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Breeding Biology of the Dipper *Cinclus cinclus* in Mountainous Riverine Ecosystem of Southern Slope of the Alborz Mountains

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Abstract
The Dipper *Cinclus cinclus* is an inhabitant of the mountainous riverine ecosystem of Iran. There has been no official study on its breeding biology in this country. We conducted a study to investigate the breeding biology of this species in Lalun, Abnic and Ahar streams, situated in Northern parts of Tehran province during the 2013 breeding season. The Dipper bred in two subsequent periods. The first period started from late March to late April (16 and 18 days for the incubation and fledging periods, respectively). The second period started from early May to mid-June (15 and 16 days for the incubation and fledging periods, respectively). More than 80% of the 21 surveyed nests were built on artificial structures. The nests were spherical in shape with the average length of 24.1 ± 2.69 cm (mean ± SD) and the average width of 20.8 ± 2.87 cm. In average, the nests were located 140.7 ± 41.7 cm above water level and weighed an average of 273.6 ± 94.1 g. The average clutch size was 4.7 ± 0.48 with a mean brood volume of 4.5 ± 0.53, which was not significantly different between the two breeding attempts. The mean egg weight in the first and second breeding attempts were estimated to be 4.57 ± 0.054 g and 4.055 ± 0.078 g, respectively. Overall, 75% and 63% of the nestlings in the first and second nestling attempts had successfully fledged. The majority of the nest failures and offspring mortalities (c. 83%) were mainly attributed to human disturbance. Finally, hatching and fledging success rates were higher in the first breeding attempt, indicating the importance of the first breeding period (March and April) in the conservation of breeding populations of the Dipper.

1. Introduction

The Cinclidae family is a group of unusal passerine birds that are completely adapted to riverine ecosystems (Hume 2002). Of the five species of this family, the Dipper *Cinclus cinclus* inhabits areas in the proximity of the fast current streams in the temperate and subarctic parts of Europe and Asia (BirdLife International 2012; Hourlay *et al.* 2008; Robinson 2005).

The species is a habitat specialist, which is dependent on riparian ecosystems. For this very same reason, this species is very sensitive to the environmental changes and could be treated as an ecosystem health indicator (Tyler & Ormerod 1994; Gregory *et al.* 2003). The breeding success of the Dipper could be of considerable interest to wildlife experts because

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it is a helpful indicator of riverine ecosystems' productivity (Ormerod & Tyler 1987; Wilson 1996; Sorace *et al.* 2002), trophic structure (Ormerod & Tyler 1991), human disturbances and contamination by environmental pollution (Oigarden & Linlokken 2010; Buckton *et al.* 1998). Likewise, their reproductive parameters could be considered as sensitive bioindicators for this population as well as the ecosystem because they indicate primary responses to the environmental changes (Temple & Wiens 1989).

A considerable body of data has been published on breeding biology of the Dipper in Britain and continental Europe (e.g. Shaw 1978; Tyler & Ormerod 1985; Vickery 1991; Smiddy *et al.* 1995; Wilson 1996), especially in their western parts of distribution. Although the center of geographic distribution for this species is Iran, Dippers are poorly studied in this country and little is known even about the basic aspects of their breeding biology.

There are a total of 13 subspecies reported for this species, of those, two subspecies (*C. c. caucasicus* and *C. c. persicus*) are inhabitants of the mountainous riverine ecosystems of the Alborz and Zagros Mountains in Iran (Kaboli *et al*. 2012). In this study, we investigated the breeding biology of the Dipper in streams originated from the Alborz Mountains. These observations were then compared to the findings from different parts of Europe. Furthermore, this study aimed at gathering basic information in order to monitor the trend of the Dipper's population changes as a potential biological indicator for riverine ecosystem in Iran.

2. Materials and Methods

2.1. Study area

One of the important habitats of the Dipper in Iran is the central Alborz Mountains (Kaboli *et al.* 2012). Lalun, Abnic and Ahar streams originate from the Alborz Mountains, situated in the north side of Tehran province (Fig. 1). These streams are inhabited by the Dipper species. However, they are facing extreme range of disturbances due to various kinds of anthropogenic activities such as road construction, industrialization, recreation activities, urbanization, and dam construction in the study area.

