

# Stunning Facts of Bird Migration: Mini-Review

Arora Sweta, Devendra Pratap and Chandana Haldar\*

Department of Zoology, Banaras Hindu University, Varanasi – 221005, Uttar Pradesh, India;  
chaldar2001@yahoo.com

## Abstract

Migration is a unique phenomenon that millions of birds perform annually. It includes various aspects such as preparation for the long journey, migratory patterns, problems faced during migration, figuring out routes, etc. Some more interesting things are genetics behind migration and urge for migration. *Zugunruhe*, a period for migratory restlessness, has been observed well in caged birds or those restricted to Zoos. The analysis of population studies in European blackcaps evidences that ADCYAP1 gene is one of the major genes which regulate the expression of migratory behavior. It is instinctively known to young birds which way to go and how to adapt complex migratory patterns of movement as this knowledge is genetically imprinted some way or the other. Astronomical cues such as solar and stellar compasses in conjunction with the earth's magnetic compass provide aid of senses in migration and this is very well received by the eyes of migrant birds to overcome the long routes of journey. Ecological implications of migration include adequate exploitation of food resources in some regions, which won't be possible otherwise. Also, migrant birds favour regions having productivity that varies with seasons as in these regions there may be food surpluses. Anthropogenic actions pose serious threats to migratory birds and also the diverse developments (mostly commercial and deforestation) of the human habitats are the worst threats the birds face during migration.

**Keywords:** Birds, Flight, Hormones, Migration, Navigation

## 1. Introduction

The annual migration of millions of birds is one of the nature's most fascinating spectacles. Over the centuries, people have struggled to understand bird's migration and how they manage them year after year. How can they fly such tremendous distances without becoming lost or so exhausted that they die? How have today's complex migration patterns evolved from what were once presumably simple movements? How do birds know the right time to leave on migration, what their destination is and how to find their route and how do they manage to survive the journey of thousands of kilometers and the crossing of deserts and oceans? Although many parts of the mystery have been unraveled, there is still much that remains to be discovered about this fascinating phenomenon. As far as individual migrating species are concerned, they differ drastically in many aspects of migration, including how

far they travel, which route they choose, and their general migration strategy. The most fascinating aspects regarding bird migration covered in this review are the "Urge for migration" and "Genetics behind migration". The majority of migratory birds, namely songbirds and shore birds, migrate at night (nocturnal migration) alone, and without the guidance by parents or other experienced individuals. Nevertheless, they find their way and do arrive at their species-specific wintering range. These birds are also able to use 'compass mechanisms' for finding their ways and, not the least, to cope with the remarkable physiological requirements allowing them to fly nonstop for many hours. During the past decade, studies on avian migration have made substantial progress through both field work and experimental research. "A small bird pits its wits against the elements of nature, be it the enormous power of weather, an earthquake or a volcano and accomplishes, as routine a journey that is truly superhuman"<sup>1</sup>.

\*Author for correspondence

## 2. Genetics of Migration Process

The initial evolution of migration is easy to imagine: it is driven by the changing seasons. Northern summers are warm and winters cold, so a bird that thrives in warmer areas will benefit by moving South in winters. If it stays in the Northern hemisphere the weather will be less severe, and if it crosses the equator it can enjoy the Southern summer. There is likely to be an area to the south where the species could live year-round, but Northern breeders may be forced onward by competition from residents of same species. This results in a long migration to an area where the summers may be too hot to breed, but where winter conditions are ideal. Many other less immediate obvious factors have over geological time caused birds to alter their movement and influenced the evolution of new species. In the long term, 'Continental Drift' affected distribution and migration patterns. The most complex systems are those that have developed between Eurasia and Africa, while those between North and South America and between rest of Asia and India are simple. The long-term factor that has influenced migration most, however, has been the succession of ice-ages that have affected the world. The cycle of ice ages has pushed that habitat which suits a particular bird species backward and forward. This may affect both its summer and winter quarters, but for a long-distance migrant the effects are more noticeable in the northern, summer, breeding area.

