



Habitat-related Egg Size Differences and Hatching Success in the Spur-Winged Lapwing *Vanellus spinosus* (L., 1758) (Charadriiformes: Charadriidae)

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Abstract: Egg size in birds is a factor that affects their reproductive success, especially in the size and survival rates of the chicks. Until they learn to find food within a few days after hatching, precocial-type chicks need to use their own biological reserves to supply the energy they expend in walking, running, hiding from predators, etc. The spur-winged lapwing *Vanellus spinosus* (L., 1758) is a common lapwing species having precocial-type offspring. The species is seen as a summer visitor in Türkiye and Boğazkent is one of its important breeding areas in the country. In the present study, the characteristics of the eggs laid in three habitats (agricultural lands, barren lands and meadows) within this area were compared. To this purpose, the eggs were weighed and their width and length were measured. In addition, the volume and sphericity index of the eggs were calculated. We found significant differences in egg measurements between the habitats with eggs laid in meadows being larger, heavier and with greater egg volume than in the other two habitats. However, the hatching rates in the meadows were the lowest (43.8 %) in comparison with the agricultural lands (67.7 %) and barren lands (73.3 %), possible due to potentially higher predation pressure in meadows.

Key words: Boğazkent, egg characteristics, hatching rate, precocial birds, Türkiye

Introduction

Egg size in birds is a factor that affects their reproductive success, especially in the size and survival rate of the chicks (BOLTON 1991, WILLIAMS 1994, SMITH & BRUUN 1998, RISCH & ROHWER 2000, AMAT et al. 2001). Precocial-type offspring in particular are nidifugous and not actively fed by their parents. Thus, they need to find food on their own (WALTERS 1984). Therefore, until they learn to find food within a few days after hatching, they must walk, run, hide from predators, etc., and they need to use their own biological reserves to supply the en-

ergy they expend (RICKLEFS et al. 1978, GALBRAITH 1988, GRANT 1991). In altricial species, however, after hatching, the young are actively fed by the parents and stay in the nest until they reach flight maturity. MAGRATH (1992) has suggested that the effect of egg mass on the survival of the offspring is greater in precocial species than in altricial species.

The quality of the habitat in which the species nests also affects the egg size (SMITH & BRUUN 1998, CHRISTIANS 2002). CIACH (2011) has reported that there are significant differences in egg sizes according to the habitat type of the nesting area. Variation in egg size may be related to the parental fit-

ness, food supply or predation in different habitats (CHRISTIANS 2002, CIACH 2011).

The aim of this study was to investigate whether there is a habitat-related difference in the egg sizes of the spur-winged lapwing *Vanellus spinosus* (L., 1758), which is identified as a species of least concern (LC) in the International Union for the Conservation of Nature (IUCN) red list but is evaluated as vulnerable (VU) for Türkiye (KILIÇ & EKEN 2004, KIZIROĞLU 2008). The spur-winged lapwing is a summer visitor and a breeding species in Türkiye (Özkan et al. 2012, WIERSMA & KIRWAN 2017). Individuals from Central Africa arrive in the area in the first week of March and, after courtship behaviour in mid-April, the first nests appear (Özkan et al. 2012). It lays its eggs on the ground, using various materials with no specific nest construction. It has a precocial type-1 chick development (STARCK 1993) and, after hatching, the offspring actively move around and feed on their own without active parental care. Their breeding habitat encompasses areas near fresh water sources and includes agricultural lands, meadows and barren lands (WIERSMA 1996).

Materials and Methods

Study area

The study area of Boğazkent is located 50 km from the city of Antalya, southwestern Türkiye, 31°04'53"–31°21'08" E and 36°48'08"–36°53'23" N. With its various habitat types and vegetation, Bogazkent is rich in avian diversity and hosts 237 bird species (ERDOĞAN et al. 2011). Boğazkent is one of the important breeding areas for the spur-winged lapwing (Özkan et al. 2012).

Bird survey

Field studies were carried out between March and October 2017 in accordance with the breeding period of the species. From April, when nesting activities begin, for three days a week, the work started after the morning light and continued until the end of the day. Nests were found by following the parents. The female and male parents sit alternately on the nest, in particular at noon when the air temperature is high, in the afternoon when the air is relatively cool, and during rainy periods. Especially during these periods, the observations were increased and the nests were located. Each nest found was marked with 10-cm sticks placed 5 m away and the precise geographical location was noted by the global positioning system (GPS). Measurements were not taken during rainy periods in order to not damage the eggs.

