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Breeding biology of Barn Swallows *Hirundo rustica* in Algeria, North Africa

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Breeding biology of the Barn Swallow *Hirundo rustica* was compared between the first and second clutches in Annaba, Algeria, in 2001–2003. Swallows nested in different buildings used by humans, including factories, garages, staircases and balconies in blocks of apartments. 55%–69% of breeding pairs produced two clutches. The average dates of the onset of first clutches were between 21 April (2003) and 21 May (2002). Average clutch size was 4.60–4.85 eggs for the first brood and 3.18–4.06 for the second brood. There was a clear negative relation between clutch size and laying date. Nest height, nest diameter, nest depth, cup diameter and cup depth did not differ between first and second clutches. Clutch size, number of hatchlings and fledglings differed between the first and second broods, being greater in first clutches. Egg length, breadth and volume did not differ between the first and second clutches. High repeatabilities (0.63–0.92) in these egg traits were detected. This indicates that there exists high variation in the egg traits between clutches laid by different females. The heights at which nests were constructed and nest shape were shown to influence hatchability; nests with deeper cups, located at lower height were more successful. Comparison with other populations shows that the proportion of pairs that produced second clutches decreased with increasing latitude. Our results indicate that extreme southern breeding populations of Barn Swallows show some specific features which need further study.

1. Introduction

The Barn Swallow *Hirundo rustica* is widespread throughout the Western Palearctic (Cramp 1988, Turner 1994), but local declines in populations in many areas have been recently reported (Tucker & Heath 1994, Robinson et al. 2003). Very little is known about any population trends or breeding biology of Barn Swallows in North Africa (Etchecopar & Hue 1964, Cramp 1988, Turner 1994). Møller (1984) found no data concerning North African populations while preparing his paper on geographic trends in reproductive variables of Barn Swallows. However, this area seems especially interesting as it constitutes a southern edge of the species breeding area and, as a consequence, some special tendencies in reproductive characteristics could be expected (cf. Møller 1984, Garcia & Arroyo 2001).

Lack (1947) put forward a hypothesis that latitude-related trends in breeding characteristics should be expected because day length increases with latitude, which enables birds to feed longer at high latitude sites. As a result of parents being capable of raising more nestlings, a selection pressure favouring bigger clutches would be expected. This effect could concur with the effect of seasonally relaxed competition for food in northern populations, as suggested by Ashmole (1963). On the other hand, a time window for producing more than one brood during the season may be narrower in those populations, so that a smaller proportion of multi-broodedness in high latitude populations could be predicted (Møller 1984). We think that such predictions can be valid for continental Europe, but we suppose that conditions prevailing at the extremes of the breeding area can be variable, resulting in disturbing general patterns (e.g. Garcia & Arroyo 2001). Productivity of aerial insects, especially big flies that compose an important part of the Swallow diet, is sensitive to weather conditions (Bryant 1975, Karg 1980, Bańbura & Zieliński 1998b). On the other hand, the start and the end of the breeding season are limited by the time range of the dry season which tends to differ from year to year (Bakaria et al. 2002). Consequently, the availability of flies seems to be variable and not to show so consistent declining trend within the breeding season as it does in the case of tree canopy insects in deciduous forests (Bryant 1975, Bańbura & Zieliński 1998b, Blondel et al. 1999). The anthropogenic habitats of Barn Swallows may still further modify insect availability. The resulting trophic conditions influence breeding biology of Swallows.

The main objectives of this study were: 1) to characterize nesting; 2) to characterize timing of egg laying and its consequences for other life history traits; 3) to obtain reliable data on clutch size, egg characteristics and breeding success; 4) to explore relationships between different reproductive characteristics.

We predicted that the reproductive performance of Barn Swallows occupying the North African part of the species breeding area, characterised by extreme and changeable environmental conditions, would show some special features. In particular, we expected that the reproductive traits might not strictly conform to potential geographic patterns of variation. We also predicted that the typical pattern of first broods being more successful than second broods in many double-brooded birds would vary between years in Swallows.

