THERMAL SOARING BY MIGRATING STARLINGS

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LARGE numbers of migrating Starlings (*Sturnus vulgaris vulgaris*) pass the vicinity of Yorktown, Virginia each year during September and October. These birds usually travel in small compact groups of some 20 to 50 individuals, although some large flocks occasionally contain upwards of 300 birds. Their southward progress is punctuated by frequent rest stops in the tops of large trees along the way, and their presence is always accented by a loud, incessant chattering.

On the morning of 23 October 1964 the weather at Yorktown was particularly clear, with cool air temperatures and bright sunshine, and large numbers of Starlings were observed moving southward aided by a fresh tail wind from the north. The presence of considerable thermal activity in the atmosphere was indicated by the strong and continuous soaring of numerous gulls in the area. At approximately 10:30 AM, a single hawk (tentatively identified as an Osprey, *Pandion haliaetus*) was observed to the north at an estimated altitude of about 500 feet, performing the continuous circling flight characteristic of thermal soaring (Cone, 1962*a*). In the immediate vicinity of the hawk and just above it was a flock of approximately 40 Starlings, wheeling with great individual precision as a tightly compacted group around an orbit almost identical in size to that of the hawk. This intimately close circling of hawk and Starlings was observed continuously for some 10 minutes or longer until the birds, still circling, drifted out of sight over some tree tops to the south.

I had observed and made notes on this rather unusual phenomenon on several occasions in previous years, but my observations at those times had been rather casual and of short duration, and I had tentatively surmised that the Starlings' behavior was in the nature of a harassment action, or else intended as a defensive maneuver designed to confuse the hawk and thus discourage any predatory intentions it might have. During my most recent observations, however, the birds were visible at close range for a considerable period of time and I was able to examine their behavior in detail. I was greatly surprised to find that, contrary to my previous conclusions as to the purpose of the Starlings' actions, these birds were making no aggressive or evasive maneuvers whatsoever, but instead were keeping a fairly constant distance above the hawk. Likewise, the hawk did not exhibit the slightest interest in the Starlings, as the group wheeled without flapping just above it. It appeared that neither the hawk nor the Starlings

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was in any way disturbed by the presence of the other. Suddenly it became quite clear that the Starlings were, in reality, performing thermal soaring flight, and that they were apparently using the hawk as a continuous guide or indicator to mark the center of the thermal updraft for them.

The fact that the Starlings were performing thermal soaring was inescapable. The existence of strong thermal convections sufficient to support soaring flight was clearly indicated by the numerous gulls soaring at the time, as well as by the soaring hawk. That the Starlings were actually in an updraft region during the entire period of observation was clear from their proximity to the hawk, which in turn was gaining altitude as it circled on outstretched wings, a feat quite impossible without the presence of an ascending air flow (Cone, 1961; 1962*a*, *b*; 1964). As the Starlings remained at all times slightly above the hawk's level (and were thus also gaining altitude), and as they accomplished this on "motionless" (i.e., nonflapping) wings, it inescapably follows that the Starlings were indeed performing thermal soaring. As the circling hawk and Starling group drifted to the south, each generated the typical trochoidal space curve characteristic of thermal soaring flight in the presence of wind (Cone, 1961; 1962*b*). The circling orbit of the Starling group, however, was not quite so smooth or regular as that of the hawk, but rather was attained by a succession of somewhat abrupt changes in the group's direction of motion so as to follow an approximately circular trajectory.

The conclusion that the Starlings were apparently using the hawk to mark the location of the thermal is based upon the fact that in no other instance has a flock of Starlings ever been observed performing such orbiting maneuvers solely by itself. At the time of the above cited observation, many other small groups of Starlings in the vicinity were progressing southward in their usual manner by vigorous flapping flight. As noted above, the rather imperfect manner in which the Starling group generated its circling orbit strongly suggests that the group was attaining the proper orbit purely by monitoring and duplicating that of the hawk, and not by an independent guidance maneuver of its own. This inference is further supported by the fact that although numerous soaring gulls were present and many other groups of Starlings, no similar association as in the case of the hawk was observed. The gulls nearly always soar in groups and circle with much greater speed than do the hawks, which have lower effective wing loadings (Cone, 1964). Thus as might be expected from the aerodynamic requirements for thermal soaring, the Starling group apparently needs a *single* guide bird whose soaring orbit can be simultaneously monitored by all members of the group, as well as one whose flight speed is slow enough that its motion can be duplicated with adequate accuracy by the group.

