Short communication

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Oological Characteristics of a Colony of Eurasian Jackdaw (*Corvus monedula* L.) in the Town of Shumen, NE Bulgaria

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Abstract: The aim of the present study is to provide comparable information about the morphology of eggs of a common widespread bird species, Eurasian jackdaw (*Corvus monedula*). A colony in the administrative building of the University of Shumen, Bulgaria, was studied. In May 2001 and 2002, nests of 13 pairs were examined. The nests were located near the ventilation holes of an attic, with distance between nests 2-10 m. Clutch size in the studied colony was 2-7 eggs (mean 4.82). The mean length and width of the eggs (in total 44) were 33.0±1.9 mm and 23.8±1.7 mm, respectively. Comparative oological analyses of colonies of the jackdaw from various parts of its breeding range demonstrated a significant influence of the surrounding environment rather than any importance of the geographical location. The obtained results are in concordance with previous studies and show that the egg size of jackdaws in cities is smaller than the one in rural areas. It can be speculated that the smaller egg size in urban areas is due to the higher pollution of the urbanised environment.

Introduction

The Eurasian jackdaw (*Corvus monedula* L.) is a widespread bird species in Bulgaria, occurring from the sea level to altitude of 1290 m a.s.l. It has patchy and dispersed distribution and prefers urban areas, i.e. towns, cities, industrial complexes, roads and other facilities. Populations in its primary habitats (rocks and old forests with hollows) are declining (Vasilev *et al.* 2007). Although the nesting biology of the species has already been studied in many European countries, data from Bulgaria are scarce.

Data on oological characteristics of the jackdaw have been published for Uzbekistan (Bakaev 1984), Ukraine (Senik & Gorban 2015), the Republic of Mordovia, Russia (Kelin & Spiridonov 2010; Spiridonov *et al.* 2015), Republic of Tatarstan, Russia (Rahimov & Zakirov 2015), North Caucasus, Russia (Malovichko & Fedosev 2015), Western Siberia (Rodimtsev & Vanicheva 2004), Poland (Kamiński *et al*. 2015) and NE Slovakia (Tryjanowski *et al.* 2001). Data on 228 nests collected from Spain in 1979-1983 have been presented by Soler (1988) and Soler & Soler (1992). Comparative data from other studies in Russia (Chernishov 1992 in Spiridonov *et al.* 2015; Fufaev 1978 in Spiridonov *et al.* 2015; Lisenkov *et al*. 2004 in Spiridonov *et al.* 2015; Popov 1978 in Rahimov & Zakirov 2015) and Europe (Cramp & Perrins 1994; Makatsch 1976; Witherby 1938 in Soler 1988; Zimmermann 1951 in Soler 1988; Folk 1968 in Soler 1988) were used in the present study. The only published data from Bulgaria on jackdaw concerns the ranges of egg length and diameter (n = 12, Prostov 1964 in Ivanov 2011) and the mean values and the range of length and breadth of the eggs (n = 20, Ivanov 2011).

Previous studies have found differences between egg dimensions of jackdaws occupying cities and countryside (Kelin & Spiridonov 2010; Lisenkov *et al*. 2004 in Spiridonov *et al.* 2015). The aim of the present study is to compare dimensions of jackdaws' eggs from a small colony in the town

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of Shumen with literature data from other sites of the breeding range of this species in order to test for geographical and (or) landscape differences.

Materials and Methods

The study colony occupied the attic of a three-storey administrative building of the University of Shumen (N 43.280332° E 26.944697°). The town of Shumen has c. 80,500 inhabitants (census 2012) and is situated at 220 m a.s.l., with an area of 136.4 km². During May 2001 and 2002, we studied 13 pairs (in total 44 eggs). The nests were located near the ventilation holes (25 x 15 cm) of the attic of the building. The distance between the nests was 2-10 m. For all measurements (dimensions of nests, eggs and chicks), a ruler, a calliper (white round dial), electronic scales and Pesola scale (0.1 g) were used. Eggs measurement was done by a non-destructive method for a short period of disturbance of breeding birds. We measured length (L), breadth (B) and weight (W) of the egg, allowing calculations of volume, surface and sphericity without disrupting the integrity of eggs (Narushin 1997). The volume of eggs was calculated using the formula $V = 0.51*L*B^2$. The factor in the formula is relevant for the most eggs with standard ellipse shape and the equation is applicable to approximately symmetrical eggs (Hoyt 1979). The egg surface was calculated using the formula $S = 4.940*V^{667}$, where V is the volume of the egg. In order to characterise eggs and to compare our results with similar studies, we calculated the sphericity index (SPH = B/L, Hõrak *et al*. 1995). According to the values of this index the jackdaws' eggs of the studied colony fitted to the category of oval-shaped eggs (Schönwetter 1960-1992). Data of eggs weight were not included in subsequent analyses since most of the eggs were in various hatching phase and probably had lost their initial weight (Bakaev 1984).