2. Materials and methods

2.1. Study area

The study of Barn Swallows was conducted in Annaba, Algeria (37° N, 8° E) in 2001–2003. The climate of Annaba is the sub-wet version of the Mediterranean-type climate, with one hot and dry season between May and September, and with a mild and wet season from October to April. The rainfall ranges from 650 to 1,000. mm per year. The study area included extensive suburbia of Annaba, with many blocks of apartments, factories and garages, south of the city centre. The province of Annaba covers c. 1,400 km^2, with population of about 550 thousand people. Some sheds in which domestic animals were kept were present in that area, but by contrast to more northern areas, they were only occasionally used by Swallows to nest. Our observations (unpublished) suggest that most Swallows nested in different kinds of buildings utilized by humans, where doors, windows or other elements of construction where kept open, which enabled birds to easily fly into and out.

2.2. Breeding characteristics

Nests were found in a fruit-processing factory, in a car service workshop and in blocks of flats, especially in staircases and in balconies of such blocks. The observation of the Swallow activity during the pre-laying time was the main method of searching for potential nest sites. Once found, the nests were controlled once a week or more frequently to monitor the course of breeding and to record basic reproductive variables. The study included the second brood in 2001 and the entire breeding seasons in 2002–2003. Therefore the data collected in 2001 were used only in some analyses.

In 2002, the distance between the nest base and the floor level (hereafter called nest site height) was measured to the nearest 1 cm using a rolled tape. The following nest variables were measured to the nearest 1 mm with a ruler: external diameter, depth, cup diameter and cup depth (terminology by Hansell 2000).

2.3. Data and analysis

The date of the first egg laying was established by direct observation or calculated assuming that one egg was laid per day. The number of eggs was recorded in complete clutches. In 2001–2002, the egg length (L) and breadth (B) were measured to the nearest 0.05 mm with calipers and volume (V) in cubic centimeters was calculated according to the formula of Manning (1979) worked out for the American Barn Swallow: $V = 0.000507*L*B^2$. All characteristics related to egg dimensions are presented as means per clutch to avoid the non-independence of egg traits within clutches (Bańbura & Zieliński 1990, Zieliński & Bańbura 1998a).

Individual egg measurements were used in one-way ANOVAs in order to estimate within- and between-clutch variance components which were presented as repeatabilities (see Lessels & Boag, 1987; Bańbura & Zielinski, 1990, 1998a). One-way ANOVAs with standard sums of squares and degrees of freedom were conducted on egg lengths, breadths and volumes in particular clutches (Sokal & Rohlf 1995). Intraclass correlations, being the statistical measure of repeatability (Sokal & Rohlf 1995, Lessels & Boag 1987), for these egg traits were calculated according to the formula:

$$R = (V_a - V_w)/[V_a + (n_0 - 1)V_w]$$

where V_a is the among clutch mean square, V_w is the within clutch mean square, n_0 is an adjusted mean clutch size and is given by:

$$n_0 = \left[\sum_{i=1}^{a} n_i - \left(\sum_{i=1}^{a} n_1^2 \Big/ \sum_{i=1}^{a} n_i\right)\right] / (a-1),$$

where n_i is the number of eggs in the i-th clutch and a is the number of clutches.

The number of hatchlings and the number of fledglings were established by counting in respective stages of broods.

The data were analysed by standard parametric and non-parametric methods (Sokal & Rohlf 1995). In the analysis of the within-clutch proportion of eggs that produced fledglings (binomial error), the generalized linear model approach was applied (Dobson 1990). Original nest characteristics were used to calculate principal components considered as indices of nest size and shape for further analysis. All analyses and calculations were carried out using MS Excel, GLIM 3.7 and STATISTICA 5.5 (StatSoft 1997).

In order to test for geographic patterns in reproductive trait variation in the Barn Swallow, we conducted a literature search. We limited the search to the papers published after 1970 that contained information on sample sizes, clutch size in the first and second broods, and on the proportion of pairs producing second broods. Moreover, we focused on continental parts of the Western Palearctic.

3. Results

3.1. Characteristics of nesting

According to the data of 2002, nest height, nest diameter, nest depth, cup depth and cup diameter did not differ between the first and second clutches (Table 1). Nests were constructed at 2.5 to 4.9 m of height above the floor level, with mean value for the first clutch in 2002 being 3.9 m ± 0.16 (SE), n = 26. This mean value did not differ between the first and second clutches (4.0 ± 0.12(SE), n = 18)(t_{42} = –0.53, NS).

