



Short Communication

Male-biased Sex Ratio and Body Size of a Wintering Roost of Brambling, *Fringilla montifringilla* Linnaeus, 1758

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ABSTRACT

Sex ratio and age composition are important parameters in population biology, related to life history and difference in mortality and behavior of male and female. Sexual dimorphism indicates divergence selective pressure between two sexes. We determined the sex and age through plumage coloration and measured 6 body measurements of each bird in 122 Brambling *Fringilla montifringilla* individuals in a wintering roost, which were captured randomly with mist nets. We found both the sex ratios of juveniles and adults were male-biased in this roost, which possible originated from different migrating strategies with sex and age. Culmen length, wing length and tail length of male is longer than female, male is heavier than female in body mass, these differences showed slight male-biased sexual size dimorphism, the larger body size of male may have resulted from sexual selection, while pressure of natural selection may not be significant as the males and females were observed almost always foraging together closely on same substrates in one flock during non-breeding season.

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Authors' Contribution

PL designed the research, coordinated and drafted the manuscript. LL and PL conducted the field work.

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Key words

Sexual size dimorphism, Wintering, age composition, Sex ratio, Brambling

In birds, sex ratio is closely related to breeding systems (Eberhart-Phillips *et al.*, 2018; Grant and Grant, 2019), and the ratio could be manipulated in different life history stages including egg-laying, nestlings and wintering (Donald, 2007; Donald *et al.*, 2007). Understanding the structure of wintering roosts is important from ecological viewpoint, and for conservation of bird populations (Arizaga *et al.*, 2012). Changes in sex ratio may affect the population structure and family composition (Grant and Grant, 2019). In birds, weather factors such as annual temperature and precipitation, food availability and sex difference in mortality, dispersing and different migrating strategies of both sexes can affect sex ratio (Brooke *et al.*, 2012; Donald, 2007; Donald *et al.*, 2007; Nevoux *et al.*, 2013).

Sexual size dimorphism (SSD) is very common across the animal kingdom, sexual and natural selection promotes its evolution (Darwin, 1871; Andersson, 1994; Haggerty, 2006; Liu *et al.*, 2020), SSD is a predictor of differential selection among males and females. Theory of natural selection especially the resource-partitioning hypothesis proposes that sex-related differences in foraging behavior contribute to the evolution and maintenance of SSD (Selander, 1966; Shine, 1989; Andersson, 1994; Temeles *et al.*, 2000; Blondel *et al.*, 2002). The sexual selection

hypothesis argues that larger size usually evolves in males because of the advantages it involves in male-male competition for access to breeding territories, food or mates (Andersson, 1994; Haggerty, 2006). SSD should increase as one sex competes more fiercely for access to mates or/and food.

In the present study, we focused on a wild passerine bird, brambling, *Fringilla montifringilla*, which winters in large roost at the beech mast areas of Switzerland (Jenni, 1987). Brambling have been reported to have differential migration, with first-year birds and females moving further to the south than adults and males following age- and sex-biased sex ratio in wintering roosts (Cramp and Perrins, 1994). The studies on structure and dynamics of wintering population in this species were documented well in Europe, but rarely in Asia. Males have been reported to dominate females to food access in a wintering roost, the males have larger body size and weigh more than females (Jenni, 1993). In this study, we want to test two predictions in brambling, a winter migrant at eastern Gansu, central China: i) sex ratio is biased towards females in our focused wintering population, because of relatively lower latitude of wintering ground location; ii) based on male and female foraging together on the same substrates in roost, we predicted that there was no sexual size dimorphism in our focused birds.

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Materials and methods

Bramblings arrived at our study site by late November

and started to leave by early April. We captured birds randomly using mist-nets from 10 December of 2019 to 24 March of the year 2020 at the campus of Longdong University (35°43'47"N, 107°41'04"E, 1367.3 m), eastern Gansu province, central China. Once the birds were captured, their sex was determined by plumage coloration, male with black head crown, while female no. Age was classified as first-year birds and adults according to the feathers of wing (Arizaga *et al.*, 2012). We measured six morphological parameters (culmen length, beak width, beak height, tarsus length, tail length, and wing length) with digital calipers (to 0.01 mm), body mass was measured with electrical balance (to 0.01 g). All measurements were taken by the same person, each bird was banded with a unique combination of colored leg rings and released after measurements completed.

We used chi-square to analyze the sex ratio, t-tests to investigate sex differences in all body measurements. We also calculated an index of dimorphism using the formula: dimorphism index = male mean/female mean $\times 100$ (Wagner, 1999) and a coefficient of variation as: $CV = SD/Mean \times 100$ (Fletcher and Hamer, 2003) for each sex and all variables to indicate the variability of each measurement (Sokal and Rohlf, 1995). All statistical tests were performed with SPSS software package for Windows 22.0, and all probabilities were 2-tailed with a significance level of $P = 0.05$, results were given as Mean \pm SD.

Results

We captured and measured 122 individuals (75 males, 47 females) in this work.

