Letter from the Desk of David Challinor
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Until WWII, Long Island Sound was filled with sea ducks in midwinter. Great rafts, mostly of scaup, often stretched for half-a-mile; at low tide the ducks would come close to shore to feed on sea lettuce, a leafy green algae. The flocks were mixed—scoter, golden-eye, ring-necked and old squaw. The rafts are gone, and I can only assume these migrants are wintering farther northeast along the coast. Bottle-nosed dolphins have also left the Sound's western end, but now in winter harbor seals are common in these waters after an absence of almost a century. Ducks and marine mammals are but two examples of the ability of a wide spectrum of migratory animals that, for various reasons, rapidly alter (in an evolutionary sense) their breeding and wintering ranges. This month's letter will consider why animals migrate and the resulting costs and benefits to them for doing so. The phenomenon is so widespread that within virtually every mobile animal population, individuals travel in recognizable patterns from daily to annual intervals.

Migration is an evolutionary development that enables mobile animals to adapt to fluctuating resources. Examples include the vast migrations of ungulates in the Maasai-Mara plains of East Africa. The herds of wildebeest, zebra and antelope migrate along traditional routes to seek new growth of forage with the start of each rainy season. The browsers and grazers move continuously to consume vegetation at different successional stages of renewed growth triggered by the rain. Such movements are classified as loop migrations because they follow routes that have been fixed for millennia. However, conditions are never stable due to climate changes and human barriers, such as fences and highways, that block traditional routes. For terrestrial animals, therefore, some flexibility is essential for survival. The endless bison herds of pre-European settlement of North America, now drastically reduced, are confined to National Parks and private ranches where their movement is limited, but their survival is assured by human intervention: they are furnished adequate food and water.

Human-constructed barriers to marine mammal migrations are rare; once harvesting of such creatures ceased or was at least controlled, most populations rebounded. The north Pacific and north Atlantic humpback whales now support a booming whale-watch industry, yet the same cannot be said of the north Atlantic right whale whose migration from coastal Georgia to Nova Scotia is beset with ship collisions—to the degree that it seriously threatens their survival. What keeps them from avoiding an approaching vessel? Scientists do not know yet. Meanwhile, the Coast Guard plots the movement of coastal right whale pods to alert large ships of their presence. The regular movements of both these species of north Atlantic whales are true migrations from southern waters for winter breeding and calving to nutritious northern ones for feeding—they are not mere wanderings.

There is a distinction between migration and dispersal. The north Pacific elephant seal illustrates both. After being exploited for their oil in the XIX century, remnant survivors retreated to California's Channel Islands. There, with full protection, their population expanded rapidly until the insular breeding breaches were saturated. By the mid-XX century, breeding harems first occupied mainland beaches at Año Nuevo, at the north end of Monterey Bay. From there, they dispersed north and south along the coast. Quite apart from this dispersal, the seals continued to leave for their principal foraging grounds in the Alaskan gulf—2,000 miles away—and return twice yearly, once to moult and again to breed. In fact, tracking devices on large males indicate that they travel farther vertically than horizontally because of their continuous feeding on deep-dwelling fish during migration.

One-way migration occurs when populations, generally of insects and some marine larvae, travel from where they hatched to another location where they produce the next generation. Eventually, after enough generations, they may end up where they started. Such passive movement of marine larvae is called drift migration because oceanic currents determine their disposition just as wind force and direction do so for insect larvae. Spruce budworm infestations, for example, spread from one infected region in the Rockies to new areas; early instar larvae exude a long spiderweb-like filament, which acts as a parachute to keep them airborne in windy conditions. Without wind, they would develop where the previous generation had already consumed their principal food—spruce buds and young needles.

A relatively rare form of migration is that caused by massive irruptions of a heretofore modest population. These movements are irregular and result from rather narrow weather conditions. The two best-known examples of this kind of population movement are the red-billed quelea (*Quelea quelea*) and the desert locust (*Schistocerca gregaria*), both of which are major African agricultural pests.

