25–30 April and the laying period started on 19–25 May (Dyrcz and Nagata, 2002). In spite of being a European country, Poland showed more similarity with Japan in terms of first laying and hatching dates (Dyrcz, 1995; Ezaki and Urano, 1995). As soon as the birds arrived in the area of study at Poyrazlar Lake (Turkey), the breeding period started. In Japan and Poland, it started 20 days after the initial arrival (Dyrcz and Nagata, 2002). Poland is much closer to Turkey than to Japan, yet the breeding ecology of the Great Reed Warbler in Poland is more similar to that of Japan than that of Turkey. This situation can be explained by the climatic characteristics of the countries. Japan and Turkey are almost at the same latitude in the northern hemisphere. Poland is farther north than the other 2 countries. Therefore, it has a colder climate. Japan is in the east of Asia, which is generally colder than western Eurasia (Trewartha, 1954). This causes the vegetation to grow later in Japan and Poland compared to Turkey. Hence, mating, nest building, laying, and hatching are all delayed. The vegetation type and characteristics play a major role in bird mating time and breeding success (Seitz and Zegers, 1993; Thompson and Burhans, 2003; Trnka et al., 2009).

All of the nests in Poland and Switzerland were built on reeds in water, as were the ones at Poyrazlar Lake (Turkey), but in Japan more than half of the nests were found in unflooded dry reed beds (Dyrcz and Nagata, 2002). The height of the nests from the water surface was higher in Japan (Kasumigaura Lake, 125.2 ± 27.2 cm) than in Turkey (Poyrazlar Lake 47.80 ± 3.93 cm) and Poland (Milicz Lake, 50.4 ± 18.5 cm). Dyrcz and Nagata (2002) explained that nests were built higher up and in reeds on land as a precaution against floods during the wet season and due to the dominant predator species being different. The water level in Poyrazlar Lake does not change during the breeding period. Therefore, there is no possibility of flooding. In addition, Marsh Harrier (*Circus aeruginosus*) is the most important predator in Poyrazlar Lake, as in Poland. For this reason, nests were built on the lower parts of reeds because of predation. Birds generally make their nests in dense vegetation so as to minimise the efficiency of predators' sight, smell, and hearing abilities (Martin, 1993). Dense vegetation affects the predators' hunting behaviours negatively (Martin, 1993; Seitz and Zegers, 1993).

According to Benassi et al. (2009), Great Reed Warbler uses only *Phragmites australis* stems to make nests. However, in our study, no nests were found on *Phragmites australis* stems. According to Dyrcz and Nagata (2002), Great Reed Warbler used both dead and fresh reed stems to support nests, and nests were attached on 2 to 6 reed stems (3.22 ± 1.00). The number of the stems used to support the nests in Poyrazlar Lake varied among the reed species: 2–4 stems were used for the nests on dead sea club-rush (2.96 ± 0.10), while 3 stems were used for the nests on fresh common spike-rush. All nests (27 nests) were built on dead sea club-rush until mid-July, while the last 6 nests were made on fresh common spike-rush stems so that eggs and nestlings could be protected from predators such as Marsh Harrier. The nests built on dead sea club-rush are hidden very safely among fresh vegetation, as it grows continuously. Dead common spike-rush stems were not appropriate for the birds' nest-building, as all of the stems were leaning on the water. Birds made their nests on fresh common spike-rush beginning in mid-July. This is probably associated with the length of the fresh reeds. The horizontal dispersion of the nests is as important as their vertical dispersion. This situation varies depending on the abundance of food, number of individuals, and especially on the size of the breeding area. As the area gets bigger, the distances between the nests get bigger, too (Trnka et al., 2009).

Gavrilov and Gavrilov (2005) stated that the Great Reed Warbler's clutch size is on average 3–6 (generally 5), and Dyrcz and Nagata (2002) expressed it as 5 ± 0.21 on average. On the other hand, in our study, the average clutch size observed was 3–5 (generally 3, average of 4.40 ± 0.27). The clutch size of a nest rose depending on the distance to the shore and the depth of water. This is because adult birds (Charnov and Krebs, 1974), which lay more eggs, prefer building their nests in places farther from the shore and deeper, to safeguard them against predators. Predators are more efficient in the nests closer to the shore (Batary et al., 2004). However, the distance to the shore did not raise the number of nests, since the young birds determined their nest places randomly, as opposed to the adults, and did not keep their nests far from the shore. Moreover, the young females left their nests empty more often and laid fewer eggs than adult females. These kinds of behaviours, which can affect breeding success negatively, are presumably related to the young individuals' ages. Age is an important factor in improving the birds' breeding success (Krüger, 2005).

Dyrcz (1986), Ezaki (1990), Urano (1990), and Bensch and Hasselquist (1991, 1994) stated that the males fed the nestlings and protected the eggs and nests against predators during and after incubation. However, in our study, the female Great Reed Warblers in the 5 nests observed by camera were alone during and after incubation, and the nestlings were fed by the females. The male made a few visits to only 2 nests for a very short time. This difference can be explained in 2 ways. First, we only observed 5 of the 33 nests in the breeding area with a camera. Even though the male was not active in these nests, he might have contributed in feeding and protecting the nestlings in the other nests. Second, the male might have ignored his tasks because of being polygamous. Polygamy is very common among the Great Reed Warbler species. As the male increases his number of mates, he takes on fewer responsibilities (Sejberg et al., 2000).

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