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Weight Specific Oxygen Consumption Values at Various Temperatures for *Scincus mitranus* Anderson, 1871 (Scincidae: Reptilia)

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Abstract: The resting metabolic rate of the sand fish *Scincus mitranus* was measured at different temperatures ranging from 15 to 35 °C at 5 °C intervals. This temperature oxygen consumption related to body mass study was done using a double chamber volumetric closed system. The resting metabolic rate (RMR) was clearly found to be mass dependent in an inverse relation equation for this species. Likewise the relationship was significant and directly proportional in the case of RMR and temperature. Small skinks and medium-sized ones proved to have higher levels of RMR than larger skinks. The mass regression coefficient (b) values were found to be temperature sensitive.

Key words: *Scincus*, temperature, oxygen, regression coefficient, reptiles

Introduction

Small animals are always more active than larger ones. This is especially seen interspecifically in the class reptiles and also within the same species (intraspecifically), as younger ones are always the subject of many hazards and are in demand of higher levels of energy. This is particularly viewed through the processes of growth and defending themselves. Speculation of this field had long been studied by Bennett (1982) referring to the situation that even reptiles of the same body weight need not to have the same metabolic scope values. Bennett and Dawson (1976) had shown that the weight specific aerobic scope of larger reptiles was always lower than that of smaller ones. Interspecific studies and in between classes reptiles and mammals of the same weight were done by Wickler and Gleeson (1993). Interspecific works on monitor lizards were done by Thompson and Withers (1997) on a comparative basis. Intraspecific studies were done by Zari (1993) on *Chamaeleo calyptratus* and by Al-Sadoon (2001)on *Scincus hemprichii*.

The relationship between the metabolic rate (O_2 ml/g/h) and body mass was shown in the linear equation:

$$Y = a + bX$$

It was also shown by the log version:

$$\log Y = \log a + b \log X$$

Other forms were the exponential ones:

$$Y = aX^b \quad \text{and} \quad MR = aW^b$$

The general form for various species of animals and a wide mass range; where "a" is the intercept on Y and "b" is the slope (Bennett and Dawson, 1976; Bennett, 1982). The metabolic rate and body mass relationship of the species under investigation was measured to precisely view the energy requirements of juvenile reptiles (Andrews and Pough, 1985).

It is noticed that Q_{10} levels usually have values of 2 and 3 according to Bennett and Dawson (1976) though later works by Al-Sadoon and Spellerberg (1985) and Zari (1991) reflected higher and lower fluctuations of those data.

This study is focused on the effect of body mass of *Scincus mitranus* on the oxygen consumption rate at different temperatures ranging from 15 to 35 °C at 5 °C intervals.

Materials and Methods

The sand fish *Scincus mitranus* lizards used in this experiment research were collected from the sandy outskirts of Riyadh, the capital of Saudi Arabia, during the summer of 2001. The lizards were divided into three groups according to their body mass. Group one were the small weight skinks (2-5 g), group two were the medium weight skinks (6-15 g) and group three were the heavy weight (large) skinks (17-25 g). The three groups were kept in large glass tanks. These tanks were embedded with sandy substrata simulating their natural habitats. Food and water were provided ad libitum. The animals were fasted for 5-6 days prior to experimentation.

The oxygen consumption rates for resting lizards were measured at 15, 20, 25, 30, 35 °C using a double chamber volumetric closed system, described by Al-Sadoon and Spellerberg (1985). The data were expressed as oxygen ml g^{-1} body weight h^{-1} and corrected to standard temperature and pressure (STP). Statistical comparisons of individual lizards were made using regression analyses. Comparisons of the linear regression equations and the log-transformed version were also manipulated.

Results

The mean oxygen consumption rate (ml O_2/g/h) increased with the increment of temperature for all the 80 specimens of *S. mitranus* (2.0-25.0 g). This was clearly observed in the 5 levels of temperature 15, 20, 25, 30 and 35 °C, plotted graphically (Figs. 1 to 5). On the other hand, in each graph the relationship between standard metabolic rate and body mass reflected a gradual decrease in the rate of O_2 consumption, starting from the lowest body mass lizards and ending with the heavier ones. This statistical analysis at all the experimental temperatures, of the slope regression values (b) are indicative very high significance ($P < 0.0001$).