We used principal component analysis to get multivariate indices of nest traits. Two principal components extracted explained 80.3% of variation in original traits: PC1 – was strongly positively correlated with nest external diameter, cup diameter and cup depth (loadings 0.88, 0.98 and 0.46, respectively); PC2 – was positively correlated with nest depth, and external diameter, and negatively correlated with cup depth (loadings 0.79, 0.31 and –0.71) (Table 1). PC1 is interpreted

Table 1. Mean values of Barn Swallow nest characteristics in the first and second clutches in Annaba, 2002 (n = 26 and n = 18, respectively).

Variable	First clutches Mean ± SE	Second clutches Mean ± SE	t	P
Nest height (m)	3.9 ± 0.16	4.0 ± 0.12	0.53	0.600
Nest diameter (cm)	10.29 ± 0.21	10.46 ± 0.25	0.52	0.602
Nest depth (cm)	9.48 ± 0.49	9.78 ± 0.67	0.37	0.716
Cup diameter (cm)	8.55± 0.22	9.12 ± 0.34	1.50	0.142
Cup depth (cm)	5.01± 0.15	5.11 ± 0.28	0.36	0.717
PC1	–0.15 ± 0.18	0.22 ± 0.26	1.22	0.227
PC2	–0.08 ± 0.12	0.11 ± 0.33	0.60	0.553

as an index of nest size, whereas PC2 as an index of shape. They were used to test a potential influence of nest traits on breeding performance of Barn Swallows.

3.2. Breeding performance in relation to the timing of breeding

Most pairs of Barn Swallows, 69.23% (n = 26) in 2002 and 55% (n = 20) in 2003, produced two clutches. No third brood was recorded. First clutches were initiated between the 8 April and the 17 June in 2002 and between 31 March and 2 June in 2003; with mean laying date being much earlier in 2003 (Table 2). Second clutches started between 5 June and 8 July in 2001, from 4 June to 31 July in 2002 and between 15 June and 12 July in 2003; the differences were not significant (Table 2).

Clutch size, number of hatchlings and fledglings differed between the first and second clutches, being greater in the first clutches (Table 2). Moreover, clutch sizes were also different between years 2002 and 2003 (Table 3). The number of hatchlings did not differ between years (Table 3). The number of fledglings differed between broods, but in that case, a relatively low number of

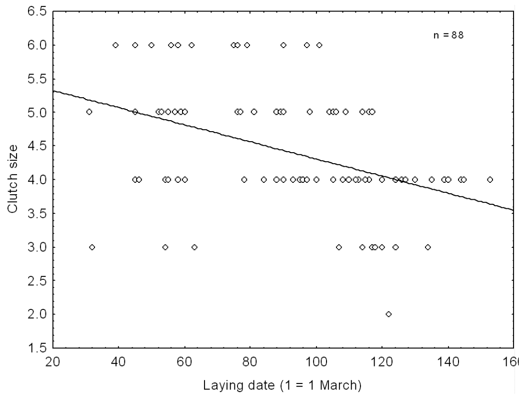

Fig. 1. Clutch size in relation to laying date in Annaba Barn Swallows in 2001–2003.

Table 2. Average dates of egg laying in the first and second brood in 2001 (only 2nd brood) – 2003. One-way ANOVAs were used to test for year effects.

	Means ± SE (N) for year		
Brood	2001	2002	2003
First	–	21 May ± 2.62 (26)	21 April ± 2.99 (20)
Second	20 June ± 3.78 (13)	29 June ± 3.21 (18)	27 June ± 4.11 (11)

Year effect for 1st brood: $F_{1,44}$ = 56.21; P < 0.001
Year effect for 2nd brood: $F_{2,39}$ = 1.76; P = 0.19

Table 3. Average clutch size, hatchling number and fledgling number in the first and second brood in 2002–2003. Two-factor ANOVAs were used to test for year and brood effects.

