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Metabolic rate in common shrews is unaffected by temperature, leading to lower energetic costs through seasonal size reduction

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Published: 31 March 2020

Sorex araneus (Linnaeus 1758)

- The **common shrew** or **Eurasian shrew** is the most common species of shrew and is also one of the most numerous mammals, being widespread throughout northern Europe.

- It measures on average 55–82 mm in length and usually weighs 5-12 grams.

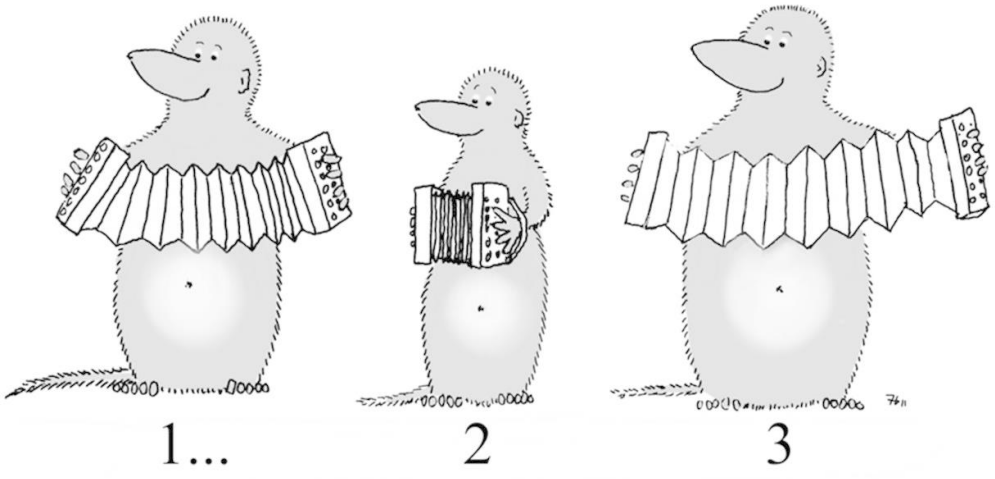
- Shrews are active both day and night, although they are much more active during the latter. They are almost always moving and only rest for a few minutes between activities.

- In order to survive, each specimen needs to consume 80-90% of its body weight every day. For this reason, shrews must eat ca. every 90 minutes. During the winter months these creatures do not hibernate, as their bodies are too small to store enough fat reserves.

Dehnel's Phenomenon

Dehnel's Phenomenon, named after its discoverer, Polish zoologist **August Dehnel** (1940s), is the ability of certain species of animals such as shrews and weasels to shrink skull, bones and major organs in order to survive scarce food situations.

In *S. araneus*, this seasonal reversible size change is reflected by an up to 25% size change of the skull, 10-20% change in the mass of the brain, large changes in the mass of several major organs, as well as overall body size.



Summer juveniles

Winter subadults

Spring adults

Aim of the study

- To test how this morphological stategy (Dehnel's Phenomenon) and seasonally shifting ambient temperatures affect energy consumption.
- Variation in seasonal activity and if this has a significant effect on daily energy consumption.

How

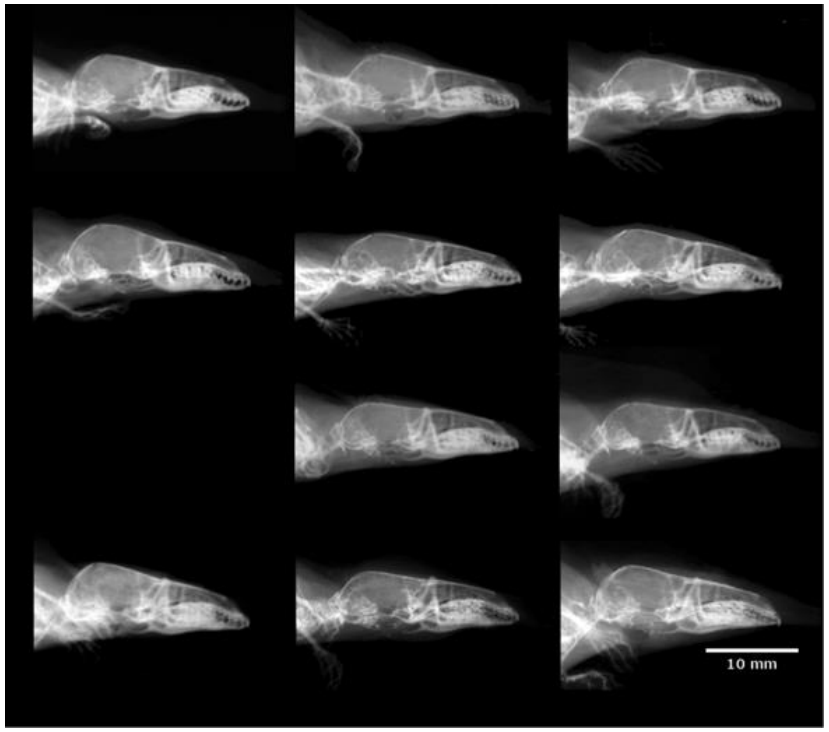
- Measuring oxygen consumption and
- Observing behaviour