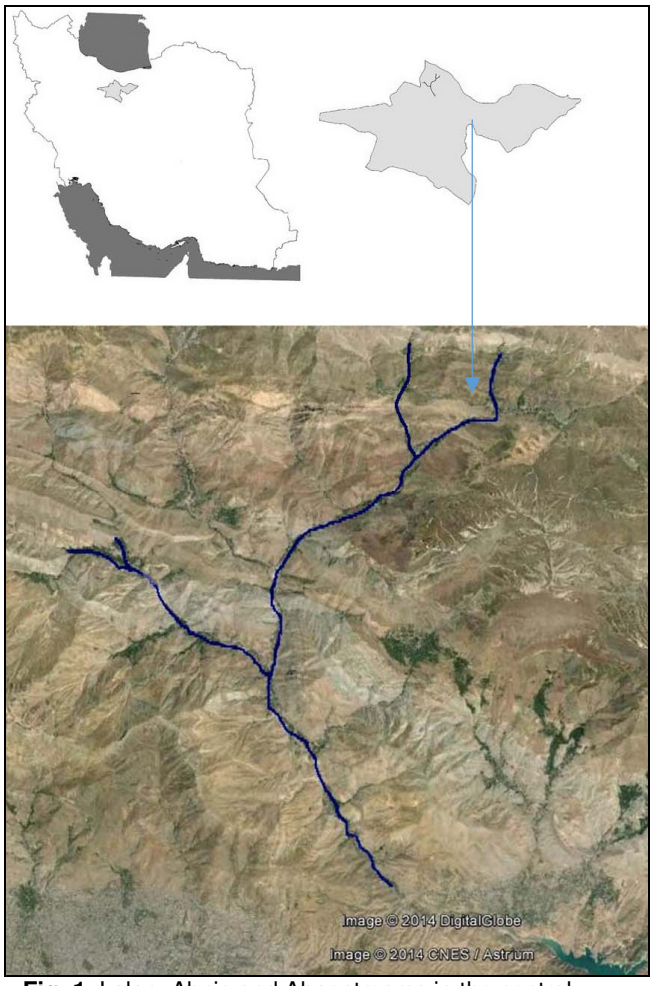

Fig. 1. Lalan, Abnic and Ahar streams in the central Alborz Mountains.

2.2. Field sampling

Data collection period was from March to July 2013, for a total of 75 days, with each sampling day entailed 10 hours of observation from early morning (6:00 am) to mid-afternoon (4:00 pm) with intensive search to locate nests and breeding pairs of the Dipper. The Sampling routes along the rivers were surveyed via direct bird observation or any signs, such as singing and feces. Approximately, more than 41 km of mountainous riverine habitats were surveyed to locate the nests (Fig. 1). All the nests were closely monitored approximately every day to check laying, hatching, and fledging dates. Furthermore, 11 inactive nests, identified by no signs of the Dipper presence, were measured for their length, width and weight. The nest height above the water level was recorded for all the nests included in the study (both active and inactive). For each active nest, the clutch size, egg length, egg breadth (down to 0.01 cm

accuracy using a vernier callipers), egg weight (down to 0.01 g using a digital scale) and number of nestlings were recorded. The potential cause of nest failure was also recorded, wherever possible. All nestlings of the two nests at each breeding period were color coded at hatching time, allowing for their individual recognition at the following stages of the study. These nestlings were weighed on two- or three-day intervals to investigate the trend of the nestling growth. Finally, to estimate the nesting success, the fate of 10 nests was followed from the egg laying stage to fledging.

2.3. Statistical analysis

Data were checked for normality using the Kolmogorov-Smirnov test. The proper parametric or non-parametric tests were then applied to compare the means. The Chi-square test was applied for the frequency data (the number of hatched eggs, nestlings, and fledging birds). All the statistical analyses were performed using SPSS V. 21 for Windows (SPSS, Inc., Chicago, IL, USA).

To estimate the nesting success, two factors were used including hatching success and fledging success. The hatching success was calculated as the percentage of eggs laid that hatched and fledging success was calculated as the percentage of the newly hatched eggs with a successful fledging.

3. Results

3.1. Nesting period

During our field surveys, nesting period was consisted of two brood-stages. In the second breeding attempt, we observed several pairs breeding at the same nest after fledging of the first brood. The first breeding attempt started from 27 March to 30 April. The incubation and nestling periods of the first attempt were 16 and 18 days, respectively. The second breeding attempt began after 10 days, from 10 May to 14 June. The incubation and nestling periods of the second attempt extended for 16 and 19 days, respectively.

