Seasonal variation in wing length and body mass in the Northern Wheatear *Oenanthe oenanthe* at the Gran Sasso area

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Abstract – In this study, we use the ringing data on Northern Wheatears captured during the period 2004-2013 in the Gran Sasso area. We considered 3222 ringed individuals to analyze seasonal variation in wing length and body mass of adults (males and females) and juveniles. During the breeding season (7 May-4 August) the wing length of adults was 2.8 mm longer in males, whereas the body mass did not differ between the sexes. The wing length increase in August can be caused by the passage of adults and juveniles from other territories that likely replaced individuals that were present during the breeding season in this area. In addition, the inter-annual fluctuations of captures probably reflected variations in weather condition between years, which is one of the major factors influencing the timing of migration (e.g. bad weather solicits early departures from breeding grounds) and reproduction (e.g. bad weather delays depositions and increases the parental effort) of high altitude bird species.

Key-words: Northern wheatear, high altitude, wing length, body mass, phenology, ringing.

INTRODUCTION

The Northern Wheatear *Oenanthe oenanthe* (Fig. 1) is a small passerine with one of the largest ranges among the songbirds of the world (Cramp 1988). This insectivorous bird occurs in many parts of Europe during migration and in the course of the breeding period. In Italy, it nests on the Alps and Apennines, with breeding occurrences in Sardinia and Sicily (Brichetti & Fracasso 2008). The breeding population is estimated of 100000-200000 pairs, with an increase of 25-30% from 2000 to 2012 (Nardelli *et al*. 2015). The breeding habitat is characterized by mountainous open environments with herbaceous vegetation, along with outcropping stones and rocks; the breeding pairs prefer to nest in sunny and dry sides whereas they generally avoid close, wet and cold valleys (Brichetti & Fracasso 2008). In the subalpine zone and in the Apennine, the species breeds at 1000-1800 m even though there are sporadic occurrences under 500-600 m (Brichetti & Fracasso 2008). In the Apennine of the Abruzzo region, the females usually lay 3-4 eggs between April and July, with a deposition peak in the last week of May; however, the breeding success is rather low and corresponds to 0.52 fledgings/nest (Brichetti & Fracasso 2008). In the area of Campo Imperatore (L'Aquila province) the breeding pairs build their nest on the ground in natural cavities between stones and rocks, but it has been reported a nesting attempt into an artificial nest positioned at a height of 5 m from the ground (Brichetti & Fracasso 2008). Moreover in the area of Campo Imperatore, the Northern wheatear shows nest fidelity as there are recaptures of both adults and juveniles in the same site 1-2 years after the first capture (Brichetti & Fracasso 2008).

This species performs post-breeding movements between August and October, and pre-nuptial movements between March and May (Brichetti & Fracasso 2008). In Italy during the period 1982-2003, a total of 6765 wheatears were ringed; most of them were captured during spring migration, i.e. form the end of March to the end of May, in the main ringing stations of the Mediterranean coasts (Spina & Volponi 2008). The analyses of the ringing data at a national scale showed that males have longer wings than females, and that individuals captured in autumn have longer wings than individuals captured in spring, probably because of the passage of migrating individuals (Licheri & Spina 2002). Although several ringing data at a national

scale, there are no multi-year studies on a wheatear population at a local scale. In this paper, we report on ringing activity data regarding a ten years study on the Northern Wheatear at the Gran Sasso area. Specifically, we describe the captures phenology and the seasonal variation of wing length and body mass of adults (males and females) and juveniles.

MATERIALS AND METHODS

Study area

The study was carried out in the Parco Nazionale del Gran Sasso e Monti della Laga, within the plateau of Campo Imperatore and the surrounding areas on the Gran Sasso Massif at an altitude of approximately 1400-2200 m, beyond the arboreal vegetation limits. Most of the study area occurs within the SPA IT7110128 and the IBA 204 Gran Sasso e Monti della Laga, which is characterized by a high altitude ecosystem with primary grasslands, snow valleys, and glacial cirques (Fig. 2).

Field procedures

The ringing sessions (i.e. the days in which the mist-nets were opened) were performed during the period 2004-2013, from the last decade of April to the last decade of September.