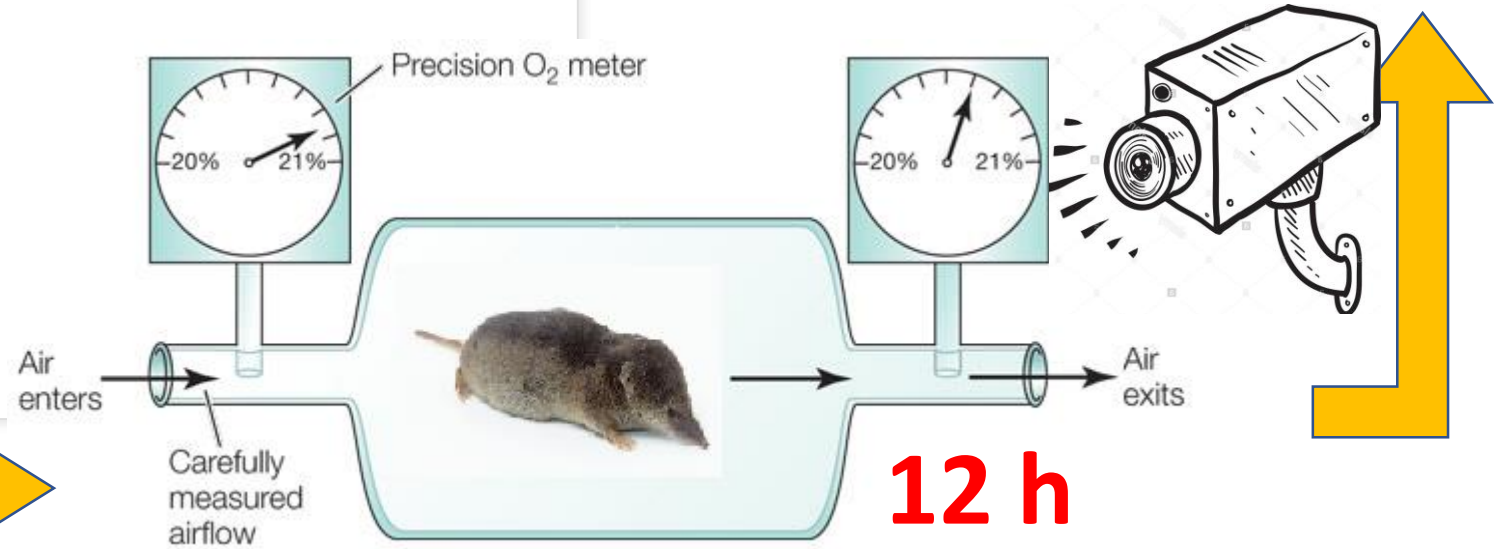
…in the three seasonal phenotypes

MATERIAL and METHODS

29 common shrews:

- June (large juveniles) -> n = 12
- January/February (size decreased subadults) -> n = 9
- April/May (regrown spring adults) -> n = 9





Season had significant effect on both body mass and braincase height.

- Summer juveniles (n = 6) were smaller than spring adults (n = 6), while winter subadults (n = 8) were the smallest.
- Braincase height (standardized to tooth row) was also smallest in the winter subadults.
- Regrowth in spring adults resulted in higher skulls, but these were proportionately smaller than those of summer juveniles.