3.2. Nest site location

Habitat characteristics of 21 Dipper nests in the study area indicated a preference for an area located near the fast current streams (streams on steep areas) with a dense riparian vegetation cover and physical structures such as bridges, cavities in rock walls, or water pipes. These structures provided enough coverage for the nests and nestlings. A majority of the nests (81%) were built on artificial structures, in particular bridges. The nests built on natural sites were mostly located inside cavities or tree roots.

3.3. Size and shape of nests

The nests were mostly built with natural material and long twigs were used for the nest cup (Fig. 2). However, artificial material, such as plastics, were also found in the nests in the study area (Fig. 3).

Fig. 2. A view of the Dipper nest in the study area.

Fig. 3. Artificial materials used in the Dipper nests.

The Dipper nests presented a variety of shapes with a high variation in the nest cup width (Table 1). This could be due to the different physical structure of the nest sites, different spatial structure of the nesting area, and the amount of space offered by the specific location for the nest building.

3.4. Cluth size and egg measurements

The clutch size averaged higher for the second breeding attempts and the brood size averaged higher for the first attempts (Table 2). However, the Mann–Whitney *U* test indicated that there was no statistically significant difference in the clutch size and brood size between these two breeding attempts (*P*=0.752 and *P*=0.352, respectively).

The egg measurements (weight, length, and breadth) were higher in the first breeding attempts (Table 3). The results of the t-test indicated that the egg length was significantly different between these two attempts (*P*= 0.011). However, there was no statistically significant difference in the egg breadth between these attempts (*P*=0.076).

3.5. Nestling growth

The increase in the nestling body mass indicated a higher rate of the growth at the beginning of this period (Fig. 5). Nestlings reached an average weight of 57.6 g (SD= 0.9) just before leaving the nest.

3.6. Nesting success

There was no signifanct difference between these two periods in term of the number of hatched eggs and fledged youngs (χ^2= 0.016, df=1, *P*= 0.898). However, the hatching and fledging success rate were higher in the first period (Table 4).

Table 1. Descriptive statistics for weight and measurements of the Dipper nests.

Nest measurements	N	Min	Max	Mean	SD	CV
Nest length (cm)	11	20	27	24.1	2.69	0.11
Nest width (cm)	11	17.5	25	20.8	2.87	0.14
Nest cup depth	11	4.8	7.5	5.9	0.89	0.15
Nest cup length	11	5.5	9.5	8.0	1.38	0.17
Nest cup width	11	2.7	7.6	5.4	2.11	0.39
Max thickness (cm)	11	8	10.2	9.2	0.81	0.09
Nest opening length (cm)	11	3.5	7	4.9	1.18	0.24
Weight (g)	11	150.9	382	273.6	94.1	0.34
Height above water (cm)	18	50	210	140.7	41.7	0.30

Table 2. Descriptive statistics of the clutch size and brood size in two breeding attempts of the Dipper.

Breeding period	Mean clutch size ± SD	Mean brood size ± SD
Fitst breeding attempt (n=6)	4.67±0.52	4.67±0.52
Second breeding attempt (n=4)	4.75±0.5	4.25±0.50
Total (n=10)	4.7±0.48	4.5±0.53

Table 3. Descriptive statistics of the Dipper eggs in two nests in two breeding attempts.

Nesting period	Mean egg length ± SD	Mean egg breadth ± SD	Mean egg weight ± SD
First breeding attempt (n=5)	27.2±1.09	21.2±1.30	4.496±0.054
Second breeding attempt (n=4)	25±0	19.75±0.5	4.055±0.078

Table 4. Nest success for the Dipper.