The breeding period was regarded as the temporal range in which females showed the incubation patch, that in our study spanned from 7 May to 4 August. We used

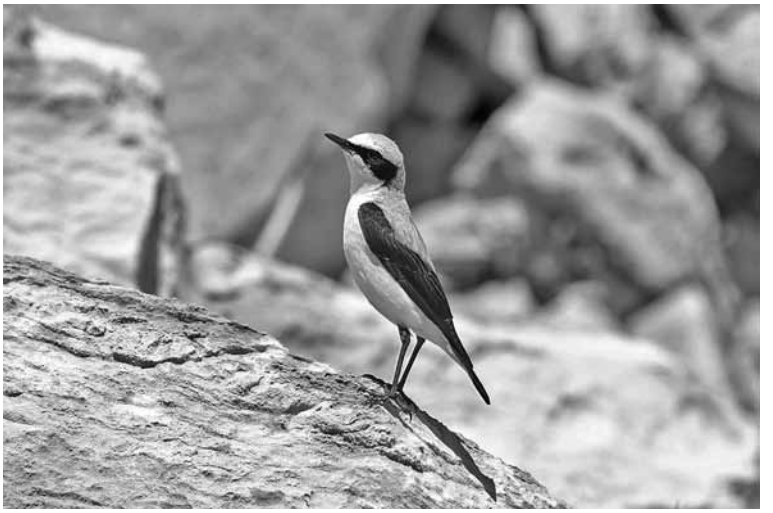

Figure 1. Northern Wheatear (adult male).

Figure 2. Campo Imperatore upland.

mist-nets of 12 x 2.4 m with four pockets and 16 mm mesh. The number of mist-nets was held constant in the same month of different years, whereas it changed between months of the same year. Specifically, 8-12 mist-nets were used in the period April-June, 10-15 mist-nets in July and in the first two decades of August, and 10-12 mist-nets were used in the last two decades of September. The number of mist-nets also changed on the basis of weather conditions, being reduced when the wind intensity increased. The ringing sessions were intensified and the number of mist-nests increased (n = 40) from the last decade of August to the first decade of September. In order to take into account for the seasonal variation in the number of mist-nets used, we computed the number of captured individuals divided by the number of mist-nets mounted multiplied by the number of ringing days, i.e. captures/(mist-nets x ringing days).

Each individual was sexed and aged according to plumage characters (Svensson 1992). We measured the wing length with a dial caliper (accuracy of 0.1 mm), and the body mass with an electronic balance (accuracy of 0.1 g). Sexing is generally easy in this species because of the sexual dimorphism: males show black lores and white supercilium, whereas females have brown-black lores and creamy-white or buffish supercilium (Svensson 1992). Individuals were aged by assessing eventual moult limit on the plumage, as juveniles undergo a post-juvenile partial moult (in summer) and a pre-nuptial partial moult (in winter), whereas adults perform a post-breeding complete moult (in summer) and a pre-nuptial partial moult (in winter) (Svensson 1992).

Statistical analyses

For each individual, we considered the measures taken during the first capture and those taken in subsequent years, but we excluded the within-year recaptures. We used one-way analyses of variance to test the differences in wing length and body mass between adults (males and females) and juveniles that were captured during the breeding season. Pairwise comparisons were carried out with *post hoc* Tukey tests to assess differences in the response variables between adult males, adult females, and juveniles. One-way analyses of variance and *post hoc* Tukey tests were also used to test inter-annual variations of captures, and seasonal variations in wing length and body mass within each group (adult males, adult females, and juveniles). All the analyses and the plots were performed with the software IBM SPSS ver. 20.

RESULTS

In this study, a total of 3222 individuals were ringed during the period 2004-2013: of these, 853 were recaptured during the same year, and 212 were recaptured in subsequent years. We obtained a total of 1092 recaptures from 742 individuals. We sexed 549 birds (17% of ringed individuals) by assessing the plumage characters, and the ageing was always done with the exception of 19 cases (0.6% of ringed individuals). We identified 514 adults (304 males and 210 females) and 2689 juveniles (17 males, 18 females, and 2654 of unknown sex).

Inter-annual and seasonal variations of the captures

The ringing days and the number of captures increased constantly over the years, with a peak of 926 captures in 2012 (Tab. 1). Taking into account for the ringing effort (number of mist-nests mounted multiplied by the number

Table 1. Annual number of captures and ringing sessions (RSs), and mean monthly number of captures per ringing session (Ind/RS).