Although queleas sometimes return to their original breeding or roosting territories, their annual migrations are controlled by local rain distribution during each wet season. These sociable, monogamous birds breed in colonies, the largest of which may exceed 25 square miles and contain as many as 10 million nests. Before leaving their breeding grounds, after their young are fledged, quelea lay down fat reserves to sustain their migration flight. After flying over what seem to be appropriate grain fields, with seed maturing rapidly after a local rain, they finally swarm down on the fields of luckless farmers and consume the entire potential harvest. The birds are fought with everything from toxic sprays to flame throwers, but they are so ubiquitous that in the end the quelea survive and conquer. If conditions are exceptionally favorable for breeding, quelea can raise three clutches in a season. It is no wonder they have population irruptions.

Desert locusts also irrupt. Generally, they behave similarly to most grasshoppers and go unnoticed. However, whenever their numbers increase to a certain critical concentration, their behavior and even their color changes. The adults start to swarm and instead of flying just by night as they do normally, they migrate in broad daylight. Swarms fly downwind and are carried by converging air currents to areas wetted by recent rains. The newly sprouting vegetation is green enough for them to eat and the soil moist enough for the females to deposit their eggs. Desert locusts range from the western Sahel near the Atlantic to India, and swarms originating in Saudi Arabia exhibit an astonishing behavior. The swarm, which normally flies southwest to Sudan, actually waits on the ground for the rare summer days when the prevailing northeasterlies shift easterly enough to carry them over the Red Sea. This incredible adaptation to changing wind direction and rainfall patterns ensures the evolutionary survival of desert locusts even as global climate undergoes rapid change. They are such a serious agricultural pest that scientists have been studying them for decades to understand the clues that trigger them to swarm, many of which are still unknown.

In contrast to the flexibility of desert locusts, some of the northern hemisphere's migrant bird species are already confronting food problems connected with current rapid climate change. The European pied flycatcher (*Ficedula hypoleuca*) still breeds in northern Europe after migration from West Africa at the same time as it has always done. Their insect prey population, however, has already adapted to global warming by developing earlier breeding cycles; thus the timing for feeding the fledging flycatchers is out of sync with the availability of the prey population. This asynchrony results in lower nestling survival that in turn has led to a marked decline in flycatcher populations.

Why migrate in the first place? The answer seems to be that it is genetically linked behavior and probably evolved to exploit short-term but abundant food sources. An example is the vast congregation of waterfowl that gather to breed on the tundra of the northern hemisphere. With continuous daylight, forage plants and insects are superabundant to nourish the young. Such a plethora of food has a cost, however, because the birds have to time their nesting to occur after the last freezing spell, but not so late that their broods have inadequate time to fledge and store the necessary fat reserves for their flight south to winter quarters.

The urge to migrate is not always strongly hard-wired. Canada geese, for example, when I was young, all flew north in the early spring. Today, however, humans have so drastically altered the landscape with lawns and golf courses—all heavily fertilized and regularly mowed to be an ideal food source for grazing geese—that many flocks have ceased to migrate. A bountiful year-round food source, therefore, is evidently sufficient to override the genetically induced urge within these geese to migrate. If this sedentary population ever increases to the level of saturating all lawns and golf courses, then that latent urge to migrate might reappear.

Migratory behavior is complicated and varies within and between species. Trumpeter swans and whooping cranes must follow parents to "learn" migration routes, and young of both species have done so by following human-piloted ultralight planes. At the other extreme is a parasitic cuckoo in New Zealand that migrates north to the Solomon Islands during the austral fall. The first-year cuckoos accomplish this flight even when raised by non-migratory foster parents. Their genetically imprinted celestial navigation system is therefore incredibly hard-wired.

It is unlikely we will ever solve all the mysteries of migration, but the phenomenon is so fascinating that scientists keep probing. Developing technologies in tagging migrants now allow us to follow precise routes and gather new information. In the process, we have also realized the barriers humans created to thwart these carefully evolved migrations. In the case of salmon, remedial steps have been taken: removing dams and altering lighting of towers and tall buildings during bird migrations. These examples are but the first steps to end or at least mitigate what humans have wrought.

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