This wintering roost with 61.5% male birds, sex ratio was male-biased (Chi-square = 6.426, $P = 0.011$), 59.8% were first-year birds, more than adults in both sexes (Table I). The culmen length, wing length, tail length of males were significantly longer (ranged 2.8–6.5%, depending on body measurement definite; all $P < 0.001$ (Table I) than females, males (23.00 ± 2.83 g, $n = 75$) were heavier than female (20.73 ± 2.69 g, $n = 47$) in body mass ($t = 2.883$, $P = 0.020$). The most dimorphic measurement was tail length (107, Table II).

Discussion

Sex ratio in our study roost was male-biased, more than 60% of the flock were males, this is consistent with the results of study in northern Europe, where females migrate further south than males (Cramp and Perrins, 1994; Arizaga *et al.*, 2012). Compared to the latitude of these study areas (above 43°N), our study site was located at a relatively lower latitude (35°N) than those mentioned above. This may suggest that our sample size was small or the origin of wintering bramblings was different from

study areas in Europe and may even be the global warming affect and the wintering ground selection by bramblings. More than 59% captured birds were first-year birds; this is in agreement to the reported results from southern Europe (Arizaga *et al.*, 2012), while contradictory to those from northern Europe (Cramp and Perrins, 1994). Some researcher argued that this contributed to the first-year birds migrating further south than adults (Cristol *et al.*, 1999). Although the juveniles with little different body size to adults, they are lacking in foraging ability, migrant more lower altitude to wintering is a better strategy for their survival (Cramp and Perrins, 1994; Cristol *et al.*, 1999; Arizaga *et al.*, 2012).

Table I. Number and frequency of each age-sex class of brambling, *Fringilla montifringilla* captured in a wintering population at the campus of Longdong University, eastern Gansu, central China.

Juveniles		Adults		Total
Male	Female	Male	Female	
46	27	29	20	122
37.7%	22.1%	23.8%	16.4%	100%

We found that bramblings exhibited slight male-biased SSD, a pattern shared with many other songbirds, such as plain laughingthrush (*Garrulax davidi concolor*, Liu and Sun, 2018), Elliot's Laughingthrush (*Trochalopteron elliotii*, Liu and Sun, 2016) and tree swallow (*Tachycineta bicolor*). This result especially the sexual dimorphism in wing length and body mass is consistent with other studies reporting on Bramblings (Jenni, 1993, Arizaga *et al.*, 2012), suggesting that the SSD widely exist in different geographical populations of brambling. SSD is variously considered to be either the outcome of natural selection for minimizing intersexual competition for limited food resources or linked to other life history traits. SSD resulted from males and females foraging for food items of different sizes, reducing intersexual competition (Shine, 1989). In wintering bramblings, males and females foraging together on the same substrates, males often forage in center of the roost and dominate females in their access to food (Jenni, 1993), small difference in food items may result in difference in the body size. Sexual selection theory proposes that intra-sexual contests offer the larger individual a selective advantage to get mates, food and defend breeding territory (Andersson, 1994; Haggerty, 2006), larger males have the potential advantages to process resources and mate successfully. A study conducted in a bramblings winter roost found that males were always foraging in the center and dominated females to access food (Jenni, 1993).

Table II. Morphometric data, dimorphism index and coefficient of variation of male and female brambling, *Fringilla montifringilla* captured from a wintering population at the campus of Longdong University, eastern Gansu, central China.

Body measurements	Sex	Mean±SD	Range	n	Dimorphism index	CV	t	P
Culmen length (mm)	male	10.10±0.45	9.14-11.53	75	103	4.5	3.169	0.002
	female	9.82±0.49	8.67-10.71	47		5.0		
Beak width (mm)	male	7.37±0.58	6.59-9.81	75	102	7.9	1.551	0.124
	female	7.21±0.54	6.42-9.91	47		7.5		
Beak height (mm)	male	7.76±0.32	7.16-8.72	75	102	4.1	1.922	0.057
	female	7.64±0.31	7.02-8.23	47		4.1		
Wing length (mm)	male	88.80±3.06	82.29-94.97	75	106	3.4	11.679	< 0.001
	female	83.79±1.67	79.71-87.59	47		2.0		
Tail length (mm)	male	65.98±4.12	57.90-78.05	74	107	6.2	6.231	< 0.001
	female	61.72±3.34	55.26-69.63	47		5.4		
Tarsus length (mm)	male	20.50±1.41	17.98-25.51	75	100	6.9	0.319	0.751
	female	20.41±1.58	16.25-22.85	47		7.7		

Measurements differed significantly between sexes was in bold ($P < 0.05$).

In the present study, the sex ratio of wintering roost in our study site was biased towards males, age composition cline to first-year birds. This is related to different migration strategies of sex and age in this bird species. Slight sexual size dimorphism in this bird mainly results in sexual selection, because the male and female always forage together.

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Statement of conflict of interest

The authors have declared no conflict of interest.

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