We used a one-way ANOVA (Statistics Calculator 4.0, StatPac Inc., Bloomington, MN, USA) to compare length, breadth, sphericity index and volume of jackdaws' eggs with data reported by previous studies.

Results and Discussion

The clutch size in the studied colony was 2-7 eggs (mean 4.82). In one of the nests, only one egg was found but it was abandoned and oviposition was not continued. In another nest we found 12 eggs, probably laid by two female birds. This clutch was also abandoned. Compared to hatches from other countries, the number of eggs in the studied colony was lower than the average (4.92, n = 15), coincided with those from Novosibirsk (Spiridonov 2015) and England (Heeb 1994), and were higher than data from Sweden (Sandell *et al.* 2008).

The average length of eggs was 33.0 mm (27.8–36.8 mm; Fig. 1), with average length measured in previous studies from Bulgaria being 34.1 mm (31.5–37.3 mm, see Ivanov 2011) and from other parts of Europe being 34.75 mm (Table 1). The maximum length of eggs measured in this study (36.8 mm) was below the mean maximum calculated from data from other countries (38.31 mm or 34.4–41.7 mm). From other parts of Bulgaria the maximum

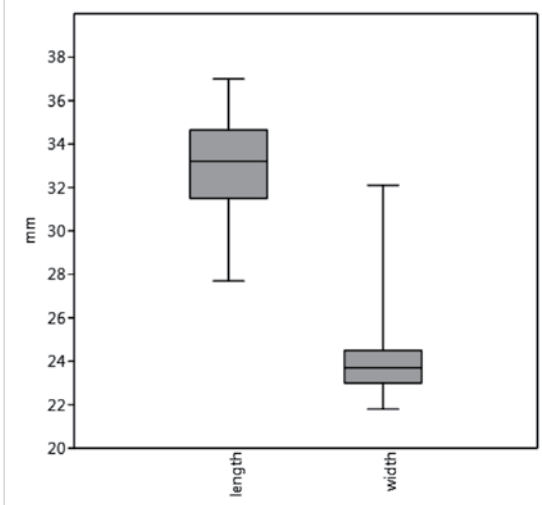

Fig. 1. Length and breadth of eggs (n = 44) of *Corvus monedula* from an urban colony in Shumen, Bulgaria. Box and whisker plots indicate mean, standard deviation and 95% C.I. of the distribution

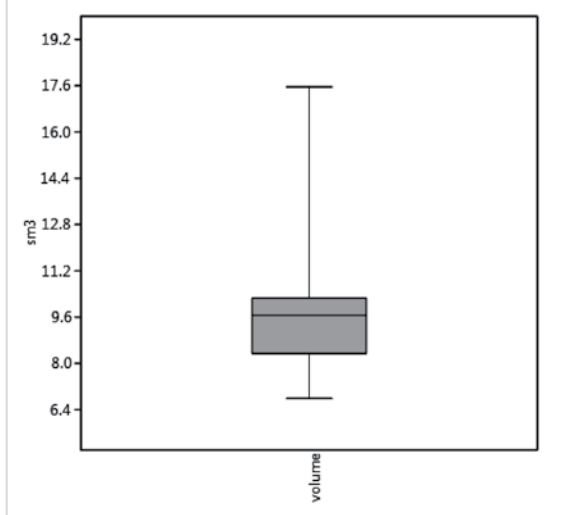

Fig. 2. Volume of eggs (n = 44) of *Corvus monedula* from an urban colony in Shumen, Bulgaria. Box and whisker plots indicate mean, standard deviation and 95% C.I. of the distribution

Table 1. Post-hoc comparisons of mean length and breadth of jackdaws' eggs between a sample collected in Shumen, Bulgaria, and data in the literature