Variable	Mean ± SE (N)		Effects	$F_{1;71}$	P
Brood	2002	2003			
Clutch size			Year	9.3	<0.004
First	4.85 ± 0.15 (26)	4.60 ± 0.17 (20)	Brood	36.2	<0.001
Second	4.06 ± 0.18 (18)	3.18 ± 0.23 (11)	Year*Brood	2.9	NS
Hatchlings					
			Year	3.24	NS
First	4.42 ± 0.20 (26)	4.40 ± 0.23 (20)	Brood	36.70	<0.001
Second	3.33 ± 0.23 (18)	2.45 ± 0.31 (11)	Year*Brood	3.12	NS
Fledglings					
			Year	0.12	NS
First	3.38 ± 0.31 (26)	4.30 ± 0.35 (20)	Brood	14.27	<0.001
Second	3.00 ± 0.37 (18)	1.82 ± 0.47 (11)	Year*Brood	7.64	<0.008

fledglings in the first brood was accompanied by a relatively high number in the second brood in 2002, whereas a high first brood fledgling number was associated with a low second brood fledgling number in 2003. Consequently, an effect of interaction between brood and year turned out significant (Table 3).

There was a clear negative correlation between clutch size ($r = -0.41$, $P < 0.001$, $n = 88$; Fig. 1), hatchling number ($r = -0.71$, $n = 88$, $P < 0.0001$) and fledgling number ($r = -0.54$, $n = 88$, $P < 0.0001$) and the laying date in the breeding season over the three years of the study pooled. The same tendency was also observed within the study years considered separately. In the case of clutch size the following correlations were found $r = -0.67$ ($n = 13$) in 2001, $r = -0.64$ ($n = 44$) in 2002, and $r = -0.60$ ($n = 31$) in 2003. It is interesting that in spite of this tendency and in spite of the fact that the laying the first clutch started earlier in 2003 than in 2002, clutch size was lower in 2003 (Tables 2 and 3).

3.3. Characteristics of eggs

Egg length, egg breadth and egg volume did not differ between the first and the second clutches (Table 4). Egg length ranged from 16.9 to 21.05 mm, breadth from 12.8 to 14.8 mm and volume from 1.55 to 2.22 cm^3. Thus, in terms of volume, the largest egg was 43% larger than the smallest one. Most of the variability in egg traits was accounted for by variation among females, as shown by very high within-clutch repeatabilities (Table 5).

Table 4. Characteristics of Barn Swallow eggs in Annaba in 2002, with per-clutch mean as the observation unit, resulting in n given.

Variable	Clutch	Mean	SE	n	t_{20}	P
Egg length (mm)	1	19.3	0.89	12	–0.55	0.586
	2	19.5	0.62	10		
Egg breadth (mm)	1	13.9	0.42	12	–0.18	0.862
	2	13.9	0.42	10		
Egg volume (cm^3)	1	1.90	0.05	12	–0.39	0.698
	2	1.92	0.04	10		

Table 5. Repeatability of the Barn Swallow egg traits in Annaba in the first clutch 2002 and in all clutches 2001–2002 pooled.

Variable	1st clutch 2002 (n_0 = 4.81)			2001–2002 pooled (n_0 = 4.46)		
	R	$F_{10,42}$	P	R	$F_{27,97}$	P
Egg length	0.76	15.9	<0.001	0.63	8.6	<0.001
Egg breadth	0.92	58.0	<0.001	0.68	10.7	<0.001
Egg volume	0.88	36.9	<0.001	0.70	11.4	<0.001

3.5. Breeding success

Overall, in all 57 clutches studied, hatchability ranged from 50% to 100%, and was on average 88.5% ± 2.2 (SE), fledging success and breeding success ranged from 0% to 100%, on average 80.1% ± 4.3 (SE) and 70.6% ± 4.3 (SE), respectively. Binomial variables characterising hatchability, fledging success and breeding success of particular clutches were further analysed to check for potential influences of nest, egg and other breeding characteristics. Most of these analyses included only the first clutch in 2002 due to the sample size.

Hatchability, fledging success and breeding success were negatively influenced by laying date (generalized linear models: χ^2_1 = 18.8, P < 0.0001 for hatchability, χ^2_1 = 15.5, P < 0.0001 for fledging success, and χ^2_1 = 14.7, P = 0.0001 for breeding success).

Hatching success was related to the height of nest sites above the floor level and nest shape as measured by PC2 (Table 6), with a contrast in PC2 between nests with 100% hatching success and those with a lower success being –0.17 v. 0.27. This essentially means that nests with a deeper cup in relation to cup diameter were more successful. Nests with clutches of eggs hatched in 100% were located slightly lower above the floor level than those, which partly failed (390 cm v. 395 cm). An analogous contrast between mean values of PC1 was –0.02 v. –0.19.

