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Ageing and sexing of the snow finch *Montifringilla nivalis* by the pattern of primary coverts

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Abstract – We provide here new methods of sexing and ageing the snow finch *Montifringilla nivalis*, a bird localised on Palaearctic mountain ranges. Between 2003 and 2009 we caught, ringed, measured and took pictures of 108 individuals in order to study the development of plumage among different age and sex classes. In particular we focused on the pattern of primary coverts (PC), to test whether they provide a reliable character for sexing and ageing snow finches. In general males had smaller black markings than females, and older individuals smaller than younger. Juvenile females had completely black PCs, while males of the same age had a little white patch on the inner PCs. This provide a reliable character to sex even fledging or nestlings of snow finches. Males in second plumage were very similar to older females, but when they could be sexed with other methods, then the pattern of PCs could be used to reliably age almost all individuals up to third plumage, with only few intermediates that should be left undetermined.

Key-words: snow finch, ageing, sexing, primary coverts, ringing.

INTRODUCTION

The snow finch *Montifringilla nivalis* is a breeding bird of several mountainous areas in the Palaearctic region; it dwells in the alpine zone where snow patches are found all year around (Cramp & Perrins 1994, Strinella *et al*. 2007). Despite its large breeding range it is one of the less studied bird species in Europe, with very few studies about its ecology, population dynamics and even plumage characteristics to correctly age and sex captured birds (but see Strinella *et al*. 2011).

Until recently it was only possible to sex adult birds by some plumage feature, such as head colouring (ash grey in males, brownish-grey in females), or by the colour of flight feathers (Cramp & Perrins 1994, Svensson 1992). These plumage characteristics are most useful during the breeding season, but are more difficult to apply after the complete post-breeding moult when males attain a buffish shade on head (Svensson 1992), and thus become more similar to females. In a previous study, Strinella *et al*. (2011) suggested that wing length could be reliably used all year around to correctly sex about 90% of adult birds in central Italy, due to the very limited overlap between sexes. It remains however impossible to reliably sex juvenile birds, and to determine bird age after the first complete moult, which occurs a few weeks after fledging (Cramp & Perrins 1994, Glutz von Blotzheim *et al*. 1997, Svensson 1992).

In addition to the above mentioned characteristics, Glutz von Blotzheim *et al*. (1997) and Svensson (1992) reported that the colour pattern of the primary coverts (PC) could be used to sex adult birds, males having white PCs with a small black tip, and females having white only on the inner web. By checking this feature during our ringing sessions, however, we found several adult females with PC pattern resembling that of adult males and, furthermore, we found a very large variation in this character between and within sexes. It was however unknown whether this variation was random or, most likely, related to some extent to bird sex and age.

The aim of this study, therefore, was to investigate whether the black and white markings on PCs of snow finches could be used to reliably determine age and sex of at least part of the population.

MATERIALS AND METHODS

Study site and data collection

From June 2003 to June 2011, 443 snow finches were caught with mist nets and net traps during the breeding period, in the area of Campo Imperatore, in the National Park Gran Sasso Monti della Laga, central Italy (42°27 N, 13°34 E).

Among these 443 birds, 108 were of known age (67 males and 41 females) having being ringed as chicks (N=73) or juveniles soon after fledging (N=35). At recapture, these birds have been sexed on plumage characteristics and on the presence/absence of breeding patch, following Glutz von Blotzheim *et al*. (1997), Mullarney *et al* (1999) and Svensson (1992). Therefore we knew both the age and the sex of these 108 birds, that were used for the present study. In our analysis we did not use the calendar age of the birds, because age and plumage are not coincident due to the complete moult of all age classes at the end of summer. Instead, we used plumage sequence, being plumage 1 the first that birds wear when leaving the nest, plumage 2 that one acquired after the first moult, plumage 3 the feather set acquired by the second moult. In our study we analysed 35 males in plumage 1, 38 females in plumage 1, 12 males in plumage 2, 8 females in plumage 2, 45 males in plumage 3 and 26 females in plumage 3. In some cases birds have been recaptured more than once, while in other cases we had no picture as juveniles, so that the sum of the samples analysed is different from the total number of birds used in the study.

