Migrations of European bird populations

Gene-Coded Addresses

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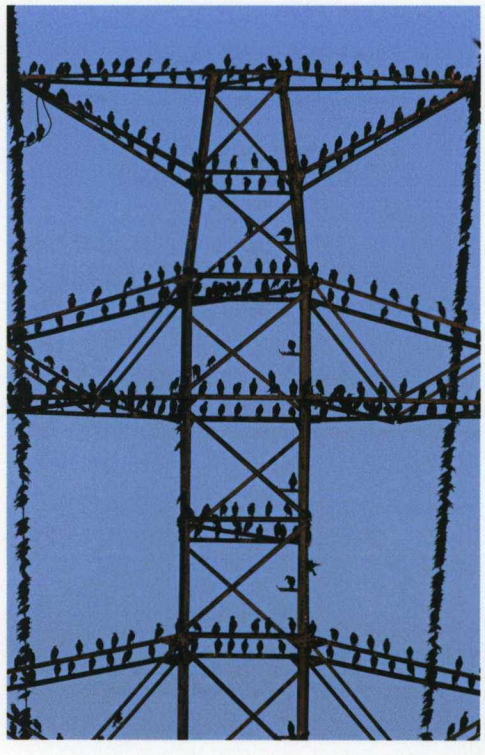
In certain bird species the memory of migration routes is retained through traditions passed on from one generation to the next, while in others it is gene-encoded and inherited within specific populations

The phenomenon of seasonal migrations (not just of birds) appears on the globe wherever living conditions change periodically over the course of the year, and a strategy of changing location yields more benefits than staying put. It therefore seems simple to explain the sense of migrating, as stemming from a kind of balance of gains and losses, since migration always involves a certain risk. Birds go to incredible effort, crossing such barriers as deserts, seas, and mountains, and in exchange they gain the ability to survive periods when the food base in their nesting area is greatly limited or simply inaccessible. But the question remains: what determines the choice and length of route? If it were up to individual specimens to decide where to spend the winter, they would likely be guided by the quantity of food present. Yet having a rich food base in autumn is not necessarily a guarantee of surviving the winter. Thus a much more effective mechanism is to repeat migration routes that were previously traveled by ancestors.

Bird education

How do birds know where to fly? Older specimens already have experience because they have been to the wintering grounds and back, and can therefore follow guidelines they have cast to memory. But for young birds the situation is somewhat more complex. Certain birds, such as cranes or geese, stick together in family groups in the post-breeding stage, enabling young birds to travel on their first migration under the guidance of adults. This is a kind of education which young birds undergo, a way for traditions to be passed on from one generation to another. Yet this is quite a rare situation in the bird world, as it is significantly more common for route information to be recorded genetically. Research by German scientists on the behavior of migratory passerines has shown that young birds possess an encoded migratory program comprised of two components: the direction of migration and the duration of the journey.

Inexperienced birds, setting out on their very first migration, are in fact flying off into the unknown, "knowing" only which direction to head in and when to change that direction. But after they have been through their first migration they have a much broader store of information, which they are able to use. Other experiments, carried out on starlings captured while on migration in the Netherlands and then taken



Michał Jończyk, www.jonieznaturalnie.com

Just a stop along the way? A flock of common starling (*Sturnus vulgaris*) resting on an electricity tower

Piotr Jonczyk, www.joniecnaturalnie.com

A crested tit (*Parus cristetus*) takes flight. These birds are usually resident (non-migratory), yet sometimes migrate short distances, huddling in flocks

to Switzerland, have shown that young birds continued to head southwest after being released, ultimately reaching areas which were not their population's normal winter habitat. Adult birds, on the other hand, quickly realized they had been transported and adjusted the direction of their migration, eventually ending up at habitats familiar to them from previous winters. Independently of their genetically encoded route, therefore, the adult birds remembered the spatial location of their wintering grounds.

Sometimes young birds on their very first migration gather information about areas "closer to home" where they might also spend the winter. Apart from the primal winter habitats for young birds, this may lead to the appearance of secondary, closer areas for experienced adult birds who know that further migration is not actually necessary. This mechanism was reported in the late 1960s and early 1970s for rooks spending the winter in Europe. But what is this "primal" target of migration, whose "address" is encoded in the direction-plus-duration program passed down from generation to generation?

Ancestors' history

During the last glacial period, the breeding grounds of the bird species common in Europe today were limited to just the southern edges of Europe, chiefly encompassing the main peninsulas (the Iberian, Apennine, and Balkan), a range of islands in the Mediterranean (which were considerably larger then due to lower water levels), and the North African coast. Being pushed into such refugia caused their nesting ranges to fragment, leading to gene pool division. If such isolation had lasted longer, it would likely have given rise to new subspecies or even species. But that did not happen because the glaciers began to recede. As vegetation capable of supporting breeding began to appear in areas freed up by the ice, would birds colonize lands lying further and further northward.

Depending on their habitat and feeding requirements, various species linked to deciduous forests, such as small insectivorous warblers, survived the ice age in refugia far to the south and only colonized Europe slowly, while the birds of the tundra, such as the Charadriiformes, did not get pushed as far south and colonized new areas just behind the receding ice. For these birds, southerly nesting areas from the glacial period disappeared as new ones emerged in the north. With the arrival of autumn each year, the shortening day triggers a mecha-

nism in birds urging them to return to the safe refugia where their ancestors survived the glacial period. The geographical fragmentation of nesting ranges thousands of years ago caused birds to colonize Europe from different directions. Even though their nesting range now encompasses all of Europe and is no longer divided, the history of their ancestors makes itself felt in the autumn, when various migratory populations choose different migration directions and head for different winter habitats. Each year, birds "reenact" the ancient history of being driven into refugia and then recolonizing northern nesting areas. This is a kind of evolutionary memory stored not in the brains of individual birds, but in the gene pool of populations.