	APR-SEP		APR		MAY		JUN		AUG		SEP	
	Total individuals	**Total RSs** (days)	**Ind/RS**	**RSs** (days)	**Ind/RS**	**RSs** (days)	**Ind/RS**	**RSs** (days)	**Ind/RS**	**RSs** (days)	**Ind/RS**	**RSs** (days)
2004	89	22			1.0	1	1.3	3	5.8	8	4.7	6
2005	127	17			2.0	1	1.0	1	9.3	6	7.8	4
2006	211	24	1.5	2	1.8	4	2.5	2	17.5	10	2.8	4
2007	468	34			2.0	3	3.0	5	22.2	14	13.0	4
2008	377	34			2.7	6	3.5	4	17.2	12	11.3	7
2009	479	24					2.0	4	29.6	14	13.5	2
2010	351	41	3.0	2	2.4	7	2.6	5	14.4	14	16.0	5
2011	542	42	5.0	5	2.2	6	1.8	4	27.2	13	11.7	7
2012	926	52	4.3	7	5.3	9	6.3	8	39.6	14	16.5	6
2013	721	51	2.8	8	3.3	9	3.2	5	33.0	15	12.9	7

of ringing days), we observed an increase of captures from 2004 to 2007 which is followed by a constant number of captures in the subsequent years with the exceptions of a decline in 2010 and a peak in 2012 (Fig. 3). Within each year, we found a significant increase of captures in July and August (Anova: $F_{5,48} = 8.24$, $P < 0.001$, Fig. 4). In particular, the captures in July were similar to those in August (*post hoc* Tukey test, $p = 0.995$) and significantly higher than those in other months (*post hoc* Tukey test, $p < 0.04$), whereas the captures in August were significantly higher than the captures in May, June, and September (*post hoc* Tukey test, $p < 0.006$) but did not differ if compared to the captures in April (*post hoc* Tukey test, $p = 0.1$).

Wing length and body mass in the breeding period

During the breeding period, the wing length of adult males was significantly longer than that of adult females and juveniles (Anova: $F_{3,841} = 23.6$, $p < 0.001$; Fig. 5a). In adults, the wing was 2.8 mm longer in males than females (*post hoc* Tukey test, $p < 0.001$). The wing of juveniles was 2.1 longer than that of adult females (*post hoc* Tukey test, $p < 0.001$), and 0.6 mm shorter compared to the wing of adult males (*post hoc* Tukey test, $p < 0.034$).

The body mass was statistically different between adults and juveniles given that both adult males and females resulted heavier than juveniles (Anova: $F_{3,866} = 14.5$, $p < 0.001$; Fig. 5b). Adults were approximately 0.9 g heavier than juveniles (*post hoc* Tukey test, $p < 0.001$), but body mass did not differ between adult males and females (*post hoc* Tukey test, $p = 1,0$).

Seasonal variation of wing length and body mass

Within each group (adult males, adult females, and juveniles), wing length and body mass showed a significant seasonal variation (Figs 6a, 6b). Specifically, both the measures significantly increased from July to August. The wing length increase was approximately of 2.8 mm in adult males (*post hoc* Tukey test, $p < 0.001$), 3.3 mm in adult females (*post hoc* Tukey test, $p < 0.001$), and 0.4 mm in juveniles (*post hoc* Tukey test, $p = 0.010$). The increase of body mass was approximately of 1.3 g in adult males (*post hoc* Tukey test, $p = 0.024$), 1.4 g in adult females (*post hoc* Tukey test, $p = 0.032$), and 1.1 g in juveniles (*post hoc* Tukey test, $p < 0.001$). In adult females, the body mass also significantly increased of about 1.6 g between April and May (*post hoc* Tukey test, $p = 0.024$), whereas juveniles and adult males significantly increased the body mass between August and September (juveniles:

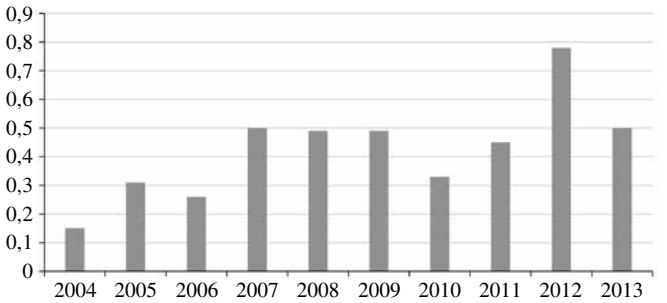

Figure 3. Number of captures in relation to the ringing effort during the period 2004-2013.

