

Erratum: "Hisamatsu" in pages 21 and 22 should be corrected to "Hisasue."

Short communication

Daytime feeding in an insectivorous bat

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Most bats are strictly nocturnal (Erkert, 1982; Kunz and Pierson, 1994). However, I once observed a bat flying and feeding at high noon on a fine day in a mountainous area in Hokkaido, Japan. This observation supports Speakman's (1990) view that bats fly and feed even during the daylight hours when they are in energy deficits. The details of the observation are as follows:

On 28 May 2002 during the daytime, I observed a bat feeding in the Higashi-Jozankei National Forest (Sapporo, Hokkaido, Japan), which covers the catchment area of the Toyohira River. I was driving on a forest road and encountered the feeding bat at 10:56 a.m. (Japan Standard Time). It was feeding over the forest road, repeatedly flying forward and backward at a distance of approximately 30-40 m in road length. The bat was flying at heights from approximately one-half to six meters above the ground. It was clearly feeding on tiny insects of a few mm in size, a kind of black fly, which were swarming over the road in a high concentration. The bat often flew within one or two meters from where I was standing on the road, which gave me the impression that the bat was highly engrossed in the feeding activity. It once disappeared from sight for around 20 to 30 seconds, and I suspected that it was taking a short rest among the foliage in one of the trees beside the road. The observation ended when it disappeared into the forest at 11:03 a.m. (JST). I stayed on the spot for another 5 minutes or so, but it did not reappear. I did not have

a bat detector at the time and could not determine whether the bat was using echolocation to detect the prey insects.

The sky was perfectly clear on that day, and the feeding bat was in direct sunlight. The sun culmination time of the spot (42° 52' 22.84" N and 141° 09' 09.06" E, 492 m a.s.l.) on the day was calculated as 11:32 a.m. (JST), around 30 minutes after the observation. The upstream of the Toyohira River was nearby (within 30 m), but its surface was 20-30 m below the road. The forest around was composed of both needle leaves (fir *Abies sachalinensis* and spruce *Picea jezoensis*) and broad leaves (oak *Quercus mongolica*, linden *Tilia japonica*, birch *Betula platyphilla* and others) (Fig. 1).

I attempted to photograph the bat and succeeded in capturing its image in five frames (Fig. 2). Professor Kishio Maeda at Nara University



Fig. 1. The forest road over which the daytime feeding bat was observed.



Fig. 2. A bat feeding during the daytime. The daytime feeding of an insectivorous bat was observed during 10:56-11:03 a.m. on 28 May 2002 at Higashi-Jozankei National Forest (42° 52' 22.84" N, 141° 09' 09.06" E, 492 m a.s.l.) in Hokkaido.

of Education, an experienced bat scientist and taxonomist, looked at the photographs, but the species could not be identified. The flight was relatively slow and maneuverable. The wingspan was visually estimated at approximately 20 cm, although I am not sure how precise this estimate was. The number of bat species recorded on Hokkaido Island was 17 at the time of this observation (Abe *et al.*, 1994). The obtained photographs provided enough information to exclude some of these species. For example, *Murina ussuriensis* and *M. hilgendorfi* were excluded as possible species because the bat in the photographs had no fur on the back of uropatagium. In addition, *Plecotus auritus*, *Rhinolophus ferrumequinum*, *R. cornutus*, and *Barbastella leucomelas* were also excluded as possible species because of the shape and relative size of their ears. Some other species were also excluded because of the rarity of the records in Hokkaido (*Pipistrellus savii* and *Tadarida insignis*) and because of their style of flight and size (*Vespertilio sinensis* and *Nyctalus aviator*). The following species remained possible: *Myotis macrodactylus*, *M. daubentonii*, *M. gracilis*, *M. ikonnikovi*, *M. frater*, *M. nattereri*, and *Eptesicus nilssonii*.