The blackcap (*Sylvia atricapilla*), a common bird of deciduous forests, has developed a complex system of migratory behaviors over thousands of years

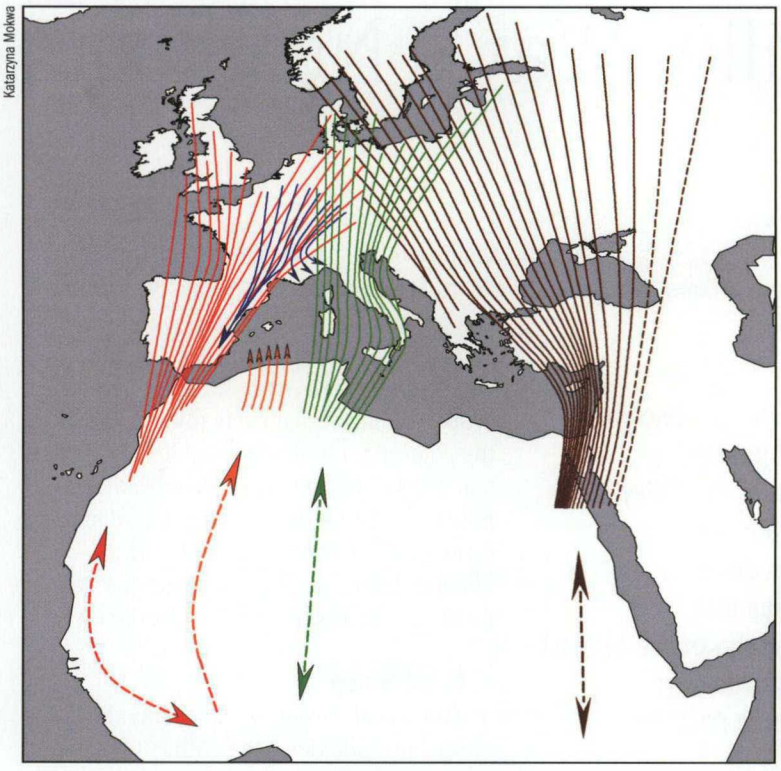
Tomasz Mokwa

Blackcaps on the move

One interesting example of a species that has developed a very complex system of migratory behaviors over thousands of years is the blackcap, *Sylvia atricapilla*, a common bird inhabiting deciduous forests, shrubs, and parks. An overall glance at the relative position of the species' nesting and wintering grounds gives one the impression of a jigsaw puzzle, with individual elements forming a complex system of migration paths. The nesting range encompasses all of Europe except for the northern extremes of Scandinavia and stretches east to Western Siberia, ending in Asia in the northwestern edge of Altai. The blackcap's wintering grounds are divided into some areas in the Mediterranean and others south of the Sahara, the latter further divided into areas in West Central Africa and East Central Africa.

Back in the 1970s, German researchers studying the migration routes of blackcaps nesting in Central Europe concluded that their destinations ranged broadly from the southwest across the south to the southeast. This complex picture did not appeal to the order-loving German scientists, so they attempted to artificially subdivide the blackcap nesting grounds into areas of birds migrating in different directions. But this was to no avail. Our understanding of blackcap migrations began to become clearer only with a shift in perspective, when the old research question (where do "our" birds go for the winter?) was replaced with a new one (where do the birds wintering in specific areas go to nest?). This new question was consistent with the concept of refugia, from which the colonization of Europe began.

In the 1980s, starting from wintering areas and utilizing ring recovery data (repeat sightings of ringed birds), three migratory populations were distinguished: Western, Apennine, and Balkan. It turns out that the nesting ranges of populations which migrate along different routes may overlap. Research the present author carried out in recent years using much broader data from most countries on the European continent plus Great Britain has added more detail to our picture of the distribution of blackcap migra-



The migration paths of the blackcap. Migratory populations are not defined by nesting site, but by the wintering grounds the birds head for

tory populations. At the same time, analysis of the timing of birds' movement into various regions of their of winter range has shed some light on the migratory strategies of the individual populations.

The latest data suggest there are actually four migratory populations of blackcaps nesting in Europe: Western, Mediterranean, Apennine, and Eastern. Their nesting ranges in large part overlap. For the Western population, a very interesting "loop migration" phenomenon has been reported. The birds in this population migrate along the Atlantic coast in the autumn. Some of them winter in the Iberian Peninsula and Morocco, others migrate to West Central Africa. In the spring, part of the population wintering in West Africa shortens its return journey by returning not along the Atlantic coast, but over the Sahara, via Algeria. Also interesting is the poorly studied Eastern population. It is mainly composed of long-distance birds which nest eastwards of Poland and Scandinavia, all the way to the Urals, but winter in East Africa.

North or South?

Under free breeding conditions it is hard to imagine how it is possible for genetic differentiation (where gene expression manifests itself in the choice of migration path) to be preserved for hundreds and even thousands of years. What is it that constitutes a "population," therefore, if not a group of specimens inhabiting the same area? Blackcaps freely interbreed throughout their entire nesting range. It often occurs that a male just back from Spain nests with a female who spent the winter in Italy (or vice versa). Where will their young migrate to? Probably some here, some there. It is not yet clear what determines which "program" will manifest itself, bit it is with all certainty not a simple model, and inheriting too complex a directional program could have side effects in the form of navigation errors. It is no chance coincidence that the blackcap is the species exhibiting the highest percentage of young birds migrating north in the autumn, rather than south. But that is another story... ■

Further reading:

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