Also egg size, as measured by per-clutch mean volume, positively influenced hatching success

Table 6. Influence of nest and nesting characteristics on hatching success of Barn Swallow clutches as indicated by a generalised linear model with nesting characteristics as linear predictors and the number of hatchlings in relation to clutch size as a binomial dependent variable. The first clutch in 2002 is considered.

Nesting characteristic	χ^2_1	P
Nest site height	11.1	0.002
PC1	1.4	0.233
PC2	5.6	0.018

Table 7. Average first clutch size, second clutch size and percentage of pairs producing the second brood multiple and partial correlations with geographical coordinates in 28 sites in the Western Palearctic. Sources of data: Alatalo 1976, Al-Rawy & George 1966, Bańbura & Zieliński 1998, Beser 1968, Beser 1974, Brichetti 1992, De Lope 1983, Dimarca & Lo Valvo 1987, Hemery et al. 1979, Herroelen 1959, Kondelka 1985, Kuźniak 1967, Löhrl & Gutscher 1973, Loske 1989, McGinn & Clark 1978, McGinn 1979, Meier 1978, Møller 1984, Nitecki 1964, Radermacher 1970, Ribaut 1982, Thellesen 1976, and Turner 1980.

Partial R with the other factor controlling for: Variable	N	R	P	Longitude	P	Latitude	P
1st clutch size	28	0.41	0.09	–0.14	0.49	0.35	0.07
2nd clutch size	28	0.25	0.43	0.23	0.25	–0.04	0.84
2nd clutch %	27	0.48	0.04	–0.48	0.01	–0.19	0.36

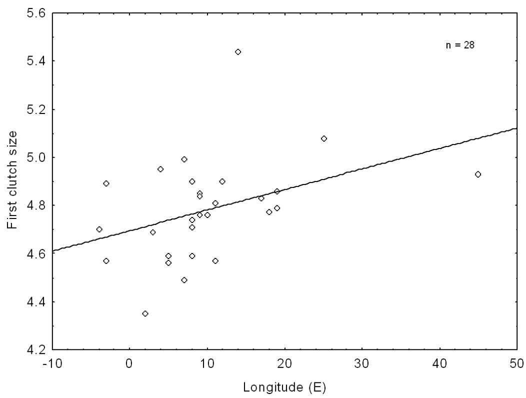

Fig. 2. Clutch size in the first brood in relation to longitude in Western Palearctic Barn Swallows. Latitude is given in degrees East, so that the numbers smaller than 0 mean latitude in degreed West. Sources of data are given in Table 7.

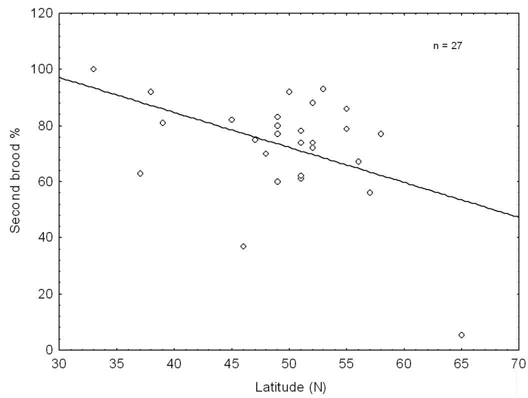

Fig. 3. Percentage of pairs producing second broods in relation to latitude (in degrees North) in Western Palearctic Barn Swallows. Sources of data are given in Table 7.

($\chi^2_1 = 12.78$, $P = 0.0003$). As a consequence, mean volume of completely successful clutches was 1.91 cm^3 whereas it was 1.87 cm^3 for clutches which partially failed.

3.6. Geographical variation in basic reproductive characteristics

There are some indications of a pattern in geographic variation in Swallow breeding characteristics in the Western Palearctic (Table 7). There is a tendency for the first clutch size to increase with longitude (Fig. 2). A significant negative relation between the proportion of pairs producing second broods and longitude is clear (Fig 3).

