FIRST DATA ON MORPHOMETRIC CHARACTERISTICS AND SEX DETERMINATION OF THE HOUSE BUNTING (*EMBERIZA SAHARI*) IN GHARDAÏA, ALGERIAN SAHARA

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Abstract. The House Bunting (*Emberiza sahari*) is a bird species adapted to urban life, particularly in the Algerian Sahara. During the 2024 breeding season, we captured, weighed, and measured 75 individuals in two localities in the Ghardaïa region of the northern Algerian Sahara. Among the captured individuals, 44% were adult males and 56% were adult females. Seven morphometric characters, as well as body weight, were recorded. Wingspan, tarsus length, and body weight showed significant differences between males and females ($P < 0.05$), with respective dimorphism rates of 4.76%, 7.14%, and 3.47%. Principal component analysis (PCA), which assesses the overall variability of morphological parameters, showed that the morphological distinction between sexes remains limited. A discriminant analysis (DFA) revealed moderate predictive power for sex determination, with a correct classification rate of 68% for individuals of known sex.
Keywords: *body biometrics, sexual dimorphism, algeria, breeding season, endemic species*

Introduction

Morphometric studies hold special significance for ornithologists (Saini et al., 1989; Xirouchakis and Poulakakis, 2008). Therefore, morphological differences between species, such as the shape and size of characteristics, are significant for species identification (Albayrak and Aytek, 2022). The body characteristics and gender differences of birds are frequently used in physiological, ecological, and behavioral studies (Shiu et al., 2005).

The House Bunting (*Emberiza sahari*) is a passerine species of the Emberizidae family (Moulaï, 2019), considered an endemic species of steppes and deserts (Guergueb et al., 2024; Isenmann and Thévenot, 2018) in North Africa and the Sahara (Moulaï, 2019). It is distributed in western Libya (Faisel et al., 2015), southern Tunisia (Azafaf et al., 2015; Schweizer et al., 2018), Morocco (Amezian et al., 2006), Mauritania (Santarém et al., 2018), and Algeria (Chedad et al., 2021; Isenmann and Moali, 2000). In Algeria, the House Bunting nests in the southernmost regions, specifically in the Hoggar and Tassili (Heim de Balsac and Mayaud, 1962; Ledant et al., 1981). Thus, in a North Saharan strip, its distribution extends from Béchar in the extreme southwest

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(Hartert, 1928; Isenmann and Moali, 2000), through Laghouat, Ghardaïa, and Djelfa, in the centre (Chedad et al., 2021), to Biskra in eastern Algeria (Isenmann and Moali, 2000). During the previous century, their distribution range expanded northward (Ryan, 2020) to Tissemsilt, Algiers, Bordj Bou Arréridj (Moulaï, 2019), and Tlemcen in the northwest of Algeria (Bouhissi et al., 2021). It is a commensal bird species of humans (Guergueb et al., 2024). It inhabits rocky desert environments, typically in proximity to water sources (Beaman and Madge, 2010; Ryan, 2020), in cities, villages, and adjacent vegetation (Beaman and Madge, 2010).

The characterization of certain morphological parameters of the House bunting has already been addressed by Kirwan and Shirihai (2007) as well as by Cheddad et al. (2021), although these studies involved a maximum of 19 individuals. The present study aims to provide a more detailed description of the biometric characteristics, still little known, of a population of House bunting from the Ghardaïa region and to identify the measurements that best allow differentiation between males and females.

Materials and methods

Study area

This study was carried out in Metlili Châamba city (32° 16’ N, 3° 37’ E) and Ghardaïa city (32°28’N, 3°42’E), 40 km distant from each other, both located in southern Algeria, 600 km from the country’s capital, Algiers (Nedjar et al., 2024). The regional climate is Saharan dry, characterized by mild winters and hot, dry summers, with annual mean temperatures varying between 16.5 and 27.5°C, and annual rainfall of approximately 80.10 mm (Bounab et al., 2024) (*Fig. 1*).