Evaluating PC pattern

From all birds caught we took one picture of the open wing, using a ruler as reference, with a digital camera. We used these pictures for the analysis of feather characteristics in relation to age and sex. As mentioned above, a few birds have been used only once, while other birds have been recaptured and photographed two or three times. We never used two pictures of the same bird in the same plumage. We analysed these pictures using the image software ©GIMP 2.6.1 (Gnu Licence) to measure the length of white and black markings of primary coverts from 4th to 7th PC, in descendent order (Fig. 1). Inner and outer webs of the PCs differed in the size of black markings, being the outer mark always longer than the inner one. We measured the length of black markings on feather rachis, from feather tip to the basis of the black marking on both inner and outer web. If only a black spot near the rachis was found, the feather was considered to be completely white (Fig. 1). In case of PC4, that usually showed a symmetric mark, we measured from the tip of the feather to the basis of black marking irrespective of which web it was. Because there was much overlap between age and sex classes in the black markings of all coverts, we did not run any statistical test, which are usually based on value distribution and would have provided only significant differences among feath-

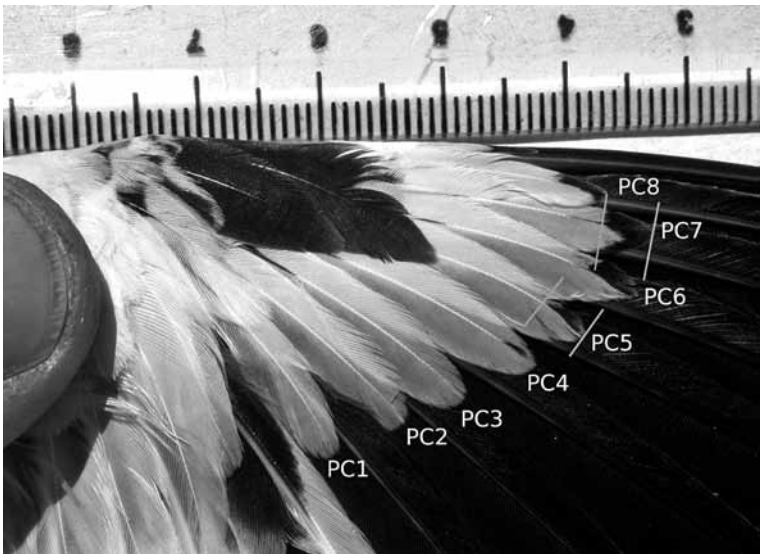

Figure 1. Numbering of primary converts, from PC1 to PC8 and methods of measuring with different patterns of black tip. PC4 was considered as completely white because had only a small black spot on feather rachis, not reaching the feather border. PC5 and PC7 were both measured from the tip of the feather to the end of the black spot, even if, as in PC5 of this example, only one side of the feather was marked.

er markings with little meaning for the field work. Rather we determined the range of the size of black markings for each age/sex combination and searched for those values that were not overlapping among categories. This allowed us to determine the pattern and the values that could be used to discriminate among sex and age classes.

RESULTS

In general the size of black markings on all PC decreases with the age. Furthermore, females had larger black markings than males of similar age (Fig. 2 and 3). The black markings of PC7, PC6 and PC5 could be used to age and/or sex most birds, although not all. In table 1 all measurements of black markings are given, while in table 2 we provide a list of features that can be used to determine sex and age classes in this species.

DISCUSSION

Black markings on PCs allow to age and sex most individuals of snow finches from EURING age code 3 (plumage 1 and 2) to age 6 (plumage ≥3). In this study we focused only on the black markings of primary coverts, which we