The temperature was 15.1° C at 11:00 a.m. on the day of the observation at the Nakayama Pass (42° 51' 24.84" N, 141° 05' 50.52" E, 831 m a.s.l.), five km from the spot (Fig. 3). Because of the difference in altitude, the temperature at the observation site should be 1.9-2.0°C higher than that at the Nakayama Pass. No strong rain or wind had been observed preceding the observation, but the air temperature had been relatively low during the nights (Fig. 3). This suggests that the preceding nights were unsuitable for bat foraging in terms of energy expenditure and the availability of prey insects. The present observation, hence, shows that even normally strictly nocturnal bats have the faculty of preying upon flying insects during daylight hours and may actually do so possibly in starvation and when plenty of prey insects are available.

Speakman (1990) has collected and analyzed 420 records of daytime flying bats in mainland Britain, which include 271 records in summer (April to September inclusive) and 144 in winter (October to March inclusive). Although only six of the records definitely confirmed the feeding activity in the flying bats, he concluded, based on various evidence derived from the analysis, that the primary function of daylight flying in summer is to feed to

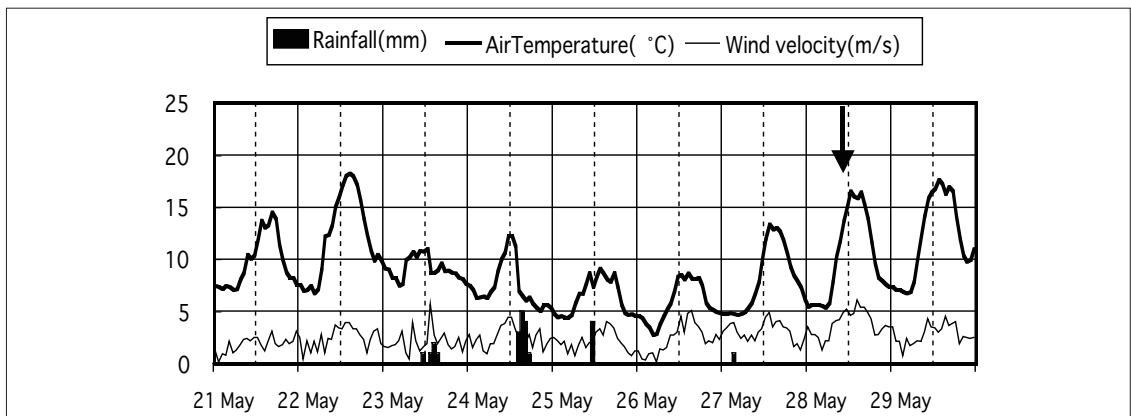


Fig. 3. Meteorological data at the Nakayama Pass ($42^{\circ} 51' 24.84''$ N, $141^{\circ} 05' 50.52''$ E, 831 m a.s.l.), five km west-southwest from the observation site, for the day of the observation (28 May 2002) and the preceding week. The air temperatures in the four consecutive nights (averaged from sunset to sunrise) preceding the observation were 5.0°C , 4.2°C , 4.9°C , and 6.5°C at the Nakayama Pass. The temperatures at the observation site should be $1.9\text{--}2.0^{\circ}\text{C}$ higher than these because of the altitude difference between the two sites. The arrow indicates the time of the observation.

compensate for energy deficits that have accrued due to inadequate food intake during nocturnal foraging. The present analysis shows that the daytime feeding bat had actually experienced the adverse weather conditions preceding the observation and, hence, was likely in an energy deficit.

Speakman's (1990) analysis also showed that daytime flying in bats increased with increasing latitude in mainland Britain, which ranges from $50^{\circ} 00' \text{ N}$ to $58^{\circ} 40' \text{ N}$. Further north, in Rautalampi, Finland ($62^{\circ} 37' \text{ N}$), Nyholm (1965) showed, based on the automatic recording of emergence and return at a roost, that *Myotis mystacinus* were diurnal at the beginning and end of their active season (May and October). Nyholm reasoned that this was because the air temperature exceeded 7°C , the critical value for the species, only during the daytime and because insect availability was greatest during the daytime in cooler months. This observation also supports Speakman's view that the nocturnality in bats is not intrinsic and that bats are ready to fly in the daytime when they are in need and the conditions meet the need, if the benefit outweighs the potential risks. As the risks of daytime flying, Speakman (1991a, 1991b, 1995) indicated avian predation as the most

prevalent factor and hyperthermia as possible one for some bat species in tropical areas.