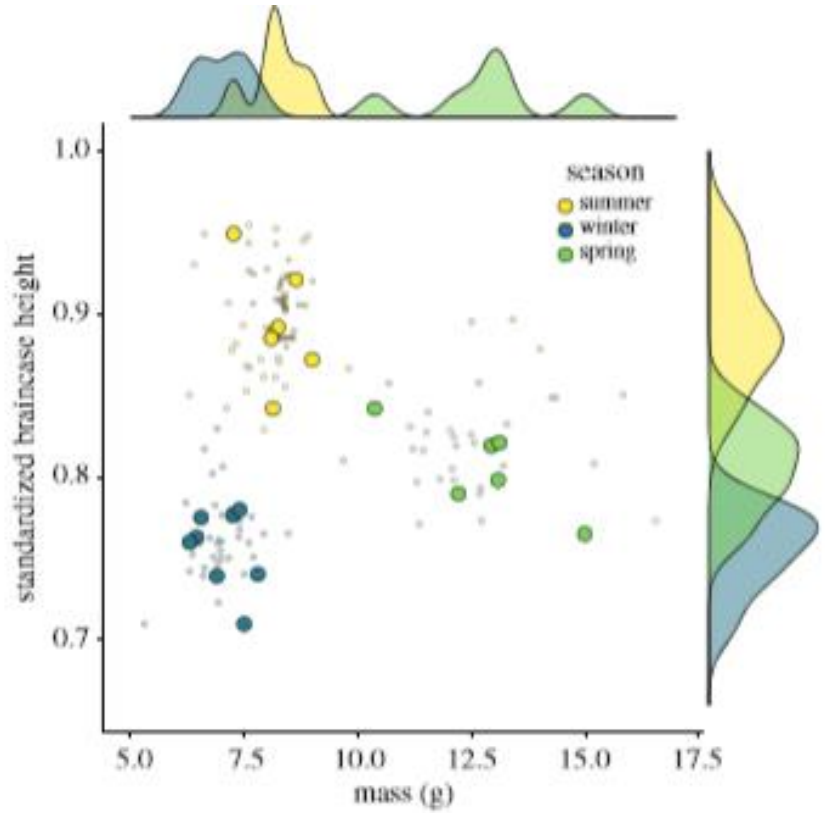


Figure 1. Shrew mass (g) and standardized braincase heights measured from X-rays. All capture data from 2014 to 2018 are shown in small circles, and the individuals presented in this study are shown as large circles. Both shrew body mass and braincase height differ by season for the animals in this study.

WHOLE ANIMAL AND MASS-SPECIFIC OXYGEN CONSUMPTION

- Increasing body mass increased whole animal oxygen consumption (a);
- Decreasing temperature was associated with slightly lower oxygen consumption across seasons but, within each season, there was a slight increase in oxygen consumption with decreasing temperature (c);
- Mass-specific oxygen consumption remained fairly consistent across seasons (d-f).