The resting metabolic rate (RMR) for the three body mass classes of skinks (small skinks 2.0 - 5.0 g, medium-sized skinks 6.0-15.0 g and large skinks 17.0 - 25.0 g) was determined (Fig. 6). There was a definite increase in the RMR with temperature elevation. At all experimental temperatures the figure reflected the finding that smaller skinks do gain higher RMR than larger ones.

Low Q_{10} values for small skinks (2.6940 and 1.710) were seen at the ranges 20-25 and 25-30 °C respectively. Low Q_{10} values for medium-sized skinks (2.289 and 2.420) were seen at the ranges 25-30 and 20-25 °C respectively. A lower level Q_{10} value than those was observed for this group at the range 15-20 °C. Low Q_{10} values for large skinks (2.130 and 2.534) were seen at the ranges 15 - 20 and 20 - 25 °C respectively (Table 2).

Discussion

The resting metabolic rate (RMR) for *S. mitranus* was temperature-dependent. It is seen from the results that this work reflected an inversely proportional relationship between metabolic rate (O_2 ml/g/h) and body mass (g) (Fig. 1-5). Lower values of b were noticed intra-specifically for *S. mitranus* (-0.0016 to -0.0131) than the inter-specific generalized values derived by Bennett and Dawson (1976) and Bennett (1982).

Table 1: Regression relationship statistical parameters showing the mass-specific oxygen consumption rates in relation to body mass of *S .mitranus* No. of lizards(n).

Temperature (°C)	Intercept(a)	Slope(b)	Correlation coefficient(r^2)	P Value	Significance
15	0.0648	-0.0016	0.843	< 0.0001	Highly significant
20	0.1222	-0.0039	0.532	< 0.0001	Highly significant
25	0.2201	-0.0073	0.765	< 0.0001	Highly significant
30	0.2953	-0.0083	0.884	< 0.0001	Highly significant
35	0.4882	-0.0131	0.750	< 0.0001	Highly significant

Table 2: The thermal dependence (Temperature coefficient) values of oxygen consumption for the three categories of the skink *S. mitranus*.

Temperature intervals (°C)	Small skinks	Medium sized Skinks	Large skins
15-20	4.617	2.007	2.130
20-25	2.694	4.053	2.534
25-30	1.710	2.289	2.823
30-25	3.118	2.420	3.311
Overall Q_{10} (5-30)	2.854	2.591	2.664

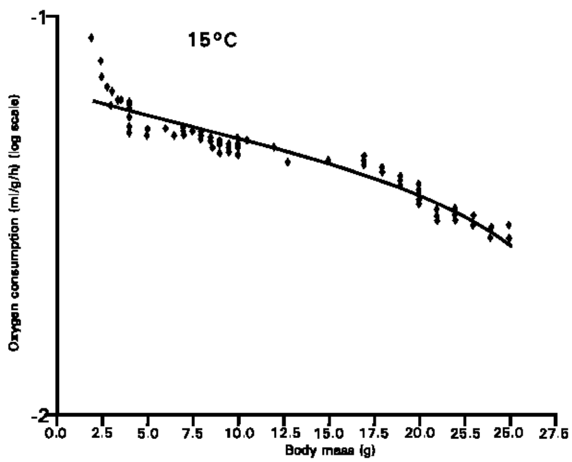

Fig. 1: The relation between oxygen consumption (O_2 ml/g/h) and body mass of *S. mitranus* at 15 °C, plotted on a log scale. Each point represents one O_2 consumption value of a lizard.

It is noticed that the RMR values we got were in close agreement with values obtained by Bennett and Dawson (1976). This is seen in the M-T curves (Fig. 6). Previous studies on lizards of comparable weights had similar values (Andrews and Pough, 1985; Al-Sadoon, 1986; Al-Sadoon and Spellerberg, 1987). Body mass has a great effect on the RMR in relation to temperature. Fig. 1-5 clearly reflect this relationship. This mass-specific difference in RMR is in good conformity with the observation that higher oxygen consumption rates per unit mass are attained by smaller animals than larger ones (Heusner, 1982). The small and the big animals had scored levels above the mean regression line, whilst animals of medium weight were below this line. This could be attributed to a variety of factors, but a system error could be highly appreciated.