Starlings, by structure and habit, do not seem to be well adapted for soaring flight, and it is only natural that they would need a guide with rather special soaring characteristics to enable them to locate and navigate thermal currents properly for successful soaring. As the Starlings must remain above the guide to monitor its orbit, the aerodynamic properties of the two birds must be closely compatible; otherwise one would soon outclimb the other (Cone, 1961). On the basis of observations made, a *group* of Starlings apparently has a minimum aerodynamic sinking speed (Cone, 1961) at least as low as that of the hawk; otherwise the Starlings would have to perform some amount of flapping flight to remain above the hawk. It is of interest to note that the only time of the year at which the soaring of Starlings has been observed has been during the fall migrations. In every observation I have recorded, the "guide" bird was a slowly circling hawk and the wind was blowing in a southerly direction. On the basis of the limited observations available, it would thus appear that Starlings "soar" primarily in the fall and that they exhibit a particular preference for hawks as their "guides."

In view of the apparent uniqueness and rarity of soaring by Starlings, one is naturally led to inquire if the phenomenon might possibly have some rational purpose or usefulness. Although such soaring seems to occur so infrequently as to be insignificant as a generally useful means of Starling locomotion, it does have a number of inherently beneficial features that would be especially valuable during migration. As previously mentioned, the southward progress of Starlings is punctuated by frequent rest stops which are apparently necessitated by the rigors of sustained flapping flight. Such stops of course delay the progress and rate of migration. By engaging in thermal soaring of the type observed, a Starling group does not have to actually stop to rest, but can "rest on the wing," so to speak. While circling in the thermal current, no energy output is required of the birds and they can "rest" from the exertion of flapping while simultaneously drifting southward with the wind. Thus southward progress is made even while the birds are "resting." As the birds do not have to stop, they are able to preserve kinetic and potential energies that they would otherwise waste upon alighting, and would have to resupply from their internal energy when they took off again. Also, in view of the natural variation of wind speed with altitude (Cone, 1964), possibly the circling Starlings could "drift" southward at a high altitude as fast as a group of flapping birds flying at a low altitude.

Of equal importance is the potential energy gained as the birds rise in the thermal. Upon leaving the thermal at a high altitude, the birds can continue on their way in flapping flight. Here they can take maximum advantage of the higher tail wind velocities afforded by their higher altitude within the earth boundary layer to increase their ground speed. Then when a subsequent rest period is needed, the birds can go into an extended glide on outstretched wings. The flock loses altitude continuously while thus gliding, but during this period the birds can again effectively "rest on the wing" while simultaneously making progress southward. Alternately the potential energy gained in the thermal can be used to lessen the power output required for flapping flight by a slow but continuous loss of altitude as the birds progress. Regardless of just how the energy is utilized in a particular case, it appears that thermal soaring under proper wind conditions can offer the Starlings the double advantage of increasing their average speed of migration (as fewer actual stops are needed and their effective tail wind is greater at altitude) while simultaneously providing valuable free energy for powering the migration flight.

Many species of birds make valuable use of thermal soaring during their migration flights, particularly the herons, cranes, ibises, gulls, and pelicans, as well as the hawks and vultures. These birds, however, are all well adapted for efficient utilization of this mode of flight. Starlings, on the other hand, appear to be somewhat unique in their attempt, as a species predominantly adapted to flapping flight, to utilize the free energy of thermal convections when migrating. In a few rare instances I have observed Chimney Swifts (*Chaetura pelagica*) soaring on outstretched wings in thermals in the company of soaring gulls. I have also observed monarch butterflies (*Danaus plexippus*) in fall migrations making continuous use of thermal soaring; their soaring methods and travel mechanics are identical in every respect to those of the vulture and hawk.

The general usefulness of thermal soaring to migrating Starlings, even in the presence of adequately strong thermals, is apparently limited by two rather strict requirements that must be satisfied simultaneously: first, a suitable "guide" bird must be available for the group to follow, and secondly the wind must be in the desired travel direction. This helps explain the apparent preference for a hawk as a guide bird, the hawk is also probably migrating and is thus trying to move southward in the most efficient manner. The difficulty of finding conditions that meet these requirements simultaneously probably explains why the phenomenon of Starling soaring is so rarely observed, despite the large numbers of flocks seen during the fall migration.

From a purely mechanical standpoint, no reason exists why conditions enabling the Starling to soar should not occur during the spring migration, but to date I have recorded no such observations. Possibly basic differences in the travel speeds and drives of Starlings in the fall and spring migrations as well as differing thermal and wind conditions are influencing factors.

Starling migration has developed in this country since the turn of the century (Thomas, 1934). It would be highly interesting to learn if the phenomenon of Starling soaring also occurs during migration or travels of the European birds (and hence is a habit of long-standing practice), or whether it is a "newly developed" trait peculiar to the American population. A review of the literature reveals no other records of it.

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