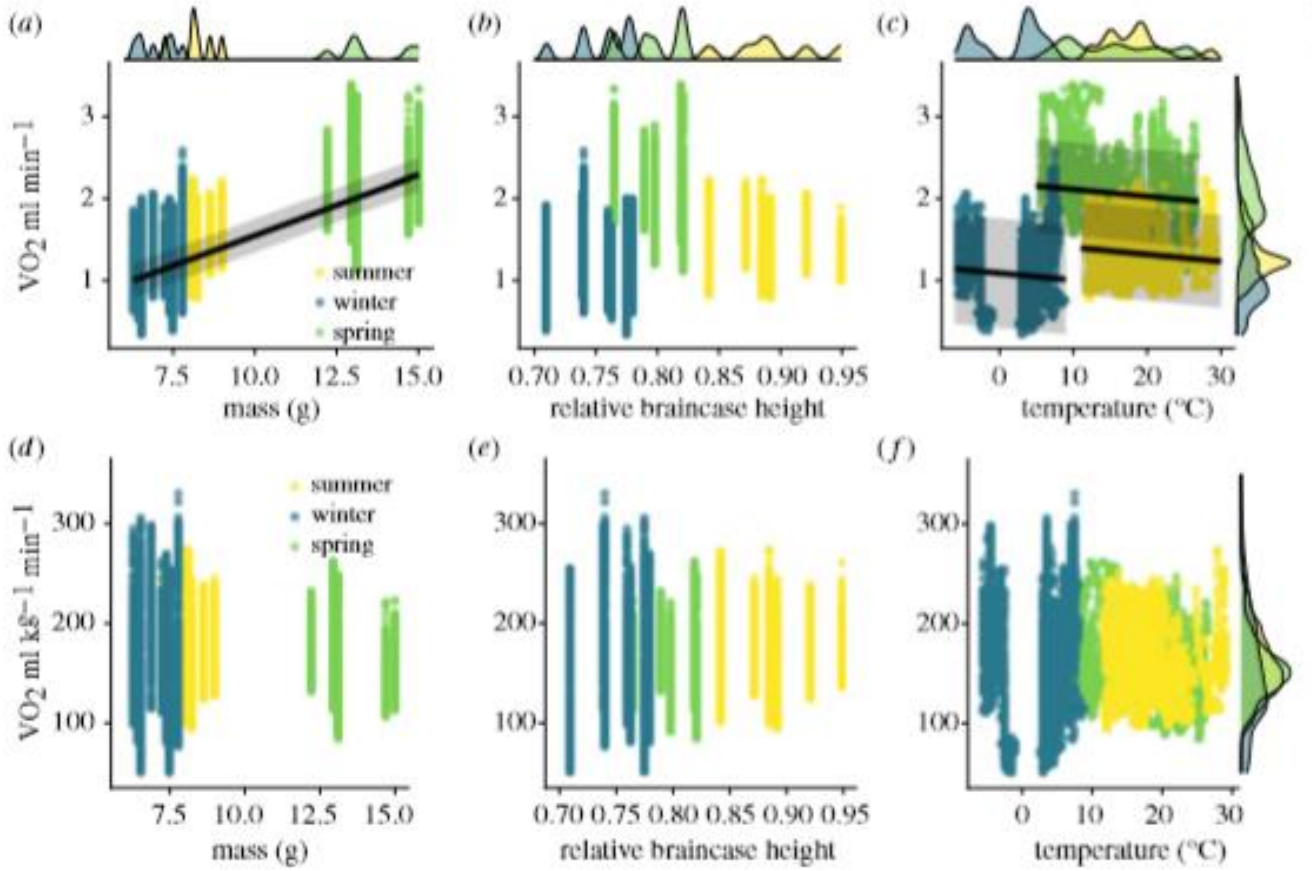


Figure 3. Shrew absolute metabolic rates (*a–c*) and relative metabolic rates (*d–f*) predicted by body mass, relative braincase height and ambient temperature. Margin plots show the density of each variable in the row or column. Mass, season and temperature had significant effects on absolute metabolic rates on their own and the lines in (*a*) and (*c*) show the predicted relationship from the models that account for random slope of season, random intercept of individual and a continuous time autocorrelation structure within the data.