Location	Year	Length						Breadth						References
		Mean	SD	*n*	*t*-value	DF	*P*	Mean	SD	*n*	*t*-value	DF	*p*	
Bulgaria, Shumen	2002	33.00	1.88	44				23.78	1.74	44				This study
Russia, Mordovia, El'niki	2009	34.22	1.53	119	-4.371	161	**0.000**	24.17	0.55	119	-2.3450	161	**0.0203**	Spiridonov *et al.* 2015
Russia, Mordovia, Novoyamskaya Sloboda	2009	34.34	1.70	37	-3.797	79	**0.000**	24.52	0.79	37	-3.5190	79	**0.0007**	Spiridonov *et al.* 2015
Russia, Mordovia, Saransk	2009	34.09	1.81	34	-3.018	76	**0.004**	24.33	0.76	34	-2.5550	76	**0.0126**	Spiridonov *et al.* 2015
Russia, Mordovia, Baevo	2010	37.40	0.80	4	-5.326	46	**0.000**	24.80	0.40	4	-2.0720	46	0.0439	Kelin & Spiridonov 2010
Russia, Mordovia, El'niki	2010	35.00	0.98	96	-6.944	138	**0.000**	24.90	2.94	96	-6.5260	138	**0.0000**	Kelin & Spiridonov 2010
Russia, Mordovia, Novoyamskaya Sloboda	2010	34.60	1.26	40	-4.630	82	**0.000**	24.50	0.63	40	-3.4960	82	**0.0008**	Kelin & Spiridonov 2010
Russia, Mordovia, Saransk	2010	32.70	2.06	47	0.904	89	0.368	23.70	0.69	47	0.4050	89	0.6868	Kelin& Spiridonov 2010
Russia, Mordovia, El'niki	2011	34.79	1.04	89	-6.140	131	**0.000**	24.20	0.47	89	-2.4180	131	0.0170	Spiridonov *et al.* 2015
Russia, Mordovia, Novoyamskaya Sloboda	2011	34.80	1.03	33	-4.941	75	**0.000**	24.10	0.63	33	-1.4740	75	0.1446	Spiridonov *et al.* 2015
Russia, Mordovia, Saransk	2011	33.04	1.53	81	-0.135	123	0.893	23.46	0.81	81	1.8130	123	0.0723	Spiridonov *et al.* 2015
Russia, Mordovia, Saransk	2004	33.36	1.25	20	-0.844	62	0.402	24.27	1.70	20	-1.9270	62	0.0585	Spiridonov *et al.* 2015
Russia, Mordovia, Countryside	1980	34.85	1.8	64	-5.971	106	**0.000**	24.71	0.88	64	-5.0380	106	0.0000	Spiridonov *et al.* 2015
NE Slovakia, Bardejov	1961-1964	34.92	1.78	518	-7.729	560	**0.000**	25.01	0.80	518	-8.3090	560	**0.0000**	Tryjanowski *et al.* 2001
Russia, Kamskoe Predural'e	N/A	34.05	0.56	193	-3.973	235	**0.000**	24.00	0.28	193	-1.3970	235	0.1637	Spiridonov *et al.* 2015
Russia, Kemerovo district	N/A	35.03	1.74	76	-6.774	118	**0.000**	24.25	0.87	76	-2.6320	118	**0.0096**	Spiridonov *et al.* 2015
Russia, Novosibirsk	N/A	34.74	1.75	212	-6.639	254	**0.000**	25.03	0.73	212	-8.0040	254	0.0000	Rodimtsev & Vanicheva 2004
Spain, Granada, Bco. Canteras	1979-1983	34.08	1.60	152	-3.988	194	**0.000**	24.72	0.74	152	-5.8250	194	**0.0000**	Soler 1988
Spain, Granada, R. Agua	1979-1983	34.22	1.69	285	-4.761	327	**0.000**	24.41	0.84	283	-4.1240	325	**0.0000**	Soler 1988
Spain, Granada, R. Baza	1979-1983	34.43	1.63	46	-4.287	88	**0.000**	24.17	0.75	46	-1.9620	88	0.0529	Soler 1988
Spain, Granada, R. Grao	1979-1983	35.07	1.13	57	-6.520	99	**0.000**	24.16	0.60	56	-2.0010	98	0.0482	Soler 1988
Spain, Granada, R. Zaragnil	1979-1983	33.58	1.66	277	-2.259	319	**0.025**	24.50	0.67	277	-4.7060	319	**0.0000**	Soler 1988

Significant differences are marked in bold.