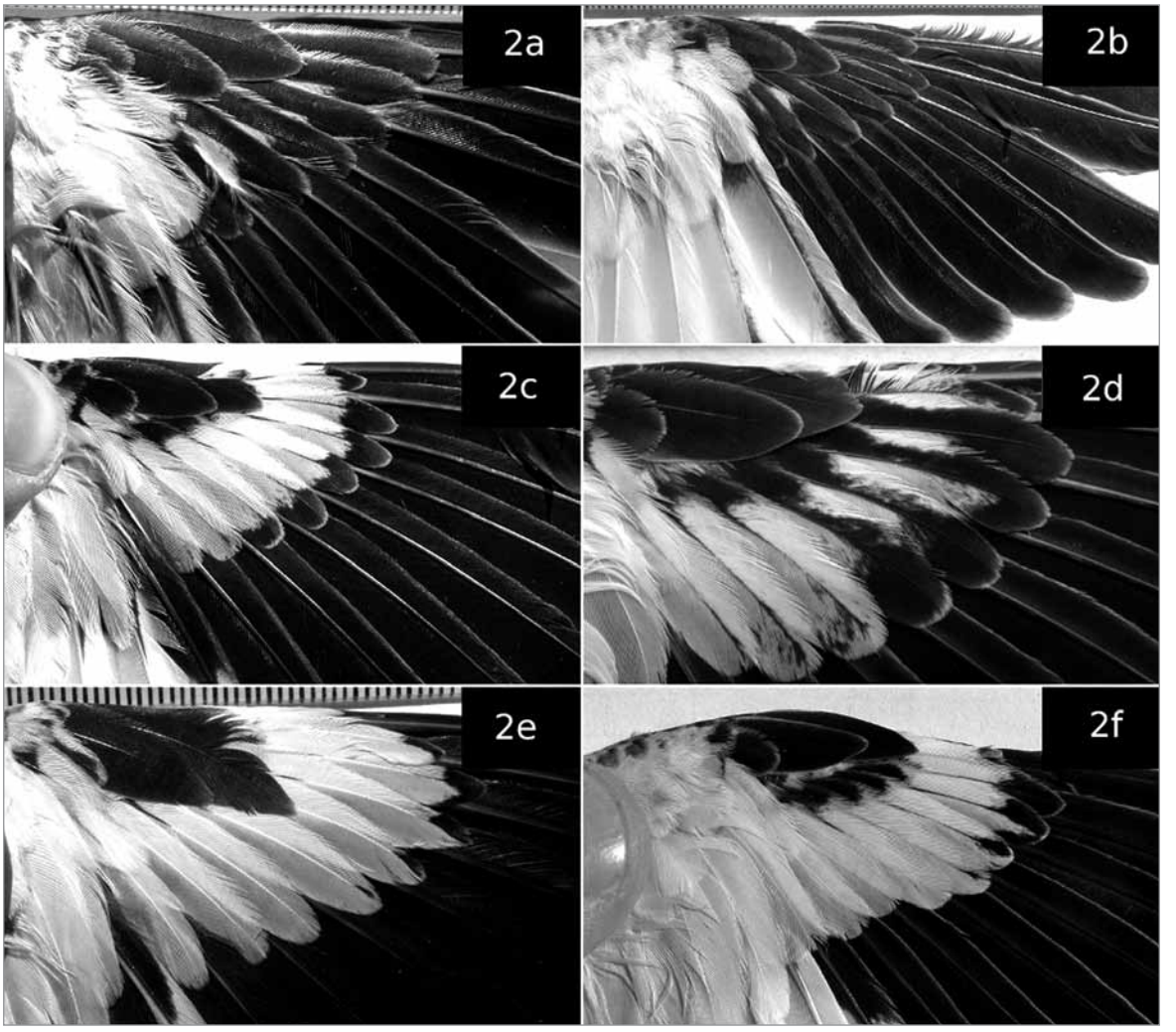

Figure 2. Markings on primary coverts in different plumages and sexes. 2a: male plumage 1, with a white basis on the inner web of PC5-PC8; 2b: female plumage 1, with all black PC5-PC8. 2c: male plumage 2, with black tips on PC5 and PC6. 2d: female plumage 2, with solid brownish-black stripe on outer web of PC7 and PC6. 2e: male plumage ≥3, with only small tips on PC7 and incomplete tip on PC6-PC5. 2f: female plumage ≥3, with brownish-black tip on PC7-PC6 and almost no marking on PC4.

