is directly compensated for by an increase in overall heat production.

SUMMARY

At temperatures between 0°C and 20°C, heat loss from the feet of Mallards was minimal (0.42 kcal hr^{-1}). In this temperature range, the metabolic heat production increased with declining temperature by 0.22 kcal hr^{-1} $°C^{-1}$. Below 0°C, however, heat loss from the feet and metabolic heat production both increased substantially. The further increase in heat production (0.22 kcal hr^{-1} $°C^{-1}$) was approximately equal to the increase in heat loss from the feet (0.27 kcal hr^{-1} $°C^{-1}$).

The observed increase in blood flow to the feet apparently serves to keep their temperatures above freezing and to prevent freezing damage to the tissues.

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INVERTED FLIGHT IN CANADA GEESE

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Canada Geese (*Branta canadensis*) are not usually associated with aerobatic flight, but during the filming of a large flock of geese (*B. c. canadensis*) landing on a field near the Bombay Hook National Wildlife Refuge, Delaware, in the winter of 1973, we recorded a series of spectacular flight maneuvers, some of which resulted in the birds flapping their wings while flying upside down. We filmed the same behavior on other occasions, and under different circumstances, and here report the results of an analysis of some properties of the behavior.

Films were taken on three separate occasions in 1973, using both Super-8 and 16mm cine equipment, and taken at various frame rates from 18 frames/second to 48 frames/second.

The first films were fortuitous. We were taking pictures of geese flying in Vee formation in connection with studies of formation flight (Gould and Heppner, Auk 91:494–506, 1974), and had a few feet of film left on a roll. We decided to shoot the rest of the roll on a flock of birds coming in for a landing, to clear the camera for a fresh roll of film. In landing, the birds flew as described below, in a way we had not seen on three previous field trips to Delaware (a reviewer has informed us that the behavior is common in geese in the midwest, but we have seen it in no more than 10% of the landing flocks we have seen in Delaware and Rhode Island). We subsequently filmed more landing flocks to obtain additional pictures of the maneuvers from different viewpoints. The geese were filmed from directly below, as they came toward the camera, as they flew away from the camera, and from the side. The only consistent meteorological variable on the days we filmed the behavior was gusty winds, although we have since seen the behavior on still days.

As working nomenclature, we have called the behavior "dumping," because it gives the visual impression that the birds are dumping, or spilling air from their wings, as a parachutist pulls his shrouds to change direction, or increase his rate of altitude loss.

Processed films were analyzed by projecting one frame at a time on a graph paper screen. Counts were taken of: 1) the number of birds in a landing flock, 2) the fraction of birds "dumping" ("dumping" defined as a 90° or greater bank) in a flock, 3) the duration in seconds of the "dumping" behavior, calculated from a wings-level position to return to wings level, 4) the fraction of "dumping" maneuvers involving some period of completely inverted flight, 5) the duration of inverted flight, 6) the number of maneuvers showing a 360° roll, and 7) the number of "dumping" maneuvers that showed a flap of the wings.

Measurements were also made of 8) the fraction of "dumping" maneuvers filmed in which a neighboring bird could also be seen displaying "dumping" behavior, 9) the mean number of birds that could be seen displaying a "dumping" maneuver at any one time, 10) the mean gain or loss in altitude of a maneuvering bird relative to the nearest neighbor in a normal attitude, measured in 1 mm "squares" on the graph paper screen, and 11) the mean period in seconds between the time the first and the last bird displaying "dumping" behavior could be seen in a landing flock.

FIGURE 1. A "dumping" maneuver in Canada Geese (enlarged from 16mm film).

Figure 1 shows a representative landing flock with birds displaying "dumping" maneuvers. Table 1 summarizes the results of the film analysis. A statistical analysis (table 1) of "dumping" (figure 1) in Canada Geese revealed that 87% of the "dumping" birds lost altitude, in some cases at a rapid rate. The maneuver itself is performed rapidly (0.56 sec), and some birds will repeat a "dumping" maneuver after a period of normal flight. Films taken in 1974 suggest that there is some lateral movement during a "dumping"

TABLE 1. "Dumping" maneuvers in landing Canada Goose flocks.

	No.	Mean	S.D.	%
1. Landing flocks studied	16			
2. "Dumping" maneuvers seen	173			
3. Birds in flock at start of filming		29.00	24.60	
4. Birds "dumping" in flock		10.38	7.98	
5. Percentage of birds "dumping"				
A. Percentage of all birds filmed				36.01
B. Mean of percentages of flocks		53.77	33.96	
6. Duration of total maneuver (sec)		0.56	0.22	
7. Maneuvers showing inverted flight	23			13.29
8. Duration of inverted flight (sec)		0.13	0.07	
9. Maneuvers showing 360° roll	0.0			
10. Maneuvers showing wing flaps	44			25.43
11. Maneuvers showing other birds simultaneously "dumping"	150			86.71
12. No. of other birds simultaneously maneuvering		2.61	1.32	
13. Change in altitude of maneuvering bird ("squares")		–2.53	3.41	
14. Percentage of maneuvering birds gaining altitude				12.72
15. Time first to last maneuver (sec)		4.23	1.91	

maneuver. It is not common to see a single bird performing a "dumping" maneuver in a landing flock. Item 5 (table 1) shows that the grand mean fraction of "dumping" birds, of all birds filmed, is 36%, but the mean of percentages of "dumping" birds in each flock was 54%. Since the latter is a weighted figure reflecting a difference in the size of the flocks filmed, this difference in means signifies that the proportion of birds displaying "dumping" behavior is greater in smaller flocks than in larger flocks.

