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How Genetics Plays A Role In Avian Migration

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Abstract:
Avian migration is an adaptive response to seasonal environments, which means that birds move from one region to another on migratory routes due to environmental factors. Migratory behavior is ubiquitous within and among many bird species, and this poster will review two studies of how migratory behavior is affected on a genetic level as well as how avian migration has independently evolved in many different lineages. A study of the Eurasian blackcap from southern France demonstrates how environmental factors and parent lineages affect the genetic behavior of migration. This study also demonstrated how sedentary populations of birds have been shown to evolve into migratory populations numerous times, suggesting that cryptic migratory traits are already present in many sedentary birds. Many bird species have also been seen to possess unique migratory routes, though when two birds from differing species produce a hybrid offspring, these offspring sometimes follow an intermediate or inferior migratory route. This behavior could lead to low fitness of hybrid birds which could result in speciation between different avian species.

The evolution of migration in resident populations and residency in migratory populations (Blackcap).

- Several different phylogenetic studies have shown that migration has evolved repeatedly and rapidly within many avian lineages.
- This pattern of migration variation also holds true within the same species, such as the Eurasian blackcap.
- A phylogeographic study in the genetics of 12 blackcap populations across the species' breeding grounds revealed that the migratory population are no more closely related than to sedentary (nonmigratory) populations. This suggests that both populations do not have large genetic differences.
- This study has also suggested that current migration patterns within the blackcap populations evolved very recently.
- Due to the genetic tendency to migrate evolving in a short amount of time, genetic variation for migratory behavior must exist in sedentary populations as well. This is illustrated in figure 1.
- The migratory statue of specific blackcaps also seems to have an impact on the migratory status of their offspring. This is illustrated in figure 2.

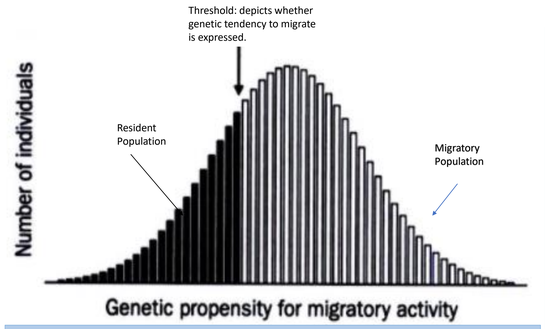

Figure 1: Threshold model of migration, representing the distribution of migratory activity in a partially migratory population. The individuals below the threshold do not express migratory behavior but genetic variation for migratory behavior in the resident population do exist. Therefor these birds are capable of migratory activity but are not phenotypically expressed. When a certain number of individuals are reached in the population, migratory traits begin to be expressed, transitioning a sedentary population into a migratory population. (Pulido, 2007)

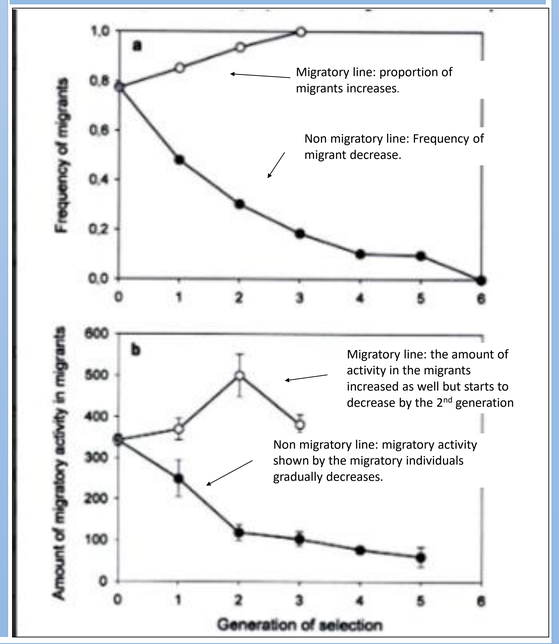

Figure 2: Results of the large-scale selection experiment of the blackcap population. Migrants were mated with migrants (migratory line) and non migrants were mated with non migrants (non migratory line). The results seem to suggest that there is a genetic component to migration since the migratory status of the parents (migratory or non migratory) seems to have an influence on the offspring's migratory behavior. (Pulido, 2007)

Correlation of genetic background and migratory orientation of blackcap warblers

- 50 nestling (four siblings per nest) were hand-raised for this experiment. Half were raised near Frankfurt and Radolfzell, west Germany, and the other half were in Bruck/Leitha and Halbturn, eastern Austria.
- When birds reached the age of 7-8 days old, they were taken and raised to independence in a laboratory in Radolfzell.
- Before the migration season, they were placed in individual cages to expose them to the day and night skies.
- When migratorily active, they were tested for orientation for around 15-20 times at dusk in Emlen funnels lined with typewriter correction paper. A diagram of an emlen funnel is illustrated in figure 4.
- During the orientation, the birds produced scratches on the typewriter correction paper and from a recording of minimum of 40 scratches, a direction was calculated.
- Using all the recorded direction from every individual of the specific group, a mean direction was created which is illustrated on figure 3 (inner circle).
- Next spring, the birds were transferred to outdoor breeding aviaries and 35 mixed pairs (one bird from east and west of the divide) were mated.
- 16 pairs produced a total of 61 F1 offspring which were hand-raised and received the same orientation test as their parents. The results are illustrated in figure 3 (outer circle).
- The results of this experiment showed that the behavior of the offspring were phenotypically intermediate between the parental groups.
- This suggests that the migratory direction in the Blackcap has a genetic basis and can be altered by cross-breeding.

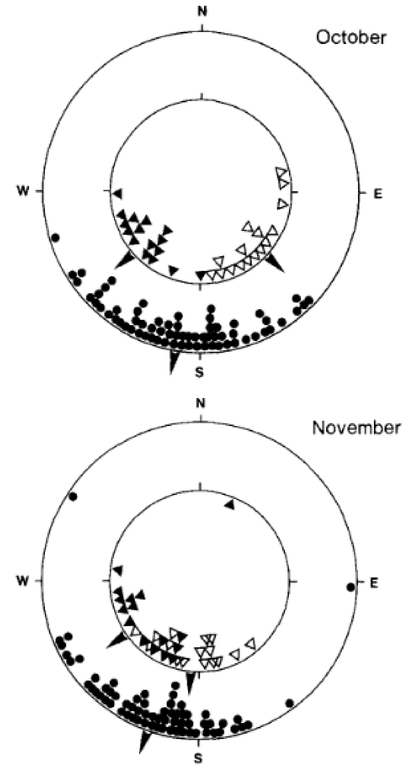

Figure 3: Results of the orientation test. The inner circle corresponds to the parental generation; the solid triangles are birds from west Germany; open triangles are birds from eastern Austria. Outer circle corresponds to the F1 generation. The arrowheads are the group mean directions. The November diagram illustrates that the eastern Austria birds changed migratory direction but did not change the migratory direction of the offspring. (Helbig, 1991)

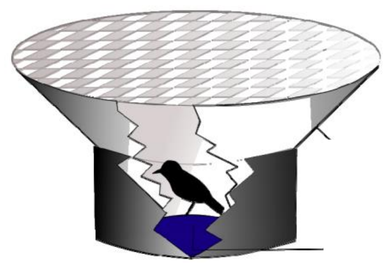

Figure 4: Diagram of an Emlen funnel.

Acknowledgments:
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References:

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Shyamal, L. (2007). Emlen Funnel (diagram).