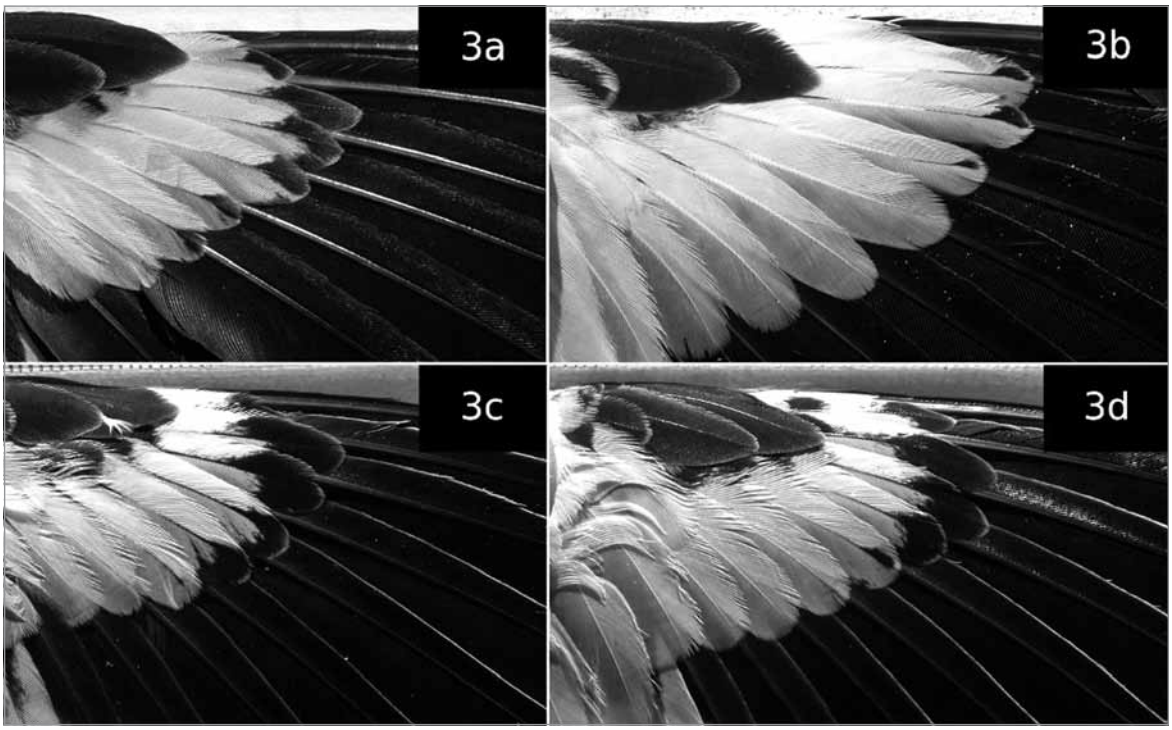

Figure 3. Exceptions in the pattern of black markings. 3a: male plumage ≥3 with black tip on PC6 and broken black tip on PC5, similar to the pattern of a plumage 2. 3b: male plumage ≥3 with very small black spots on PC5-PC8, probably characteristic of some very old males. 3c: female plumage ≥3, with a large black tip on PC4 similar to the pattern of plumage 2, but lacking the black stripe on PC6 and PC7. 3d: female plumage ≥3, with mottled, not solid, blackish stripe on the outer web of PC7, similar to the pattern of plumage 2. Note, however the small spot on PC4 typical for ≥3 plumage.

found to be rather distinctive among age and sex classes, although with some overlap.

We found that the snow finch represents one of the rare cases among European passerines where even fledglings can be reliably sexed using feather markings. Juvenile females (plumage 1) are the only birds that have completely brown-black PCs, without any sign of white markings on the inner web (Fig. 2b).

Birds of all other age and sex classes had at least some small white markings on the inner web of PCs, and therefore juvenile females were easily. Juvenile males had a white base on the inner web of PC5-PC7, that was very diagnostic (Fig. 2a). In following plumages, ageing and sexing are more difficult because of a certain amount of overlap in feather markings.

Females in plumage 2 could be readily identified by the solid black stripe along the outer web of PC7 and usually PC6 (Fig. 2) which was very characteristic and never found in males. Unfortunately about 15% of older females (probably plumage 3) showed a similar marking, although rather mottled and never as solid as in birds in plumage 2 (Fig. 3d). These older females, however, typically showed a brown-black tip on PC4 shorter than 4mm, usually without markings in the inner web (but Fig. 3c). The brown-black tip of PC4 in plumage 2 females was always very extensive, covering usually more than 6mm and being solid brown-black with mottled margins. We cannot exclude, however, that few females in plumage 3 show both characteristics of plumage 2, although this combination was never represented in our sample. We suggest, therefore, that females with unclear characteristics should be better left without precise ageing.

Males could be aged mostly using the size and the shape of the black markings on PC5 and PC6 (Tab. 1 and 2). A male with a black tip >4mm on PC5 and >6mm on PC6 is surely in its plumage 2. Similarly, birds in plumage 3 never showed a full black tip or a large spot on PC4, as it was commonly found on plumage 2. However, a big overlap in markings was found between females in plumage 3 and males in plumage 2 and 3.