The small weight group and the medium-sized group have got a sharp increase in their M-T curves at lower temperatures (15-20 °C and 20-25 °C, respectively). High Q_{10} values are indicative of this (4.617 and 4.053 respectively). The next phase of the M-T curves reflected a more flattened level (25 - 30 °C) and further (30-35 °C). This variation could be attributed to the argument that at lower temperatures the skinks can increase their metabolic rate till they approach their preferred body temperature (PBT) then they can control their level of oxygen consumption (Cloudsley-Thompson, 1972; Bennett and Dawson, 1976). Al-Johany

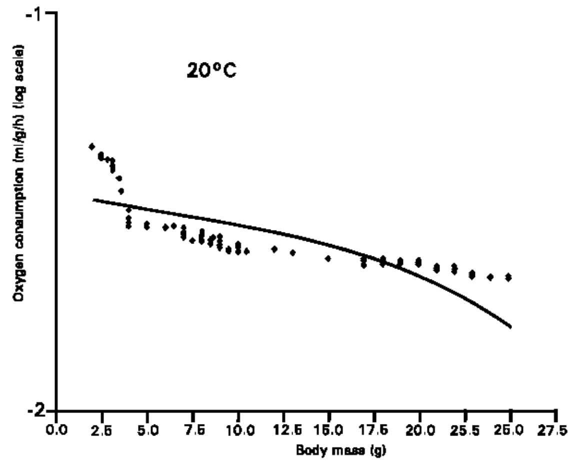

Fig. 2: The relation between oxygen consumption (O_2 ml/g/h) and body mass of *S. mitranus* at 20 °C, plotted on a log scale. Each point represents one O_2 consumption value of a lizard

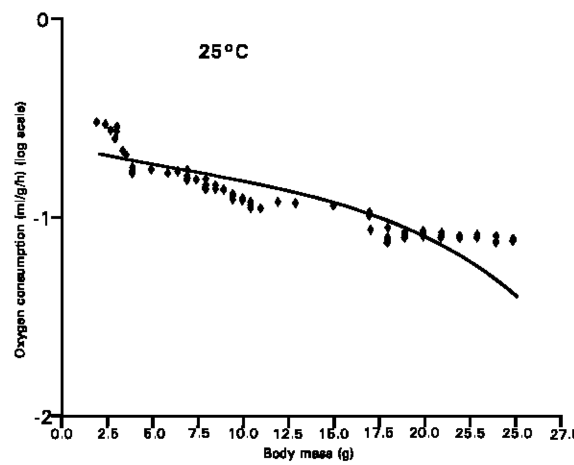

Fig. 3: The relation between oxygen consumption (O_2 ml/g/h) and body mass of *S. mitranus* at 25 °C, plotted on a log scale. Each point represents one O_2 consumption value of a lizard.

et al. (1999) working on *S. mitranus* found its PBT to be 34-35 °C which conforms with the finding that high Q_{10} values were attained at lower temperatures with gradual decrease at higher ones. This is at least the situation in the case of the small weight and the medium-sized groups. The works of Zari (1992) done on *Hemidactylus turcicus* and *Ptyodactylus hasselquistii* and his work (1993) on *Chamaeleo calyptratus* reflected comparable results. The works of Buikema and Armitage (1969) had revealed the fact that reduction in metabolism of animals is a direct effect of excessive heat gained within range of PBT. The works of Al-Sadoon (2001) on *Scincus hemprichii* that belongs to the same Fig.

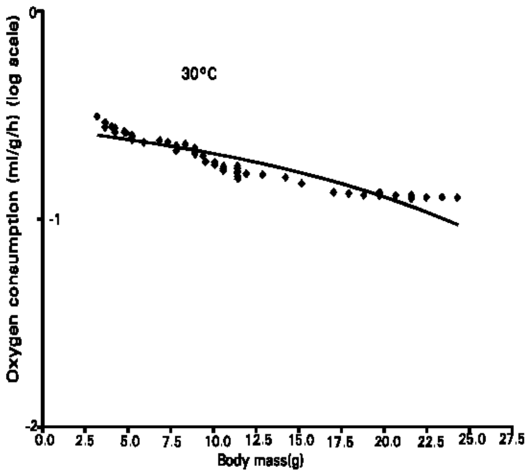

Fig. 4: The relation between oxygen consumption (O_2 ml/g/h) and body mass of *S. mitranus* at 30 °C, plotted on a log scale. Each point represents one O_2 consumption value of a lizard