Collection of egg data

After the nests were located, the clutch sizes were recorded and measurements (width, height, weight) of the eggs were taken. A digital calliper with an accuracy of 0.1 mm was used to measure egg sizes, and a scale with a sensitivity of 0.01 g was used for weight. Egg volume (V) was calculated as:

$$V = 0.51 \times L \times B^2 \text{ (HOYT 1979)} \quad (1)$$

The egg sphericity index (ESI) was calculated according to the equation:

$$ESI = 100 \times B / L \text{ (WINKEL 1970)} \quad (2)$$

In the equations, L represents the egg length and B represents the width.

After all procedures were completed, in order to monitor predation and calculate the incubation period, the nests were checked at 3-4 day intervals. Although the eggs are light in colour when they are first laid, they become darker towards the end of the incubation period and the hatchlings start to chirp a day or two before they emerge. During these proceedings, the monitoring was increased, and remote observations were made using binoculars. The incubation period was calculated after the chicks had hatched.

Reproductive success is evaluated according to hatching success and fledging success (NADEEM et al., 2014). Eggs in different habitats were compared and breeding success evaluated according to hatching success in this study.

Statistical analysis

In order to compare the data of eggs from the different habitats, analyses were carried out using the SPSS 17 statistical program. Firstly, the data were tested for normality using the Kolmogorov–Smirnov test. The data were found to be normally distributed after $\log_{10} + 1$ transformation and used parametric procedures the one-way analysis of variance (ANOVA) was applied. To compare hatchling rates in the three habitats, first Arsin transformation for percentage data was performed and used non-parametric procedures the Kruskal-Wallis H test.

Results

The spur-winged lapwings arrived in Boğazkent in the first week of March and left towards wintering grounds by mid-October. The egg-laying period lasted four months (April to July), with highest number of clutches laid in the end of April and mid-June (Fig. 1). The mean incubation period was found to be 26.1 ± 0.21 days.

Measurements were taken of 87 eggs from 25 nests found in three habitats situated near water

channels: agricultural lands (n=32), meadows (n=29) and barren lands (n=26). (Fig.2, Table 1). The average clutch size was 3.7 ± 0.15 eggs. Four eggs were laid in the majority of the clutches (60 %), but three (28 %) or two (12 %) were laid in some (Fig. 3).

Whereas there was no significant difference between the barren lands and agricultural lands in terms of egg width ($p \geq 0.05$), the eggs were larger in the meadow areas compared to the other habitats ($p \leq 0.05$) (Table 1). When evaluated in terms of egg volume, although the barren lands and agricultural lands did not differ ($p \geq 0.05$), the egg volumes in the meadows were greater than those in the other two areas ($p \leq 0.05$). In terms of egg length, no difference was found between the agricultural lands and meadows ($p \geq 0.05$); however, eggs in the bar-

ren lands were shorter than those in the other two areas ($p \leq 0.05$). In terms of weight, all habitats differed ($p \leq 0.05$) and were ranked from heaviest to lightest as: meadows > agricultural lands > barren lands. Finally, egg sphericity index (ESI) differed between the three habitats ($p \leq 0.05$) and ranked as meadows > barren lands > agricultural lands.

The hatching rate in the three habitats was 67.7 % for agricultural land, 73.3 % for barren lands and 43.8 % for meadows. There was no significant difference between the three habitats in terms of hatching rates ($p \geq 0.05$).

Discussion

The spur-winged lapwing inhabits a wide variety of habitats including cultivated fields, grasslands near water, mudflats, sand dunes, rice paddies, flooded fields, beaches and sand dunes (WIERSMA 1996). They have also been reported to nest on rooftops in some areas that host large populations (YOGEV & YOM-TOV 1997). In Boğazkent, nests were built in meadows, barren lands and agricultural lands; the mean size of the eggs laid differed between these three habitats. Egg size can affect bird reproductive output, particularly via the effects on brood size and survival (BOLTON 1991, WILLIAMS 1994, SMITH & BRUUN 1998, RISCH & ROHWER 2000, AMAT et al. 2001). WILLIAMS (1994) stated that egg size was an indicator of egg quality. Because larger eggs contain more nutrients and provide more energy, hatchability and offspring survival are higher (BLOMQUIST et al. 1997). PINOWSKA et al. (2002) found that egg

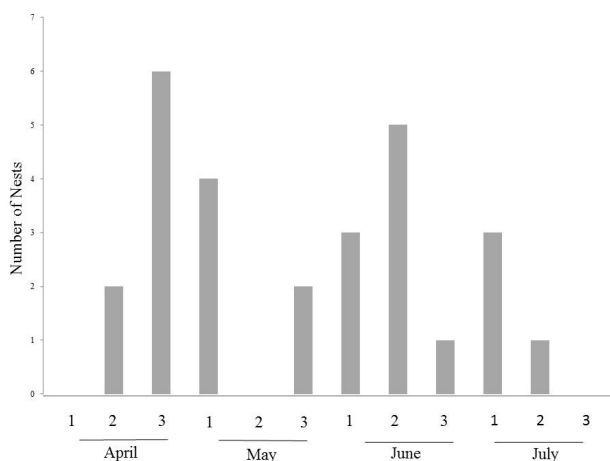


Fig. 1. Egg laying of spur-winged lapwing *Vanellus spinosus* over 10-day periods at Bogazkent.