*"Most young birds know instinctively, which way to go and how to find the way back"*

The true wonder of migration is that it is instinctively known to birds generation after generation and more often birds are able to undertake these complicated patterns of movement.

Each year some 50 billion birds take to the skies to migrate, an often grueling pilgrimage associated with changes in diet, physiology and behavior<sup>2</sup>. Evidences come from the European 'Blackcap' *Sylvia atricapilla*, a warbler that spends summer in Northern Europe but winters in warmer Southern Europe or Northern Africa, is typically active only during the day, but prepared to fly at night during migration. The captive bird's night time restlessness (*Zugunruhe*) as a proxy for migrating behavior in the wild has been noted in cages. It is suggested that blood samples for genetic signatures could account for variations in nocturnal migratory activity. An association between a microsatellite polymorphism and migratory behavior only has been found at one candidate locus, the ADCYAP1

gene. This polymorphism explains about 2.6% of the variation in migratory tendency among populations and 2.7% - 3.5% of variation in migratory restlessness among individuals within 2 independent populations. Longer alleles are associated with higher migratory activity. The consistency of results among different populations and levels of analysis suggest that ADCYAP1 gene is one of the major genes controlling the expression of migratory behavior. No nocturnal restlessness was found to be linked to the gene ADCYAP1. *"This gene may do more than simply encourage night time fidgeting; it encodes a protein called PACAP, which plays a major role in melatonin secretion, energy metabolism and feeding. These functions are crucial for preparing birds for long flights"*<sup>3</sup>.

## 3. What Triggers Migration?

For centuries, people who have kept caged birds have noticed that the migratory species go through a period of restlessness each spring and fall, repeatedly fluttering towards one side of the cage. German behavioral scientists gave this particular behavior the name "*ZUGUNRUHE*" meaning 'Migratory Restlessness'. Different species of birds, and even segments of the population within the same species, may follow different migratory patterns.

"There is more than one single reason for different birds to migrate but it all come down to survival, not just for each individual bird, but also for the families they hope to raise".

The mechanisms initiating migratory behavior vary and are not always completely understood. Migration can be triggered by a combination of changes in day length, lower temperatures, changes in food supply and genetic predisposition.

## 4. Orientation and Navigation

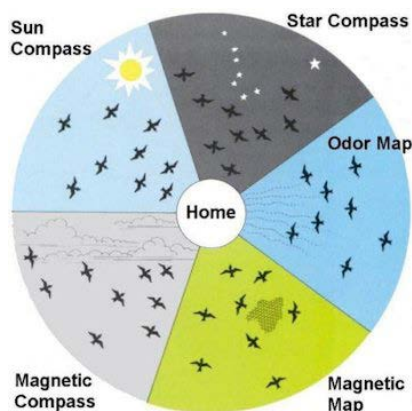
Migration generally takes place on a broad front, although many natural features funnel or guide orientations of the migrant birds. Such features, known as leading lines, may be in addition to provide them with clues to navigation. Many leading lines are also excellent places to observe migrants. Navigation is the art of getting to the destination. This generally means that a migrating bird has to know when it has arrived at its destination (mostly breeding), which is easier if the migrant birds has done it all before.

For many birds, simply flying in the right direction for the correct length of time should be good enough to

get from one place to another. This all sums up together with the recognition of suitable habitat and is enough for a small bird with a fairly extensive wintering area to accomplish its 'outward' migration.

The 'return journey' is more crucial but here too birds are looking for a large area with which they are familiar and, after they have bred, they almost certainly have a real target to aim for<sup>4</sup>. Most birds have ability to navigate to within about 6-12 miles of their goal, after which they use landmarks to reach their precise destination. "The eyes of migrant bird" receive major navigational clues from the stars at night and the sun by day. They also allow it to note landmarks so that the bird can orient itself and recognize specific features, once it has returned to a specific area which is familiar.