Breeding period	No. of eggs	No. of hatched eggs(hatching success)	No. of fledging young (fledging success)	Nest success (%)
First breeding attempt (n=6 nests)	28	28 (100)	21 (75)	87.5
Second breeding attempt (n=4 nests)	19	17 (89.5)	12 (63)	76.25
Total	47	45 (95.7)	33 (70)	82.75

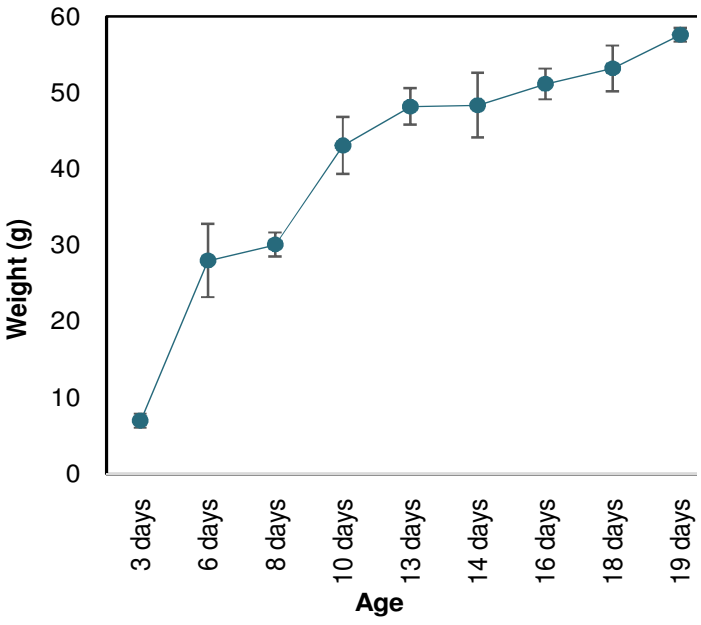

Fig. 5. Trend of nestlings body mass change (Mean ± SD) during the fledging period (n=9 nestlings).

The death of 12 nestlings was recorded during the study period (Table 4). The major cause of death (83% of 12 nestlings) was due to different anthropogenic factors (human disturbance or nestling fled). Two of the nestlings were found dead by unknown natural predators. However, there was no signs of nest destruction due to natural or human disturbances.

4. Discussion

A number of other studies (e.g. Snow & Perrins 1998; Wilson 1996) have also suggested that Dippers breed from May to June, which coincides with the breeding period recorded in our study area. There was a 10-day interval between the two nesting periods in England and Ireland (Shaw 1978), similar to what we observed in our study area in Iran, where the first period ended on 30 April and the second period started on 10 May. The nest building in the study area (i.e., near rivers, in cavities, and bridges) was similar to that of what was observed in Europe (e.g. Snow & Perrins 1998).

More than 80% of the nests were built on artificial structures. This tendency toward artificial nesting sites has also been reported in South Western Ireland (Smiddy *et al.* 1995) and England (Shaw 1978). Moreover, the average nest height above the water surface was reported to be less than two meters in nearly 95% of the streams. This was similar to the nest height reported in England with 80% of the nests less than 2 meters above the water surface (Shaw 1978).

Shaw (1978) reported a mean clutch size of 4.42 eggs for the Dipper in England, which was close to the clutch size observed in our study (4.7). This was also in line with the findings of Tyler & Ormerod (1985) in Wales (4.8), and the clutch size in Scotland (4.6) as suggested by Wilson (1996). However, the clutch size in our study area averaged higher than that of the Ireland (4.16) (Smiddy *et al.* 1995). The mean egg weight in South Western Scotland was 4.6 g (Vickery 1992) with a 26 mm length and a 19 mm breadth. These numbers were close to those of the Dipper egg measurements in the first breeding attempt in our study area, with the average weight of 4.5 g, 27.1 mm length, and 21.2 mm breadth.

A long term study in England and Ireland on the Dipper breeding biology (Shaw 1978) indicated that 55% of breeding failure was due to a direct harvest by human or parents leaving the nest due to human presence. In the present study (Tehran province), 83% of the failures was due to the human interference.

Finding of artificial materials in the Dipper nests could be due to one of the primary consequences of an improper waste management in the study area. Moreover, the pH changes could lead to a dramatic decrease in the breeding success of Dippers (Vickery 1992). However, there has been no study investigating the pH of the streams in our study area. There were many human activities in the study area, such as various kinds of developments and tourist activities. These activities could lead to an increased habitat disturbance level for Dippers. Adult Dippers responded to human presence or lower security levels by leaving the nests (Shaw 1978). Moreover, nestlings may dive out of the nest to avoid human approach (Shaw 1978). Therefore, the breeding success of the Dipper could be heavily affected by anthropogenic factors in the study area. We recommend further expanded studies on the effects of environmental pollutions and human disturbances on the breeding success of Dippers in riverine ecosystems in Iran.

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