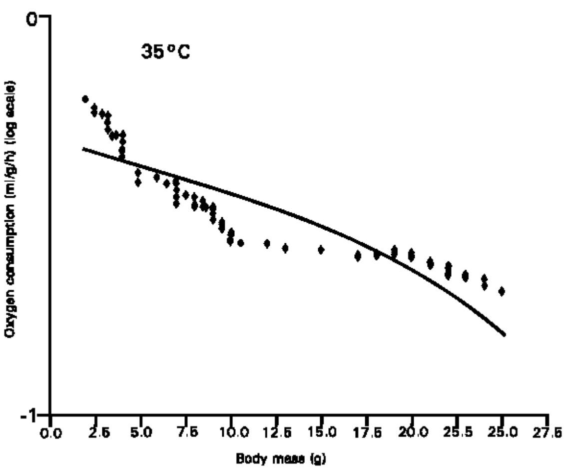

Fig. 5: The relation between oxygen consumption (O_2 ml/g/h) and body mass of *S. mitranus* at 35°C, plotted on a log scale. Each point represents one O_2 consumption value of a lizard

family (*Scincidae*) gave comparable results to those done on *S. mitranus*. Variations in the numerical values in the allometric parameters could only point to facts or findings by earlier workers (Snyder, 1975) who said that Q_{10} values of O_2 consumption for lizards are rather complicated and of no certain predictable pattern. Zari (1993) had argued this point extensively. Comparative eco-physiological studies done on Saharan lizards by Vernet *et al.* (1988) and the earlier works of Bennett and Dawson (1976) do give a right path to track and manipulate this situation. *S. mitranus* is a sand burrower, which means that it leads a primarily anaerobic behavior. Measurements of resting, active and total metabolic scope are parameters that can correlate between activity and behavior of animals and especially reptiles. Bennett and Dawson (1976) had given a ratio of 5:6 for resting and active behavior of reptiles, at their PBT. Other studies on *S. mitranus* gave a 4-fold ratio by Al-Johany *et al.* (1999), on *Dipsosaurus dorsalis* that gave a 17-fold ratio by Bennett and Dawson (1972), on the turtles *Pseudemys scripta* and *Terrapene ornata* that gave 20-24 fold (Gatten, 1974) and on *Chalcides ocellatus* that gave an 8:5 (Al-Sadoon and Spellerberg, 1987). At variable temperatures

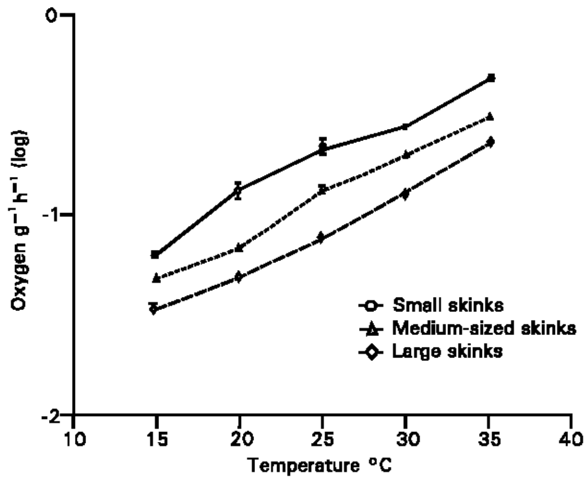

Fig. 6: The M-T curves of three *S. mitranus* groups plotted at 5°C intervals for a range of 15-35 °C

this behavior was very different. At 15 *S. mitranus* was able to increase and reach a 7-fold resting metabolic rate compared to a 4-fold one at 35 °C. This could only refer to the fact that this factorial metabolic scope is temperature independent.

Biphasic M-T curves are a good pointer to reptile behavior, but the works done on surface dwellers (*Uromastyx aegyptius*) by Zari (1991) should lead and point to further works on the ones that can survive a subterranean existence.

