The relations between soil permeability, the gaseous environment of burrows and acid&base physiology of rodents

Abstract

We propose to investigate the relationship between ecophysiological aspects of the life of a semifossorial desert rodent, Sundevall's jird (*Meriones crassus*) in the context of the physical properties of the soil in which their burrows are built. Our **first objective** is to assess the relative contributions of convection and diffusion through the soil to the overall exchange of gases between the burrow and the atmosphere. We hypothesize that the mechanisms of exchange will vary between different parts of the burrow depending on burrow geometry. We predict that in parts of the burrow that are relatively deep, far from openings or in dead-ended chambers diffusion is the dominant mechanism for the exchange and that the rate of diffusion depends on soil porosity. In order to determine the dominant mechanisms of burrow-atmosphere gas exchange we will measure the concentrations of respiratory gases at different locations in the burrow before it is occupied, during periods when the rodent is resting and when it is active and examine the effects of reduced soil porosity on the respiratory gas composition in different parts of burrows. We further hypothesize that in places where diffusive gas exchange dominates, and in which one or more animals reside, FCO_2 will be well above atmospheric values. Therefore, our **second objective** is to quantify the relations between the physical properties of the soil and the concentrations of respiratory gases in different parts of burrows, and especially in brood chambers, where we assume that the most extreme conditions prevail. High inspired FCO_2 may lead to respiratory acidosis, with possible pathological consequences. In addition, rodents urinate in their burrows, and bacterial decomposition of urinary urea is a potential source of NH_3 that causes respiratory alkalosis and is toxic even at low concentrations. Thus, our **third objective** is to investigate the physiological attributes that enable semi-fossorial rodents to tolerate high FCO_2, and alternate between high and low CO_2 environments and to address the question of whether the jirds enjoy reciprocal physiological compensation between NH_3 and CO_2 in environments where both gases are present. In the laboratory, we intend to a) measure relevant acid-base variables in intact animals, whole blood, and plasma equilibrated to simulated burrow conditions; b) test the tolerance of adult and young Sandevall's jird to high concentrations of CO_2; c) measure the responses of blood acid-base variables to short-term changes in CO_2 concentrations; and d) test a model of reciprocal compensation between CO_2 and NH_3. Our **forth objective** is to compare acid-base and blood buffering variables between adult and young jirds, and compare these with the same variables of other species of semi-fossorial rodents (Fat sand rats, *Psammomys obesus*, Levant voles, *Microtus guentheri*) and a fossorial one (Middle East blind mole rat, *Spalax ehrenbergi*). Since Adult jirds are free to move in and out of their burrows and young cannot, we predict the acid-base attributes of adult jirds and other adult semi-fossorial rodents will be similar, whereas those of juvenile jirds will be similar to those of the fossorial Middle Eastern mole rat. We will use several novel techniques; including mapping burrows using remote-sensing methods (*i.e.* ground penetrating radar) and directly measuring the gas composition in chambers occupied by the jirds, overcoming shortcomings of other studies. The importance of this study lies in the general implications it might have concerning our understanding of the hundreds of endothermic vertebrate species, mammals and birds, that spend much of their lives in burrows and cavities, especially in light our paucity of knowledge concerning the gaseous environments of these important habitats.