4. Discussion

It is well known that in the Western Palearctic Barn Swallows prefer buildings in which livestock is kept as their nest sites, with no clear influence of the type of livestock on the breeding performance being reported (Vietinghoff-Riesch 1955, Møller 1983, Cramp 1988, Turner 1994). In most European countries they rarely nest in towns, but in the Middle East and North Africa it happens very often (Turner 1994). This seems associated with the tendency to nest in buildings that are not used to keep domestic animals, as it was the case in the present study or in the Iraqi study (Al-Rawy & George 1966, Sakraoui in prep.). Because the buildings used for nesting can have different design, and Barn Swallows place the nest close to the ceiling, on walls or beams, the height of nest sites is constrained by the distribution of suitable sites (Pikula & Beklova 1987). The height distribution observed in Annaba is well within the range reported in the literature (e.g. Al-Rawy & George 1966, Pikula & Beklova 1987, McGinn & Clark 1978). However, in any case the height may have important consequences for breeding success. Because we did not record any human disturbance, we suspect that a possible reason for the observed influence of the nest site height on hatching success may result from a physical factor, possibly frm temperature changing with the distance from the floor and from the ceiling.

Turner (1994) reports that Swallows start laying in March in North Africa and southern Spain. We recorded first egg laying on the last day of March in one year and about one week later in the other year. A difference in mean laying date of the first brood between the two years of the complete study was one month. This means that laying dates may be highly variable in Algeria, which would be expected at the edge of the breeding area of avian species (cf. Sanz 1997, Garcia & Arroyo 2001). The start of laying seems to result from a plastic reaction to environmental clues. Weather certainly influences insect food of Swallows (Turner 1980, 1994), resulting in different springs being variable with respect to trophic conditions. Swallows arrive at Annaba in mid-January, which gives them ample time to assess particular spring conditions. Laying dates reported by Al-Rawy & George (1966) for Barn Swallows in Baghdad, located at latitude similar to our study site, seem earlier than those in Annaba. They observed that Swallows started laying their first eggs during the first week of March. Taking into consideration the fact that the laying of the last clutches during the breeding season is limited to the first week of June in Baghdad, it means that the whole breeding season of the Annaba population is postponed c. 3–4 weeks, in spite of a very similar day length. The difference in the timing of breeding is probably caused by a difference in climatic conditions between Annaba (sub-wet Mediterranean climate) and Baghdad (dry continental climate). The climatic conditions in the late part of the breeding season, being very severe for the dry continental climate, may constrain a possibility of successful breeding and thus enforce as early breeding as possible.

In contrast to Møller (1984), we found no geographic trend was found for the second clutch size. This type of analysis is limited by a lack of reliable comparative data. This lack of data is especially clear for the extreme regions of the Swallow breeding area, in particular for North Africa, Middle East and North Europe, for which only single published data sets are available. This paper provides an important data point, but further studies are obviously needed for a more complete comparative analyses.

A between-location comparison of breeding traits is complicated by inter-year differences. However, it seems that mean clutch size in both Annaba and Baghdad populations of Barn Swallows is similar and relatively high, 4.60–4.85 and 4.93 for the first brood, and 3.18–4.06 and 4.07 for the second brood, for the two populations, respectively. In a little more northerly localized Spanish population studied in Extremadura mean clutch sizes are 4.99 in the first brood, 4.52 in the second brood, and 3.89 in the third brood (de Lope 1983). For comparison, mean clutch size in a much more northerly living population in central Poland is 4.86 for the first brood, and 4.47 for the second brood (Bańbura & Zieliński 1998b).

A decline in clutch size during the course of the reproductive season shown in this paper is typical of all the Western Palearctic populations analysed (Lohrl & Gustscher 1973, McGinn & Clark 1978, Kondelka 1985, Bańbura 1986, Cramp 1988, Loske 1989, Bańbura & Zieliński 1998b). The declining trend occurs consistently both between and within years. Klomp (1970) and Crick et al. (1993) suggest that this type of trend is characteristic for single-brooded rather than multi-brooded bird species. The reason is that the latter should start breeding as early as possible, even well before a trophically optimal time, in order to be able to produce the second brood. This would result in an initial increase and then decline of clutch size during the breeding season. Again, the data on Algerian Barn Swallows conform to a version of Crick et al's. (1993) hypothesis, modified for long-distance migrant species (cf. Bańbura & Zieliński 1998b). Breeding time of such species is limited by the time of arrival from winter quarters.