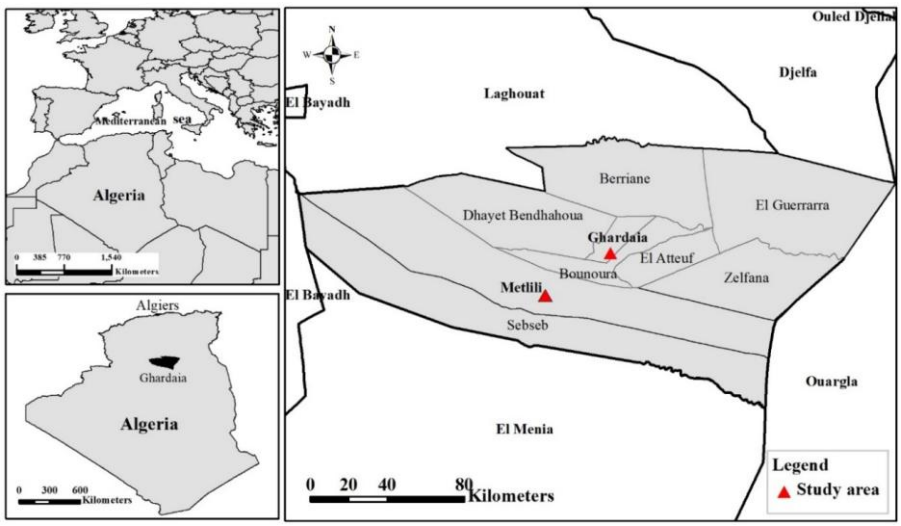

Figure 1. *Map of the study area. The two locations for data collection are marked with (red) triangles*

Morphometric measurements

Biometric characteristics were obtained from 75 House Bunting specimens, captured with standard ornithological net. Eight different morphometric characters were measured: (1) body weight (BW): using an electronic scale with 0.01 g precision. (2)

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total length (TtL): measured from bill tip to tail tip; (3) wingspan (WS): the distance between the extended wing tips; (4) tail length (TL): measured from the insertion of the central tail feathers to their tips; (5) bill length (BL): measured along the dorsal surface of the upper mandible from the tip to the first feathers of the skull; (6) wing length (WL) : measured from the carpal joint to the tip wing; (7) tarsus length (TrL): measured from the tarsometatarsal joint to the base of the middle toes; (8) head length (HL): measured from the bill tip to the posterior center of the cranium. Measurements were taken using a digital Vernier caliper with 0.01 mm precision.

Statistical analysis

Initial descriptive statistics were calculated for all morphometric measurements, including the mean, standard deviation, as well as the minimum and maximum values. The Shapiro-Wilk normality test was used to check if the morphometric traits followed a normal distribution. The results were analyzed using non-parametric tests. We assessed the differences in morphometric characteristics between males and females using the Mann-Whitney test. We calculated the percentage of sexual dimorphism for each parameter using the formula:

$$100 \times \left[\left(xm / xf \right) \right] - 1 \qquad \text{(Eq.1)}$$

where xm and xf are the mean values of males and females respectively (López-López et al., 2011). The interrelations between the body morphometric variables were examined using Spearman's correlation test, with a significance threshold set at $\alpha = 0.05$.

To highlight the major trends in the variation of morphological parameters, we used principal component analysis (PCA), A discriminant analysis (DFA) was then conducted to identify the most discriminative morphometric variables between males and females, producing a linear function that optimizes the separation between the two sexes. All statistical analyses were performed using R Studio software, version 4.5.0.

Results

During the breeding season in 2024, 75 House Bunting specimens were captured. Among these, 42 (56%) were adult females and 33 (approximately 44%) were adult males. The mean values of the various morphometric measurements show that males are slightly larger than females, particularly in terms of body weight, wingspan, and tarsus length (*Table 1*).

Sexual dimorphism in morphology

House Bunting males are distinguished by a grey head, a prominent white eyebrow, and a striped crown, while females have a less pronounced white eyebrow and a less distinct striped crown. The tarsus and tibia are reddish in color, with black toes and dark grey legs in both sexes. (*Fig. 2A, B*).