Among the possible functions of this "dumping" flight, testable through future observations, are the following:

1. The birds are sideslipping, or flying inverted to lose altitude, to avoid overshooting a landing point. Leopold (A Sand County almanac, Oxford Univ. Press, New York, 1949) offered this view. Whereas it is true that our data suggest that birds performing "dumping" maneuvers do usually lose altitude relative to other birds, the significant fraction which gain altitude must be accounted for.

2. The birds are being upset, or bounced by strong local gusts. But the films suggest that the birds initiate the movement by folding the wing on the side toward which the bird will roll.

3. The birds are performing these maneuvers to adjust their position in the flock laterally. The films indicate there is some lateral movement during "dumping" maneuvers, but there are other, easier ways to shift laterally, such as using the trailing edges of the wings as ailerons.

4. The incoming birds are conveying some type of information to birds on the ground, analogous to the "waggle" dance of bees. The information might be about location of good feeding sites. We have seen birds displaying "dumping" maneuvers at all times of the day, including just before sunset, when the birds were coming in for the night.

5. The incoming birds might be requesting information, by means of a wing signal, from birds on the ground or water. In particular, some response from birds on the ground suggesting that they are not decoys. If this were the case, "dumping" would have had to evolve since men started using decoys. It might be possible to examine very old hunting stories to see if there was mention of the behavior a hundred or more years ago. We have seen the behavior demonstrated only when other birds are on the ground or water. It might be possible to test this hypothesis by simultaneously filming landing birds and landed birds, to see if there is some response by birds on the ground to the sight of birds displaying a "dumping" maneuver.

6. The birds might be performing violent evasive maneuvers to avoid collision. While this is undoubtedly a possibility in some cases, a cursory look at the films shows birds "dumping" that are nowhere near another bird.

7. They might be doing it just for their enjoyment. This hypothesis is not testable with present methods, but it is possible that "dumping" shares some functional characteristics with gull soaring, which may also represent a behavior which animals do, for lack of a more rigorous concept, because it feels good.

"Dumping" poses two linked questions: why do geese do it, and why don't they do it all the time?

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THREE ADULT RED-TAILED HAWKS TENDING A NEST

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The occurrence of extra helpers at nests is known for several avian families, notably the Sittidae, Hirundinidae, and Corvidae (Lack 1968). Skutch (1961) listed more than 130 species exhibiting this behavior. Although such situations are not common in the Falconiformes, there are several published reports of helpers at the nests or polygamy in this order: Marsh Harrier (American) (*Circus cyaneus hudsonius*; Hecht 1951, Reindahl 1941, Yocom 1944, Balfour 1957, Hamerstrom 1969), Hen Harrier (*Circus cyaneus cyaneus*; Jourdain 1924, van der Kraan and van Strien 1969), Montagu's Harrier (*Circus pygargus*; Jourdain 1924, Hens 1926, Dent 1939), Marsh Harrier (*Circus aeruginosus*) (Bengtson 1967), European Sparrow Hawk (*Accipiter nisus*; Balfour 1924, Greeves 1926, Jourdain 1928, Young 1973), and European Kestrel (*Falco tinnunculus*; Mathew 1882). Reports of polyandry are few: Harris' Hawk (*Parabuteo unicinctus*; Mader, pers. comm.) and Galapagos Hawk (*Buteo galapagoensis*; de Vries, unpubl. data). Clayton White (pers. comm.) observed three adult Bald Eagles (*Haliaeetus leucocephalus*) attending nests in the Aleutian Islands although sex of the adults was not determined. My purpose here is to describe an instance of three Red-tailed Hawks (*Buteo jamaicensis*) attending one nest.

Observations were made at approximately 3-day intervals from March through July 1973 incidental to a population study of Red-shouldered (*Buteo lineatus*) and Red-tailed Hawks in Orange County, California. On 7 March I found a Red-tailed Hawk's nest in a narrow oak grove which followed a dry stream bed through a 2.1-km long canyon. This canyon intersected a larger canyon approximately 450 m downstream from the nest tree. The larger canyon had a permanent stream and a broad, wooded flood plain. The nest was exposed at the top of an 11.6-m live oak (*Quercus wislizenii*).

During my first visit to the nest area, I observed one adult Red-tailed Hawk nest-building. On 17 March I observed an adult incubating. Four eggs were present on 30 March. Again, I saw only one adult (later determined to be a female from the distinctive plumage). She was moderately defensive, circling low overhead and calling with low-intensity defense vocalizations.

I noted a plumage difference in the incubating birds on different days but paid only casual attention to this observation, thinking it was merely a difference between the male and the female. On 24 April, when I climbed the nest tree again, I realized that three birds were defending the nest area. Judging from their relative body sizes and behavior, the three