

Evidence for spontaneous torpor in *Crocidura flavescens*

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Periods of no activity between 02.00 and 10.00 and lasting for up to 7 h 40 min are reported for two captive *Crocidura flavescens* (I. Geoffroy, 1827). During one of these periods, the weight specific energy requirement of the shrew dropped to 25.1% of the usual, indicating a period of spontaneous torpor. Nest-box temperatures also drop during the periods of prolonged inactivity suggesting a lowered body temperature. Data for a younger animal suggest shorter periods of torpor. The timing of the torpor spans the coldest period of the day when the animal would expend most energy maintaining a constant body temperature.

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Introduction

Since Vogel (1974) reported reversible hypothermia in *Suncus etruscus*, similar facts have been reported for other crocidurine shrews by *inter alia* Frey and Vogel (1979), Vogel *et al.* (1981) and Genoud (1985). Generally, in these studies torpor was induced by reducing the food ration of captive animals. Frey (1980) reports that torpor induced by food reduction lowers the animals metabolic rate to a level similar to that obtained during spontaneous torpor while Vogel and Genoud (1981) report torpor under field conditions. This has led to the conclusion that in crocidurines, torpor is an additional energy-saving strategy which goes with their relatively high thermoneutral zone (Nagel 1994) and their tropical origins (Vogel 1976).

Most of the data on soricid torpor is from European species although Vogel *et al.* (1981) do report it in *Crocidura juvenetae*, an African species. During an investigation into the metabolic rate of *C. flavescens* (I. Geoffroy, 1827) (R. Baxter, unpubl.), it became evident that one specimen had spontaneously entered torpor and four others showed signs of short periods of torpor. Circumstances were such that only the former, together with one other shrew, were further investigated and those results are reported here.

Materials and methods

The two animals used in this study were a 31 g female *C. flavescens* approximately 15 months old and a 32 g male aged 3–4 months. Both had been trapped in the Pietermaritzburg district in South Africa approximately one month before testing, which was in late autumn.

Metabolic measurement was performed in a closed circuit respirometer based on the design of Moors (1977) but including an automatic oxygen feed. Simultaneous activity measurement was obtained using a capacitance method modified from the design of Baxter and Davis (1981).

Further activity runs without measurement of oxygen consumption, were performed with simultaneous monitoring of the temperature of a small nest box using a telethermometer. It was reasoned that during rest the nest-box temperature would change as a function of the animals body temperature.

The nest box was sufficiently small (45 × 45 × 35 mm) to make it virtually impossible for the shrew to seek shelter in it without lying on the probe of the telethermometer. The box was also liberally supplied with holes to allow the air in it to mix freely with the air in the chamber. No nesting material was provided.

One O₂-consumption run (28 h) and two temperature-monitoring runs (24 and 30 h) were performed with the older shrew whereas the younger one had an O₂-consumption run of 24 h and four temperature-monitoring runs of 32, 24, 24 and 30 h. During every run, food (lean minced oxheart mixed with powdered dry dog food) and water were supplied *ad libitum*. All runs were performed in a Conviron constant environment chamber at a temperature of 17°C with a light period lasting from 06.30 to 18.00. All the results were recorded on a Hewlett Packard two-pen chart recorder and the O₂-consumption results were adjusted to STP.

Results

The average mass specific energy expenditure of the younger shrew was 79.40 J·g⁻¹·h⁻¹ at an activity level of 8.17%. This was slightly higher than a mean for five *Crociodura flavescens* of 76.59 J·g⁻¹·h⁻¹ at an activity level of 11.13% (R. Baxter, unpubl.) recorded over a total of 98 h. The longest inactive period during the O₂-consumption monitoring was 75 min but it was not possible to determine whether the shrew was torpid or not.

In contrast, the average mass specific energy expenditure of the older shrew was 44.05 J·g⁻¹·h⁻¹ over 28 h at an activity level of 6.17%. This included, however, a period of complete inactivity lasting 7 h 40 min (02.00–09.40) during which the animals O₂-consumption was considerably reduced for 5 h 20 min (03.30–08.50). During this period the energy expenditure dropped to 14.79 J·g⁻¹·h⁻¹ compared with 59.01 J·g⁻¹·h⁻¹ for the rest of the run. Thus, energy expenditure was 25.1% of the norm during torpor.

The energy expenditure and activity levels of the older shrew were 55.0% and 76.0% of that of the younger animal respectively. Clearly the torpid period resulted in an energy saving.

The nest-box temperature recordings provided circumstantial evidence for short periods of torpor in the young shrew while the results for the older animal were more convincing. In all the monitoring periods, when there was high activity, the nest-box temperature was 17°C.

In the younger shrew the longest period of inactivity during each run was 84, 139, 40 and 70 min respectively. At the start of each inactive period, the nest-box temperature rose from ambient to between 23°C and 25°C, indicating that the animal was lying on the probe. With the exception of the 40 min recording where the temperature stayed 22°C, the temperature had dropped to 19°C by the midpoint of the inactive period but had risen to around 23°C before activity was recorded again. The inactive periods tended to occur between 04.00 and 09.00 with another low activity period between 14.00 and 16.00.

In the case of the older animal, there was a long period of inactivity in each of the runs – 4 h 20 min (04.10–08.30) and 6 h 50 min (03.50–10.40). As with the younger animal, the nest-box temperature was approximately 24°C at the beginning of these periods but it dropped to between 18°C and 20°C within 50 min and remained low until just before activity was recorded again. There was then a brief rise in temperature followed by a drop to ambient temperature during activity. The mean activity profile for this animal shows a very clear tendency for no activity between 03.00 and 10.00.

Discussion

The energy expenditure values for the older *C. flavescens* indicate that this species does indeed utilize torpor. The telethermometer and activity data support this assertion and indicate that relatively long periods of torpor occur and that there is a reduction in body temperature during the torpid period. These results are consistent with those reported for other crocidurines (Vogel 1974, Vogel *et al.* 1979, Genoud 1985) and the occurrence of torpor during the early hours of the morning corresponds with that found for *Suncus etruscus* (Frey and Vogel 1979). The fact that the older animal appeared to go into torpor every time it was monitored is consistent with the findings of Genoud (1985) for *C. russula*, which can undergo daily torpor.

In contrast, the energy expenditure of the younger *C. flavescens* was considerably higher than that of the older one. This is at least partly due to the absence of any prolonged period of torpor in this shrew. The telethermometer data did suggest that this animal might be utilizing short periods of torpor (< 184 min) and that this generally occurred in the early morning hours. The data, however, are inconclusive due to the lack of sophistication of the measuring instruments. Short periods of torpor (1.5–2 h) have been recorded for European *Suncus* and *Crocidura* (Vogel 1974, Genoud 1985). The fact that this animals energy expenditure was higher than the older animals outside of torpor, corresponds with data for some soricines (Gębczyński 1965, 1971) and is in contrast to the findings of Dryden *et al.* (1974) for *Suncus murinus*. Torpor is a useful strategy for saving energy (Nagel 1994). The data presented here indicate that the period of torpor generally occurs between 02.00 and 10.00, which spans the coldest period of the

day. The implication of this is that the shrew stops defending its body temperature at the time when it would use most energy to maintain it. The energy saving reported here for the older animal using a long period of torpor (45% energy expenditure reduction with a 24% activity reduction), appears to be comparable to that reported for *C. russula* (Genoud 1985).

Obviously these data are preliminary and warrant more research. However, one can tentatively say that *Crocidura flavescens* has the same physiological adaptations as the European crocidurines.

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