Are There Specific Adaptations for Long-Distance Migration in Birds? The Search for Adaptive Syndromes

Outline of the European Science Foundation Workshop

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Twice a year, numerous species of almost all bird genera face the challenge of overcoming distances of up to several thousand kilometers between breeding and wintering grounds. Migrations enable birds to explore highly seasonal habitats and exploit resources during their peak abundance, primarily for reproduction. Time spent in migration can exceed that spent in other phases of the annual cycle. Metabolism is at its peak, due to high catabolism required during the energetically costly flight, while anabolism predominates during subsequent stopover periods. With respect to time and energy spent, and resources that are accumulated and depleted, migration is a dominating phase within the annual cycle of long-distance migratory birds. In the frame of the “Optimality in Bird Migration” program of the European Science Foundation, scientists were able to investigate, discuss, and exchange their thinking about the phenomenon of bird migration. The main issues of the “optimality approach” is that each individual is selected to maximize its individual fitness, and for the migration program it has been proposed to do so by either (1) minimizing time, (2) minimizing energy costs of transport, or (3) predator minimization.\textsuperscript{1}

In recent years we have achieved a substantial increase in our knowledge about the ecophysiology of long-distance migration, but we are yet far from understanding the mechanisms that shape the phenomenon of long-distance migration. There is a long history of addressing the question whether different migratory traits should be seen as adaptations to specific needs, or as constraints set by the architecture of the birds and the laws of physics. It is clear, however, that most adaptations will not go without posing constraints on other potentially important traits, and that therefore we need to consider how different migratory traits are combined and traded off.

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against each other to produce the optimal migratory phenotype. Investigating long-distance migration as an adaptive syndrome may give such a superordinate view and could simplify investigations of single aspects of the process.

Phenotypic changes of organs occurring during migration should thus be interpreted as adaptations that also may constrain flexibility in other traits. For example, the reduction in organ mass is a strategy by migrants to reduce flight and maintenance costs, but also reduces capacity for immediate refueling at new stopover sites. The optimal strategy for changes in organs during migration thus should depend on the species or specific possibilities of the individual to perform, for instance, short versus long flights, and therefore these selection pressures should not be ignored in explaining the adaptation. Compositional changes, such as increases in key catabolic enzymes in the flight muscles prior to the onset of migration, suggest an adaptive nature of these phenotypic changes. Phenotypic flexibility of organs during migration is likely to be a common adaptive syndrome, typical for vertebrates living in variable environments.

In the workshop entitled, “Are There Specific Adaptations for Long-Distance Migration in Birds? The Search for Adaptive Syndromes,” we aimed to discuss the indications for an adaptive syndrome from scientists offering different perspectives in the field of bird migration. The workshop was held from 6 to 8 January 2005 at the Max Planck Institute for Ornithology. Contributions from research ornithologists from a variety of backgrounds, including functional morphology, stopover ecology, behavioral ecology, evolutionary ecology, quantitative genetics, eco-physiology, dynamic modeling, and molecular biology were scheduled with the goal of investigating the existence of a syndrome for long-distance migration. We are convinced that the only way to understand adaptations for long-distance migration in the future is through combining these different perspectives, because specific adaptations will most likely reduce the degrees of freedom for other adaptations.

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REFERENCES