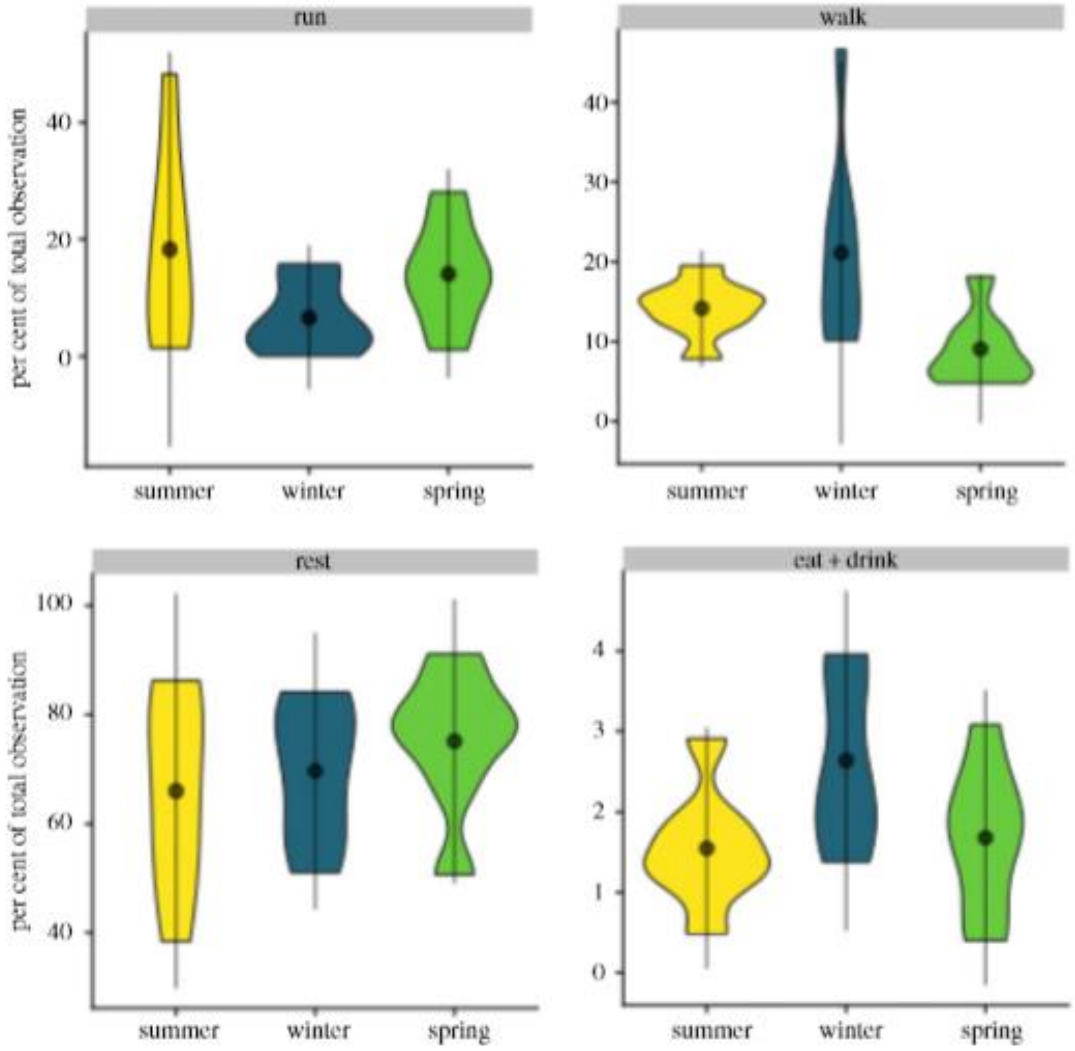


Figure 2. Activity budgets as per cent of total observations that shrews spent in four activities. Shrews in winter spend more time eating and looking for food.

Shrews could alter their activity to minimize energetic expenditure across the seasons.

Activity budgets were calculated per individual as <u>percentage of total observation time engaged in Eat + Drink, Rest, Run or Walk</u> during the respirometry trials and these differed among the seasons:

- Summer juveniles and spring adults showed the same activity distribution.
- Winter subadults spent less time running than in either summer or spring phenotypes, and more time eating, drinking and walking.

DISCUSSION

- Winter energy demands of endotherms are generally assumed to be among their highest across the annual cycle given the challenges of thermoregulation.

- For small endotherms, such as shrews, their large surface area relative to body mass should make them particularly vulnerable to heat loss.

- A common assumption was that winter energy expenditure in animals showing the Dehnel's Phenomenon was influenced by the reduction in the size of expensive tissues, especially the brain. Brain size did not prove to be the main determinant of oxygen consumption within this study.

- Unexpectedly, the effect of temperature on oxygen consumption in shrews housed at ambient environmental temperature was opposite to predictions.

- **SIZE REDUCTION IN SHREWS REDUCED ABSOLUTE ENERGY CONSUMPTION AND THUS OVERALL ENERGY COSTS ACROSS A WIDE RANGE OF AMBIENT TEMPERATURES.**

Thank you!


Feild Mouse said my mouth is weird. Do you think my mouth is weird??
I never thought about it before.
I'm kinda freaking out.