Table 2. Post-hoc comparisons of mean jackdaws egg' sphericity index and volume between a sample collected in Shumen, Bulgaria, and data in the literature

Location	Sphericity index						Egg volume						References
	n	Mean	SD	*t*-value	DF	*p*	*n*	Mean	SD	*t*-value	DF	*p*	
Bulgaria, Shumen	44	0.72	0.06				44	9.59	1.72				This study
Russia, Mordovia, Saransk	47	0.73	0.60	-0.071	89	0.94	47	N/A	N/A				Kelin & Spiridonov 2010
Russia, Mordovia, El'niki	96	0.69	0.40	0.246	138	0.81	96	N/A	N/A				Kelin & Spiridonov 2010
Russia, Mordovia, Novoyamskaya Sloboda	40	0.71	0.50	0.086	82	0.95	40	N/A	N/A				Kelin & Spiridonov 2010
Russia, Mordovia, Baevo	4	0.67	0.70	0.143	46	0.89	4	N/A	N/A				Kelin & Spiridonov 2010
Slovakia, Bardejov vicinity	518	0.71	0.75	0.095	560	0.92	518	11.00	0.99	-8.661	560	**0.000**	Tryjanowski *et al.* 2001
Spain, Granada, R. Zaragnil	277	0.73	N/A				277	10.10	1.17	-3.031	319	**0.003**	Soler 1988
Spain, Granada, R. Agua	283	0.71	N/A				283	10.55	1.01	-5.714	325	**0.000**	Soler 1988
Spain, Granada, Bco. Canteras	152	0.73	N/A				152	10.20	0.86	-3.437	194	**0.001**	Soler 1988
Spain, Granada, R. Grao	56	0.69	N/A				56	10.32	0.60	-3.495	88	**0.001**	Soler 1988
Spain, Granada, R. Baza	46	0.70	N/A				46	10.52	0.95	-4.254	88	**0.000**	Soler 1988

Significant differences are marked in bold.

length was 38.6 mm (n = 12, see Prostov 1964 in Ivanov 2011). The minimum length measured (27.7 mm) was with 3.4 mm below the average minimum length known so far and was with 1.3 mm lower than the lowest values known so far, i.e. 29.0 mm from Zurich (Zimmermann 1951 as cited in Soler 1988) and Saransk (Spiridonov *et al.* 2015).

The average breadth of the eggs from the studied colony was 23.78 mm (20.8–32.1 mm; Fig. 1), while the average breadth from other sites was 24.5 mm (21.2–29.3 mm; Table 1). Ivanov (2011) has reported a range of 23.5–25.8 mm for the breadth of eggs (n = 20) in Bulgaria. We measured one abnormal egg with breadth of 32.1 mm and almost entirely round shape (33.2 x 32.1 mm, SPH = 0.966). The minimum breadth of eggs in the studied colony was also at the lowest limit at 20.8 mm and was with 0.4 mm below the minimum breadth measurement so far, i.e. 21.2 mm (Zimmermann 1951 in Soler 1988).

The sphericity index was 0.722 (0.620–0.966) and did not differ significantly from the average calculations for other places, 0.704 (0.646–0.795; Table 2). The average volume of the eggs was 9.59 mm^3 (6.79–17.6 mm^3) and was similar to the lower values calculated from other data for this species, i.e. 10.49 mm^3 (10.1–11.1 mm^3).

Our results showed a significant difference in egg length, breadth and volume between our sample and other samples collected from the countryside in European and Asian range of the jackdaws, however no difference was found for the city of Saransk, Russia (Table 1). There was no difference in sphericity index in comparison to any samples found in the literature (one-way ANOVA: $F_{1,13}$ = 0.107, p = 1, Table 2).

Conclusion

Our results, in concordance with the results of previous studies, show that the egg size of jackdaws in the cities is smaller than in villages and rural areas. These findings suggest an effect of the surrounding environment rather than any importance of the geographical location. Perhaps these results are due to the higher pollution in urbanised areas compared to rural areas. Further studies can reveal the possible reason for such differences.

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