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Use of Stable Isotope Ratios to Investigate the Migratory Routes of Passerines

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For the conservation of migratory birds it is of paramount importance to determine migratory routes, in particular delineating the structure of flyways that link breeding and wintering areas [1]. However, this type of information is limited and innovative methods are required to outline these spatial links for effective conservation. Intrinsic markers such as stable isotope ratios have become a powerful tool for tracking the spatial movements of animals. This is due to the fact that the isotopic composition of bird tissues reflects the isotopic signatures of the environment in which the tissues were grown [2]. Furthermore, the combination of stable isotope methods with other approaches to tracking individuals (e.g. ringing data) can increase the precision of origin assignments.

The aim of this study was to evaluate, for the first time, the use of isotopic and ringing data to efficiently delineate the geographical origin of two of the most abundant passerines migrating through the Italian Alps during the post-breeding season [3]: the pied flycatcher (Ficedula hypoleuca) and the European robin (Erithacus rubecula).The stable isotope ratios of C, H, N and S in feathers were determined in about 200 pied flycatchers and European robins captured in the Italian Alps during autumn migration. The stable isotope ratios were determined with Isotope Ratio Mass Spectrometry, following preparation according to Bontempo et al. 2014 [4]. Furthermore, data from the EURING data bank, which includes the capture and recapture histories of individual adults and hatch-year flycatchers and robins until 2008, were used to determine the direction of autumnal movement of the birds recaptured in the Italian Alps.

δ^2H and ringing data were used to develop a likelihood-based assignment method to assign a geographical origin to each sampled robin and flycatcher. Furthermore, generalised linear regression models were developed to determine the seasonal isotopic shift for the four stable isotopes, in order to compare the trends for the two species, which have a distinct migration phenology.

The results of this study show the effectiveness of combining stable isotopes with ringing data in defining migratory connectivity on a continental scale. Using this approach, the birthplace of two common species was determined during autumnal migration through the Italian Alps. In particular, the direction of movement by robins resulting from recapture data was shown to lie on a north-northeast to south-southwest line between the Baltic basin and the Alps. Furthermore, probabilistic geographical assignment suggests that the birds migrating through the Italian Alps originate predominantly in Central Europe, but with several individuals probably originating in the Baltic basin. On the other hand, the area of origin of flycatchers was shown to be more easterly, expanding the area of natal origin from the Baltic basin to western Russia [5]. As with robins, geographical assignment showed that most flycatchers were of central-European origin, with several individuals probably originating in the Baltic basin and south-western Russia.

This study highlights for the first time several advantages of using a multi-isotopic approach associated with classic ringing data to study two passerine species migrating along the Western Palaearctic flyway across the Italian Alps. In particular, the use of carbon, nitrogen and sulphur stable isotope ratios to gain insight into spatial patterns with δ^2H isoscapes was shown to considerably increase accuracy for probabilistic calculation of the geographical assignment of birds.

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