Body biometrics

Morphometric measurements revealed sexual dimorphism in adult House bunting. Significant differences were observed between adult males and females regarding

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body weight (Z = -2.22, $P = 0.026$), wingspan (Z = -2.57, $P = 0.010$), and tarsus length (Z = -2.14, $P = 0.032$), with body weight showing the highest percentage of sexual dimorphism (7.14%). Adult males exhibited higher average values than females (*Table 1*).

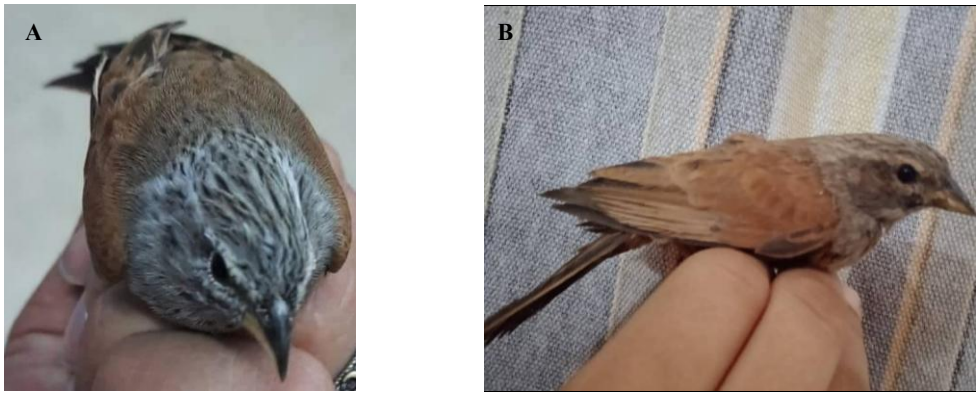

Figure 2. *Photographs of (A) adult male, (B) adult female of house buntings (E. sahari) (photographs by Zouatine, O.)*

Table 1. *Descriptive statistics and univariate comparisons of morphometric measurements for adult house buntings. Significant differences between sexes are shown in bold*

Adults house bunting							
	Males (n = 33)		Females (n = 42)		% Dimorphism	Z	p
	Mean + SD	Range	Mean + SD	Range			
BW (g)	15.51 ± 1.41	11.17-18.23	14.99 ± 1.34	12.89-18.48	3.47	-2.22	**0.026**
TtL (cm)	13.77 ± 0.92	11.96-16.44	13.57 ± 0.07	10.83-15.00	1.74	-0.86	0.387
WS (cm)	22.90 ± 2.12	18.90-27.34	21.86 ± 1.37	19.93-25.61	4.76	-2.57	**0.010**
TL (cm)	6.28 ± 0.56	5.29-7.40	6.19 ± 0.70	4.30-6.68	1.45	-0.89	0.369
BL (cm)	0.99 ± 0.11	0.75-1.32	0.96 ± 0.12	0.72-1.21	3.13	-0.93	0.347
WL (cm)	7.74 ± 0.46	6.91-8.67	7.58 ± 0.55	6.58-9.46	2.11	-1.69	0.090
TrL (cm)	1.95 ± 0.21	1.50-2.30	1.82 ± 0.28	0.92-2.50	7.14	-2.14	**0.032**
HL (cm)	2.64 ± 0.52	1.76-3.50	2.62 ± 0.51	1.97-3.60	0.76	-0.09	0.927

The Spearman's correlation matrix among the morphometric characteristics of adult individuals shows that body weight is positively correlated with Wingspan ($P < 0.001$), Bill length ($P = 0.048$), and Wing Length ($P = 0.001$), while Wing Length is positively correlated with Wingspan ($P < 0.001$), total length ($P = 0.035$), and Tarsus length ($P = 0.003$). Wingspan exhibits a negative correlation with Head length (0.04850) and a positive correlation with Wing length ($P < 0.001$) (*Fig. 3*).