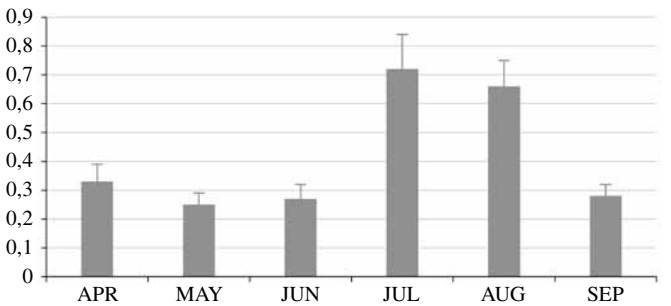

Figure 4. Seasonal variation in number of captures in relation to the ringing effort. Bars represent the mean values and the error bars show the standard error of the mean.

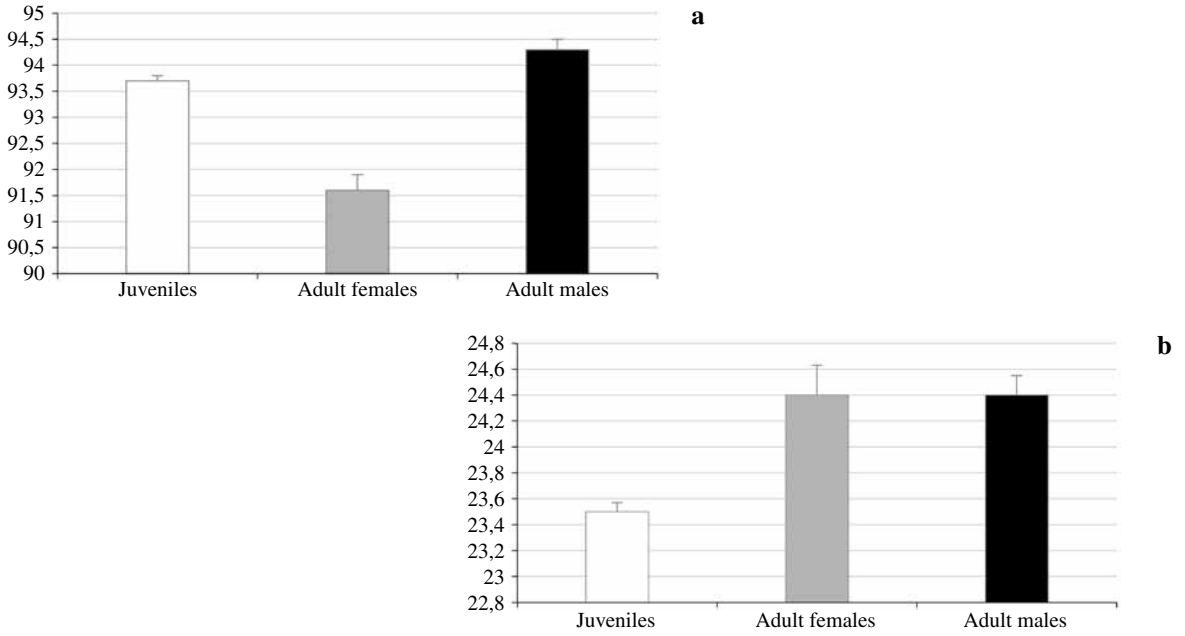

Figure 5. Wing length (**a**) and body mass (**b**) of juveniles, adult females, and adult males during the breeding period. Bars represent the mean values and the error bars show the standard error of the mean.