The geographic pattern of distribution of multi-broodedness is also complicated, as shown by Møller (1984). Three broods per year are absent in northern populations including Polish ones (Bańbura & Zieliński 1998b), but happen in increasing frequency in more westerly and southerly-located areas, as Westphalia (Loske1989) or Spain (de Lope 1983). Our data on Algerian Swallows and Al-Rawy and George's (1966) data on an Iraqi population suggest that further in the South only two broods are possible again. It is most probably associated with the summer becoming progressively very dry in North Africa and the Middle East. Thus, producing only two broods per season, observed in both these populations, is probably a result of climatic and day light constraints correlated with latitude. It is interesting that Aristotle described the Barn Swallow as a double-brooded species in his *Historia animalium* in the 4th century BC. It is evident that his observations concerned Greek populations, quite close in latitude to the two southern populations mentioned above.

We found an egg volume of c. 1.9 cm^3 as well as egg linear dimensions that are similar to sizes reported for other Western Palearctic areas (Cramp 1988, Bańbura & Zieliński 1995, 2000, Ward 1995, Zieliński & Bańbura 1998), suggesting that there is no clear geographic pattern. Within-clutch repeatabilities of all egg characteristics are very high; with values ranging from 0.76

to 0.92 in the first brood they belong to the highest values reported in the literature (Bańbura & Zieliński 1998a, 2000). The repeatabilities calculated for all clutches pooled are a little lower. This is reasonable, as different clutches of the same females were not controlled and discriminated, which could obviously decrease between-female component of variance (Sokal & Rohlf 1995).

We consider our findings concerning effects of different reproductive traits on hatchability, fledging success and breeding success very important. The influence of the timing of breeding is perhaps the most obvious relationship. It suggests that environmental conditions for reproduction indeed become progressively worse during the course of the breeding season. This should generate a selective pressure for smaller broods, the result that is in fact reported here. The negative influence of the height of nest above the floor level on hatchability seems less reasonable. It might result from the air temperature close to the ceiling being too high. The reported effect of a principal component nest shape index (PC2) may reflect some incubation-related properties of nests. Furthermore, nest building behaviour of Barn Swallow males is known to undergo sexual selection (Soler et al. 1998), which could potentially affect nest shape and breeding performance, resulting in subtle associations between nest characteristics and hatchability.

Any effect of egg size on hatchability is rarely reported in the literature (Williams 1994). The reason may be that most studies are conducted in the middle of avian species geographic areas. The influence of egg size on breeding success is probably more important in the extreme conditions experienced around the limits of the breeding area, as in the case of Algerian Swallows.

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Haarapääskyn *Hirundo rustica* lisääntyminen Algeriassa

Algeriassa vuosina 2001–2003 kaksi pesyettä kaudessa tuottaneiden haarapääskyjen lisääntymismenestä verrattiin ensimmäisen ja toisen poikueen välillä. Tutkimuksen parit pesivät rakennuksissa ja 55 %–69 % pareista tuotti kaksi pesyettä. Vuonna 2003 ensimmäisen pesyeen muninta aloitettiin keskimäärin 21.4. ja vuonna 2002 21.5. Ensimmäisessä pesyeessä oli keskimäärin 4,60–4,85 munaa ja toisessa 3,18–4,06. Pesyekoko oli sitä pienempi, mitä myöhemmin pesintä aloitettiin. Pesän korkeus, halkaisija, pesäkuopan syvyys tai sen halkaisija eivät eronneet ensimmäisen ja toisen pesyeen välillä.

Munien lukumäärä sekä pesäpoikueiden ja lentopoikueiden koot erosivat ensimmäisen ja toisen pesyeen välillä, kun taas munien mitoissa (leveys, pituus, tilavuus) ei ollut eroja. Munamittojen toistuvuuskerroin oli (0,63–0,92), mikä viittaa siihen, että munien ominaisuuksissa on naaraasta riippuvaa suurta vaihtelua. Pesän muoto ja sen sijainti vaikuttivat munien kuoriutuvuuteen. Pesissä, jotka oli rakennettu matalalle ja joissa oli syvä kuoppa, poikaset kuoriutuivat munista varmimmin. Vertailtaessa tutkimuspopulaatiota muihin populaatioihin kävi ilmi, että kaksi pesyettä tuottavien parien määrä väheni etelästä pohjoiseen. Tutkimuksemme osoittaa, että haarapääskyn eteläisillä tutkimuspopulaatioilla on ominaisuuksia, joita tulisi tutkia jatkossakin.

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