Bats on a budget: use of torpor by bats to conserve energy during migration

A study on migrating silver-haired bats (*Lasionycteris noctivagans*) has revealed that they use torpor-assisted strategy while roosting during the day to conserve energy and thus avoid stopovers to refuel. Torpor is a physiological state, where the metabolic rate and body temperature are reduced to enable animals to survive periods of food scarcity. It is generally used by animals to survive cold climates as it allows them to save the energy that would normally be used to maintain a high body temperature. Some species of animals remain in torpor or physiologically inactive state for long periods to escape extreme temperatures. This is termed hibernation (at low temperatures) or aestivation (at high temperatures).

Many species of bats living in temperate regions hibernate, while some others like the silver-haired bat migrate to warmer climate in search of food (Figure 1). Individuals undergoing migration face many perils. Seasonal migrations are a challenge, especially for bats and birds as they rely heavily on the nutrient deposits that they pack prior to the long journey. It is a trade-off for better quality habitats, at the price of higher predation risks and greater energy expenditure. When migrating, bats and birds fly during night, stopping over just before sunrise to refuel and rest. As bats are nocturnal, it creates a conflict between travelling and halting to refuel. This is not an issue in birds as they travel during the night and forage during the day. However, bats would need to choose either to rest or refuel, thereby increasing the migration time and the risks associated with it.

McGuire *et al.*[1] examined the energy costs incurred by silver-haired bats during their autumn migration between August and September in Long Point, Canada. Silver-haired bats are insectivores and are found in USA and parts of Canada and Mexico. They migrate south towards southern USA and Mexico to escape the freezing winters. The research team predicted that the bats used a torpor-assisted strategy to minimize their energy consumption during stopovers along the migration route. Using a combination of respirometry and temperature-sensitive radio telemetry, the energy costs of the bats and the amount of energy they save using torpor while roosting during the day were estimated.

Using mist nets, 49 silver-haired bats which included adult males and females, and sub-adults were caught and then divided into two groups. Individuals of the first group were housed in respirometry chambers in order to measure their body temperatures and metabolic rates. Individuals in the second group were tagged with temperature-sensitive radio transmitters and then freed back. Respirometry trials were conducted on the bats in group 1 between sunrise and dusk when they were inactive. They were exposed to temperatures varying between 15°C and 27°C, and their metabolic rates both during normal conditions and torpor were measured. The data collected were then correlated with the skin temperatures of the tagged individuals from group 2, that were acquired through the temperature-sensitive radio transmitters. This enabled the scientists to calculate the metabolic rates of the individuals in group 2 during both normal and torpor conditions.

Results revealed that torpor was used by both male and female individuals across all age groups. By being under torpor during stopovers, the silver-haired bats saved 91% of the energy they would otherwise have spent on maintaining normal body temperature. They were also found to modulate the use of torpor according to the temperature of their surroundings. On cooler days, they were in torpid state for longer hours compared to warmer days. It was also discovered that the bats did not use torpor when the temperature in their roosting area was >25°C. Migrating birds spend longer hours at stopover than during flight. However, by lowering body temperatures when inactive (when not foraging or flying), bats save much of their energy, thus reducing the frequency of stopovers for refuelling. This makes migration more efficient and quicker compared to most birds. During migration, there is a trade-off between time and energy. But by using the torpor strategy, silver-haired bats are successful in conserving both.

Figure 1. Silver-haired bats migrate to warmer climates during winter.

1. McGuire, L. P., Jonasson, K. A. and Guglielmo, C. G., *PLoS One*, 2014, **9**(12), e115724.

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