There are 3 main means – all compasses- (i) the sun compass; (ii) the stars compass; and (iii) the magnetic compass, by which birds detect the absolute NEWS i.e., North, East, West and South.



**Figure 1.** Aid of senses in migration. ("The Eye of migrant bird". From: <https://www.nationalgeographic.org/media/how-do-birds-navigate/>)

Solar and stellar compasses are sometimes lumped under the name of astronomical cues, as both of them are the base on the apparent rotation of the celestial bodies and of visual system of birds. They are contested with the magnetic compass which is based on radically different principles and utilizes an own sensory system.

The redundancy of information provided by compass systems apparently demands a hierarchy and integration rules. It has been many times shown that even though the magnetic compass is believed to be innate, its successful use during migration in many bird species depends on ability to observe celestial rotation<sup>5</sup>.

## 5. Hormonal Basis of Migration

Although birds have frequently been subjects of research, surprisingly there is less information about hormonal regulation and thereby the underlying endocrine mechanisms of their migratory nature. There have been numerous case studies on vernal and autumnal migration suggesting the occurrence of former one in periods of gonadal development and increasing levels of reproductive hormones and the latter one occurring after the reproductive (breeding) period when gonads undergo inactive state and the level of circulating reproductive hormones is quite basal<sup>6</sup>.

In birds, the earliest theories implicated the role of gonadal hormones as causative agents but recent studies have revealed that prolactin, adrenal steroids, thyroid hormones, gonadotropins and gonadal steroids can all influence migration. There were studies which examined the role of prolactin in migratory restlessness (*Zugunruhe*) and its role in fat deposition that are required for prolonged migratory flight. Studies on the effect of prolactin alone and in combination with other hormones, specifically adrenal steroids, concluded that both are critical for migration. In other experimental studies, thyroidectomy was performed on some migrant birds captured on their wintering areas, which reduced *Zugunruhe* and pre-migratory fattening. Further, restoration of  $T_3$  and  $T_4$  hormones restored the fattening and locomotory activity as well. Studies on warblers<sup>7</sup> recognized the role of Ghrelin as a hormone tied to both appetite and migration. Those birds that were given boosted doses of Ghrelin ate less and also displayed migratory restlessness.

Studies by Weise<sup>8</sup> on male white throated sparrows investigating gonadectomy revealed that castration

under critical photorefractory periods of autumn caused reduction in migratory behavior and premigratory fattening in the spring. It was suggested that the effect of gonadectomy might be indirect due to disturbance of the normal pituitary gonadotrophin negative feedback loop and a consequent overproduction of LH that would lead to diminished production of Prolactin<sup>9</sup>.

Never the less, it is important to note here that there exist significant variations across species in the actual pronounced effects of specific hormones on their migratory behavior and physiology of birds of different zones, temperate or tropical.

## 6. Conclusion

'Migration of birds' is the primary mode of locomotion used by most bird species for survival of their specific species. Most importantly flight assists birds while feeding, breeding and avoiding predators while migrating.

There are many ecological implications of migration. The food resources of some regions would not be adequately exploited without moving of the populations. The sequence of migratory movement of almost all birds is closely integrated within the annual cycle of ecosystems characterized by productivity fluctuations. Migrant birds interestingly avoid equatorial forests where productivity is constant throughout the year, and food surpluses do not occur. They do congregate, on the other hand, in Savannas where productivity varies with seasons.

Many bird species migrate in order to survive. However, migration is a perilous journey and involves a wide range of threats. Only a small number of birds are actually threatened by natural events. Sad but true, human activities such as industries releasing polluted fumes at height and deforestations are the most dangers hurdles for migrating birds.

In 2006, the United Nations established "World Migratory Bird Day" to be held on the second weekend of May every year. The event was founded as an effort to raise awareness of migratory linkages between regions of the Globe.

*"There is symbolic as well as actual beauty in the migration of birds. There is something infinitely healing in*

*the repeated refrains of nature-the assurance that dawn comes after night and spring after winters". Rachel Carson*

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