Fig. 2. Nest distribution of spur-winged lapwing *Vanellus spinosus* at Bogazkent.

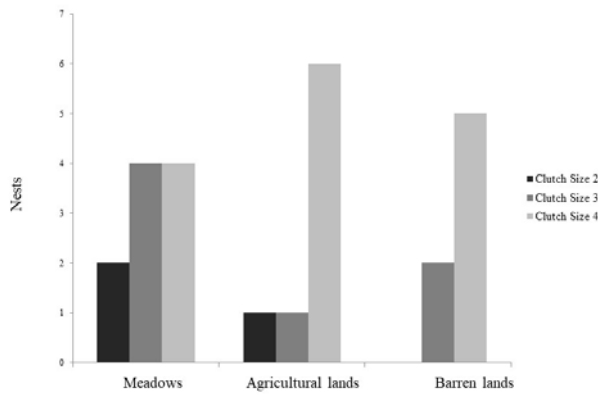


Fig. 3. Clutch size of nests of spur-winged lapwing *Vanellus spinosus* at Bogazkent.

Table 1. Comparison of egg dimensions of spur-winged lapwing *Vanellus spinosus* among three habitats. Legend: N: Total number of eggs measured. SD: Standard deviation.

Egg size (Mean ± SD)	Habitats		
	Meadows	Agricultural lands	Barren lands
Length (mm)	40.7 ± 1.19	40.4 ± 1.08	39.5 ± 1.18
Width (mm)	29 ± 0.47	28.6 ± 0.78	28.4 ± 0.48
Weight (g)	17.6 ± 0.61	17 ± 1.08	15.9 ± 1.03
Volume (cm ³)	17.8 ± 7.8	16.8 ± 10.9	16.5 ± 9.3
Sphericity Index (%)	75.2 ± 2.31	70.7 ± 2.3	71.8 ± 1.81
N	32	29	26

size might affect incubation ability in severe weather conditions, whereas PERRINS (1996) reported increased hatching rates in larger eggs. GALBRAITH (1988) noted that northern lapwing *Vanellus vanellus* chicks from large eggs were heavier at hatching and had a better survival rate than those from small eggs. In a similar study in the Nile Delta, CIACH (2011) made comparisons by taking measurements from 77 eggs laid by the spur-winged lapwing in 25 nests in three different habitats. As a result, he reported that there were differences between the habitats in terms of egg length and volume, and that bogs and urban areas were more productive habitats in terms of eggs. In our study, the highest egg-yielding habitat, the meadows, had the lowest hatching rate. Predators in the area include stray dogs, sheep dogs, foxes (*Vulpes vulpes*) and hooded crows (*Corvus cornix*). Although there is not enough data for statistical analysis on predators, the presence of shepherd dogs and stray dogs in the meadows and the presence of hooded crows in these areas due to the open garbage piles may be negative factors that will affect the reproductive success. In addition, according to my observations in 2017, the nests in barren areas and agricultural lands were decreasing

due to anthropogenic activities. The very high human activity may be affecting negatively the nesting in these habitats, making both the incubation process and post-hatching period difficult for the spur-winged lapwing. HILDEN (1965) stated that the range of habitats occupied by a species is dependent on population density, and that only optimal habitats are utilised where the density is low, whereas when density increases, habitat selection occurs in order of preference. Earlier studies in Boğazkent showed that individuals ringed with coloured metal rings settled in the same meadow areas where they had nested in previous years (Özkan et al. 2012, Özkan 2014). These observations are in line with those of HILDEN (1965) and support the idea that experienced pairs settle on fertile meadows, whereas young individuals nest in other areas. However, since the relationship between habitats and egg productivity can be shaped under the influence of many factors, long-term studies are needed.

Conclusions

When evaluated together with the data reported by different researchers, habitats selection may be related to food, age, social status and breeding experience, although predator pressure (human or animal) is often problematic for the reproductive success of the spur-winged lapwing in Boğazkent. Finally, recommendations include carrying out detailed studies in order to monitor the negative factors in the breeding area and to ensure that these habitats are preserved. In addition, further studies should be undertaken to evaluate the survival of the offspring.

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