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References

Al-Johany, A.M., M.K. Al-Sadoon and S.A. Al-Farraj, 1999. Thermal ecology and activity of the sand fish lizard, *Scincus mitranus* (Scincidae) in Central Arabia. J. King Saud Uni. Sci., 11: 1-16.

Al-Sadoon, M. K., 1986. An investigation of oxygen consumption in the lizard, *Lacerta vivipara* (Jacquin) in connection with photoperiod and the parietal eye. J. Coll. Sci., King Saud Univ., 17: 55-65.

Al-Sadoon, M. K., 2001. Thermal selection and metabolic rate of the skink, *Scincus hemprichii* Wiegmann, 1837 (*Scincidae*; Reptilia). Zool. Soc. A. R. Egypt , 36: 89-102.

Al-Sadoon, M. K. and I. F. Spellerberg, 1985. Comparison of thermal acclimation effects on the metabolism of *Chalcides ocellatus* (desert lizard) and *Lacerta vivipara* (cool-temperate lizard). Comp. Biochem. Physiol., 81: 939-943.

Al-Sadoon, M. K. and I. F. Spellerberg, 1987. Metabolism of the lizard *Chalcides ocellatus* (Forskal) from Egypt. J. Arid Environ., 12: 159-168.

Andrews, R. M. and F. H. Pough, 1985. Metabolism of squamate reptiles: allometric and ecological relationships. Physiol. Zool., 58: 231-241.

Bennett, A. F., 1982. The energetics of reptilian activity. In Gans C. and Pough F. (Eds) Biology of the Reptilia. London. Acad. Press. 13: 155-199.

Bennett, A. F. and W. R. Dawson, 1972. Aerobic and anaerobic metabolism during activity in the lizard *Dipsosaurus dorsalis.* J. Comp. Physiol., 81: 289-299.

Bennett, A. F. and W. R. Dawson, 1976. Metabolism. In Gans C. and Dawson W.R. (Eds) Biology of the Reptilia. London. Acad. Press., 5: 127-223.

Buikema and Armittage, 1969. The effects of temperature on the metabolism of the prairie ringneck snake, *Diadophis punctatus arnyi* Kennicott. Herpitologica, 25: 194-206.

Cloudsley-Thompson, J. L., 1972 Temperature regulation in desert reptiles. Symposium of the Zoological society of London, 31: 39-59.

Dawson, W. R., 1976. Interspecific variation of physiological responses of lizards to temperature. In Milstead W. W. (Ed) Lizard Ecology: A Symposium. Columbia. University of Missouri Press., pp: 230-257.

Heusner, A.A., 1982. Energy metabolism and body size. 1. is the 0.75 mass exponent of Kleiber's equation a statistical artifact? Respiratory Physiology, 48: 1-12.

Snyder, G.K., 1975. Respiratory metabolism and evaporative water loss in a small tropical lizard. Journal of Comparative Physiology, 104: 13-18.

Thompson, G.G. and P.C. Withers, 1997. Standard and maximal metabolic rates of goannas (Squamata: Varanidae). Physiol. Zool., 70: 307-323.

Vernet, R., M. Lemire, and C.J. Grenot, 1988. Ecophysiological comparisons between two large Saharan lizards, *Uromastix acanthinurus* (Agamidae) and *Varanus griseus* (Varanidae). J. Arid Environ., 14: 187-200.

Wickler, S. J. and T.T. Gleeson, 1993. Lactate and glucose metabolism in mouse (*Mus musculus*) and reptile (*Anolis carolinensis*) skeletal muscle. Amer. J. Physiol. II, 264: 487-491.

Zari, T.A., 1991. The influence of body mass and temperature on the standard metabolic rate of the herbivorous desert lizard, *Uromastyxs microlepis*. J. Thermal Biol.

Zari, T.A., 1992. Effects of temperature on resting metabolism of two species of juvenile nocturnal geckos, *Hemidactylus turcicus* and *Ptyodactylus hasselquistii* (Reptilia: Gekkonidae) in Jeddah, Saudi Arabia. Comp. Biochem. Physiol., 102: 491-495.

Zari, T.A., 1993. Effects of body mass and temperature on standard metabolic rate of the desert chameleon *Chamaeleo calyptratus*. J. Arid Environ., 24: 75-80.