The preliminary survey using the mailing list of the Asian Bat Research Institute (abri-ML with 52 registered members) during 4 - 10 January 2005 collected 18 observations of daytime flying in bats from various parts of Japan (Nara to Hokkaido). Of those, 13 referred to the species (eight for *Pipistrellus abramus*, three for *Murina ussuriensis*, and two for *Nyctalus aviator*) and nine were specific to the day. Four reported feeding activity, and one reported drinking. Only one observation, made by Masaaki Hisamatsu, was specific to the day and confirmed the feeding activity. In this case, a *Murina ussuriensis* was feeding on dragonflies around noon on 1 September 2003 at the Akanuma Pond in the Minami-Hakkoda mountain area in Aomori Prefecture ($40^{\circ} 36' 34'' \text{ N}$, $140^{\circ} 55' 49'' \text{ E}$, 680 m a.s.l.). The meteorological data at Sukayu Onsen ($40^{\circ} 38' 54'' \text{ N}$, $140^{\circ} 50' 54'' \text{ E}$, 920 m a.s.l.), eight km from the site, showed again that the air temperature had been relatively low in the three consecutive nights preceding the observation (Fig. 4). Hence, this observation also suggests that the bat was likely in an energy deficit because of

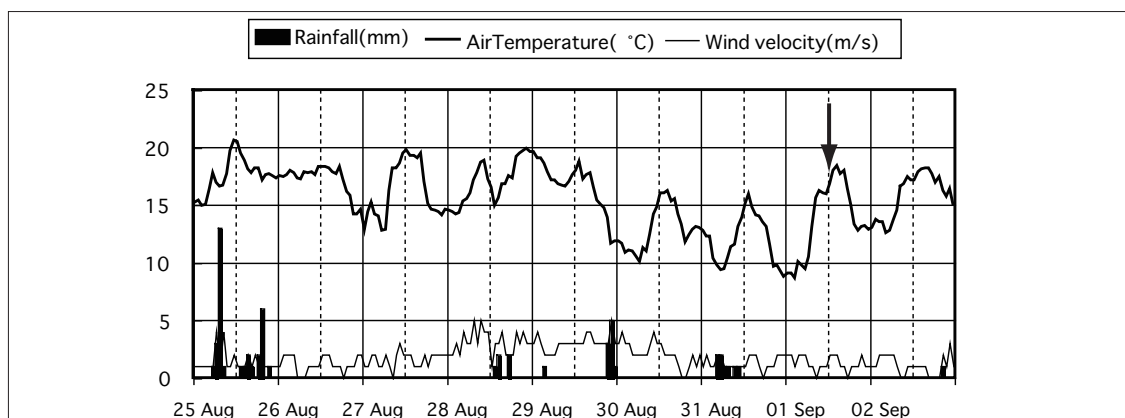


Fig. 4. Meteorological data at Sukayu Onsen (40° 38' 54" N, 140° 50' 54" E, 920 m a.s.l.), eight km northwest from the observation site of a daytime feeding bat, for the day of the observation (1 September 2003) and the preceding week. The average air temperatures in the three consecutive nights (averaged from sunset to sunrise) preceding the observation were 12.2°C, 11.8°C, and 9.6°C at Sukayu Onsen. The temperatures at the observation site should be 1.3–1.4°C higher than these because of the altitude difference between the two sites. The arrow indicates the time of the observation.

the unsuitable foraging conditions in the preceding nights.

We should pay more attention to the daytime flying and feeding in bats because the analysis of the phenomena can reveal weather conditions that are obstacles to nighttime foraging in bats. Conversely, this means that we can determine the weather conditions that are required for their adequate food intake during the night. The conditions should vary depending on the species, time of year, location, and other environmental factors. The further collection and analyses of data would certainly help us better understand the foraging ecology of bats.

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