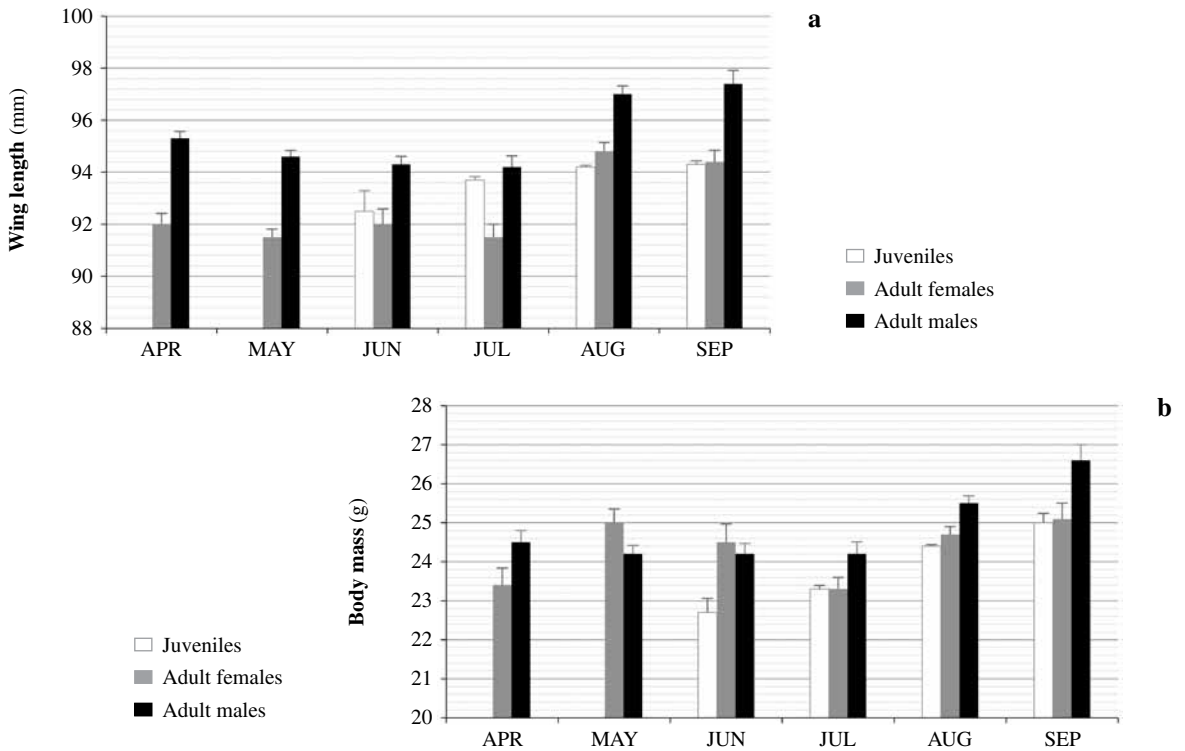

Figure 6. Seasonal variation in wing length (**a**) and body mass (**b**) of juveniles, adult females, and adult males during the period April-September. Bars represent the mean values and the error bars show the standard error of the mean.

+0.5 g, *post hoc* Tukey test, p = 0.001; adult males: +1.1 g, *post hoc* Tukey test, p = 0.038).

DISCUSSION

We showed that the abundance of an avian species living in a mountainous open environment shows annual and seasonal variations that are likely explained by climatic fluctuations that generally occur at high altitudes. In particular taking into account for the ringing effort, we observed a different number of annual captures that probably are due to unfavourable environmental conditions that may reduce the number of breeding pairs, juveniles, and/or migrating individuals.

The lack of data in April of some years and in May 2009 was due to the presence of abundant snow on the ground which impeded to set the mist-nets, and then to activate the ringing station. In other cases, the mist-nets were mounted but we did not capture any wheatear probably because of the presence of few individuals in the study area. The significant increase of captures in July and August may highlight the passage of individuals from nearby grounds and/or in migration. This idea is also supported by the significant increase of wing length and body mass that we observed from July to August.

During the breeding season, the sexual pattern of wing length was similar to that observed at a national scale (Licheri & Spina 2002), being the wing of males significantly longer than that of females. Although the wing length of juveniles was significantly different from that of adult males and females, it was closer to the wing length of adult males. It would be interesting to investigate whether in this population the sex-ratio of juveniles is male-biased, but the difficulty of sexing juveniles only through plumage characters makes this hypothesis hardly verifiable unless of specific molecular analyses. In adult females, the increase of body mass from April to May can be explained by the proximity to the laying period, when the females became heavier because of the eggs in formation that they are carrying (e.g. Redfern 2010).

Despite the breeding and migrating strategies of this species in the Apennine remain poorly known, this study allowed to observe inter-annual abundance fluctuations, probably due to climatic and environmental factors, and to show seasonal variations of wing length and body mass, probably linked to the capture of individuals from different territories that to some extent replace adults and juveniles of the local population.

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