The best way to identify these classes is to check the size of the black tip on PC5: males in plumage 3 had the black tip on outer web always <4mm, and never a whole black tip as most males plumage 2 (84%). If a marking was

Table 1. Ranges and averages of black markings of primary coverts among the different sex and age classes. PC4 had always a symmetrical black tip, and thus we report only one measurement.

Sex		N		PC4	PC5	PC6	PC7
Males	1	35	outer web	12.6	14.6	15.6	16.1
			inner web		(7.2-12.1) 8.6	(8.6-11.9) 9.4	(9.5-13.7) 10.8
Males	2	12	outer web	(0-5.2) 3.6	(4.1-7.5) 5.6	(5.4-10.7) 7.8	(6.3-12.7) 8.6
			inner web		(0-6.0) 2.9	(1.8-7.3) 4.4	(2.5-9.2) 6.6
Males	≥3	45	outer web	0	(0 – 4.2) 3.1	(2.9-6.0) 4.5	(3.1-7.0) 5.0
			inner web		0	(0-3.3) 0.6	(0-6.4) 2.9
Females	1	38	outer web	12.6	14.6	15.6	16.1
			inner web		14.6	15.6	16.1
Females	2	8	outer web	(4.9-12.6) 7.4	(5.0-13.1) 10.2	(7.9-15.6) 13.6	(7.7-16.1) 15.0
			inner web		(6.0-8.5) 7.3	(5.3-9.5) 7.7	(7.5-10.8) 9.5
Females	≥3	26	outer web	(0-3.9) 2.6	(3.2-6.3) 4.8	(5.4-16.1) 9.3	(4.2-15.4) 7.4
			inner web		(0-6.2) 2.2	(0-7.6) 4.3	(2.3-9.8) 6.4

Table 2. plumage characteristics of different plumages and sexes.

Sex	Plumage	PC4	PC5	PC6	PC7
Males	1	Black with white base on inner web.	Black with white base on inner web.	Black with white base on inner web.	Black with white base on inner web.
Males	2	Very variable, from all white to large black tip.	Usually (90%) with complete black tip. Black tip always ≥ 4 mm.	Always with complete black tip, usually > 6 mm.	With little black tip.
Males	≥3	Almost always white; sometimes with a black spot on rachis, never with black tip.	Never with a complete black tip; Black tip on outer web ≤ 4 mm.	Black tip on outer web ≤ 6 mm. Usually no marking on inner web.	With little black tip.
Females	1	Brownish-black with or w/o white base on inner web.	All brownish - black.	All brownish - black.	All brownish - black
Females	2	Sometimes with black stripe on outer web; Large black tip ≥ 5 mm.	Sometimes with black stripe on outer web. Large black tip ≥ 6 mm.	Almost always with solid black stripe on outer web.	Always with solid black stripe on outer web.
Females	≥3	Very variable; Sometimes all white, sometimes with black tip, always < 4 mm.	Usually with small black tip. 77% with outer web marking > 4 mm	Usually with complete black tip.	With black tip, never a solid black stripe on outer web.

found on the inner web, this was usually like a small mark protruding from the outer web in males plumage 3 (Fig. 2f and 3a).

Only 23% of females plumage 3 had the brown-black tip on outer web <4mm as in males plumage 3. Females plumage 3 and males plumage 2 had a practically complete overlap in marking size and we were not able to find any reliable method to distinguish between these two plumages. We suggest therefore, that these birds should be first sexed using other characteristics, such as head colour or

biometrics (see Strinella *et al*. 2011, Svensson 1992) and then aged. In this way, only a few birds should be left without precise age and sex determination. A summary of all features that should be used to sex and age snow finches are represented in Tab. 2.

Finally, we found several adult males and a few adult females with very small black markings on PCs, and we suppose that these were very old birds, possibly in their plumage 4 or even older. While we could not test this hypothesis, we suggest that with further studies this or other plumage features could be found to age even older birds. To conclude, we are aware that the characteristics found in our study might only apply to the local population of Central Italy, however, given the absence of known morphological variation among the several European populations, we think that these results might well be usable in the whole European range. Nonetheless, we recommend other researchers to test whether our results apply also to other populations in the large range of this species.

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