Principal component analysis (PCA) reveals that the first two components together explain 52% of the total variance (Dim1: 28.2%, Dim2: 23.8%). Head length (HL), tail length (TL), wingspan (WS), and Body weight (BW) are the variables that contribute most to the structuring of these two axes, thus explaining a significant portion of the morphological variance. Other variables, such as total length (TtL) and tarsus length (TrL), show a lower contribution, suggesting a lesser influence in the initial morphological discrimination (*Fig. 4A*). The individual graph shows significant

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dispersion and notable overlap between females and males in the factorial space defined by the first two principal components. This suggests that the morphological distinction between the sexes is not strongly marked (*Fig. 4B*).

A discriminant analysis (DFA) was conducted to identify the morphometric variables in distinguishing between the two sexes of *E. sahari*. The analysis generated a single discriminant function (LD1), sufficient to separate the two groups (*Table 2*).

The eigenvalue associated with this function is 11.82, indicating a strong discriminating power. The Wilks' statistic ($\lambda = 0.079$) confirms an excellent morphological separation between the sexes. The variables that contributed the most to the discrimination are bill length (BL) and tarsus length (TrL), with respective coefficients of 2.65 and 2.29, suggesting that these two traits are the most determining for distinguishing the sexes. The analysis correctly classified 68% of individuals according to their actual sex, with an accuracy of 78.6% for females and 54.5% for males, confirming moderate sexual dimorphism, detectable from morphometric measurements, but significant in the species (*Table 2*).

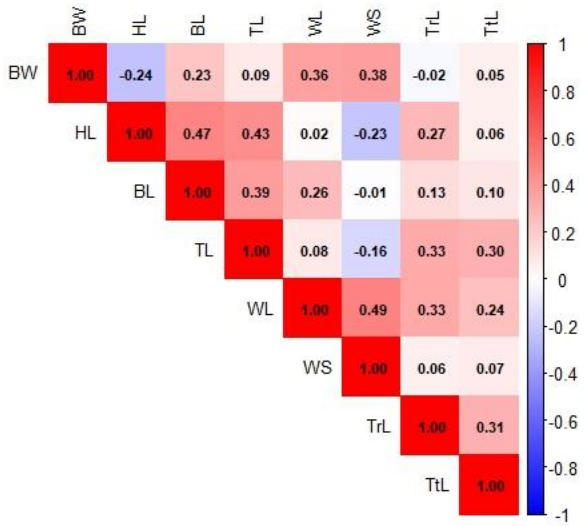
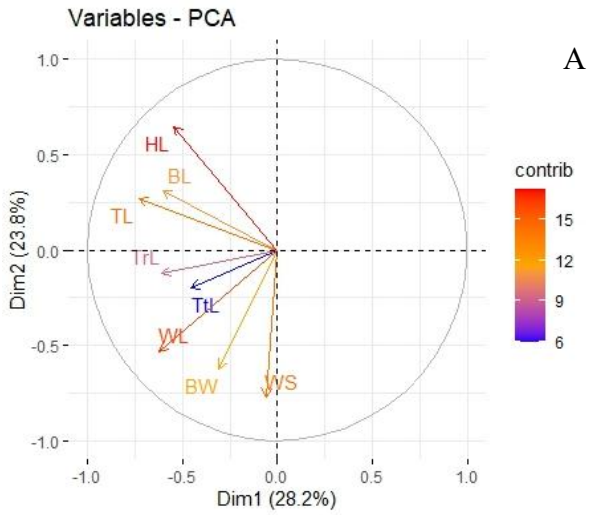


Figure 3. *Correlation plot displaying Spearman's correlation matrix between morphometric variables measured from adult house buntings from the region of Ghardaïa*



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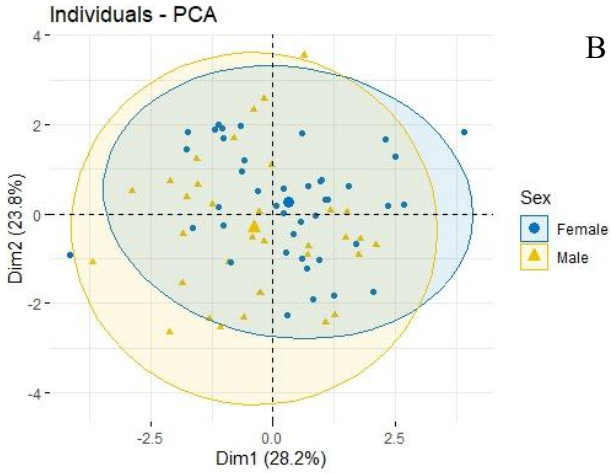

Figure 4. *PCA of morphometric variables in adult male and female house buntings*

Table 2. *Discriminant functions for sex determination of house bunting*

Discriminant function	Group centroids		Wilks' lambda	Selftest (%)
	Males	Females		
LD1 = 0.232 BW − 0.049 HL + 2.654 BL + 0.220 TL − 0.607 WL + 0.418 WS + 2.288 TrL + 0.092 Tt	0.448	-0.359	0.079	68 %

BW: body weight, TtL: total length, WS: wingspan, TL: tail length, BL: bill length, WL: wing length, TrL: tarsus length, HL: head length

Discussion

Studies on the biology and ecology of the House Bunting in Algeria and North Africa are very scarce, with only a few scientific notes in recent years regarding their range expansion to the north (Bouhissi et al., 2021; Moulaï, 2019), along with a more or less comprehensive study in the monograph of this species in Algeria (Chedad et al., 2021). The morphometric characteristics of the House Bunting are poorly understood, with measurements available for only a few individuals (4 females and 7 males); including body weight, total length, wingspan, wing length, bill length, tail length, and tarsus length (Chedad et al., 2021). Only three parameters, the bill length, wing length, and tail length, were measured for about 19 individuals (9 females and 10 males) in the study by Kirwan and Shirihai (2007).

The sex of the House Bunting is easily identifiable in the field with the naked eye, unlike other species of the genus Emberiza, such as *E. pusilla*, for which sexual identification is not possible in the field. This relies instead on size differences and confirmation through molecular sexing, particularly during the autumn migration period, as shown by the work of Cho et al. (2022).

All aspects related to plumage patterns, as indicated by the findings of Kirwan and Shirihai (2007) on the House Bunting complex, suggest that *E. sahari* shares a relatively close morphological resemblance with Striolated Bunting (*E. striolata*), with two subspecies *E. s. saturiator*, and *E. s. jebelmarrae* exhibit considerable similarity in appearance *to E. sahari*, which appears darker on the upper part and head, particularly in the central and eastern parts of the Sahara.

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We observed that adult males of House Bunting exhibit partial differences from adult females in terms of plumage patterns and eyebrow colouration. In comparison with adult females, males display a greyer hue on the head and breast, along with broader and darker streaks on the crown, accompanied by a more pronounced striping on the head-sides. These observations align with the descriptions provided by the studies of Chedad et al. (2021) and Kirwan and Shirihai (2007).

The average values of the overall morphometric characteristics of all individuals measured in the study area show that adult males are slightly larger than adult females in all measured parameters, with a significant difference ($P < 0.05$) in body weight, wingspan, and tarsus length. In *E. striolata*, Ali and Ripley (1974) reported that males were larger than females. In contrast, Chedad et al. (2021) stated that adult females of *E. sahari* are larger based on body weight, tarsus length, total length, stretched wing length, and wingspan in the same region. These differences between the results of the present study and those of Chedad et al. (2021) are likely due to the small number of individuals measured by the latter (4 females and 7 males), as well as in the study by Kirwan and Shirihai (2007), which only worked with (9 females and 10 males) from a population in the North and Northwest of the Algerian Sahara.

Conclusion

The results of this study contribute to the morphometric characterization of the nesting population of the House Bunting in the Ghardaïa region, in the northern Algerian Sahara, as well as to determining the sexual dimorphism of this species during the breeding period.

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