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A study of the anatomy and physiology of sleep in African rodents with unusual phenotypes and life histories

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PhD Thesis

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Abstract:

Studies of sleep in rodents have mainly focussed on the laboratory rat and mouse, and while all these studies are important they do not allow for inferences or predictions to be made regarding sleep phenomenology when changes in body size, brain size, phylogeny or natural history occur within a mammalian order. This thesis investigated the anatomical and physiological aspects of sleep in five unusual rodent species – the African pygmy mouse (*Mus minutoides*), the agouti (*Dasyprocta agouti*), the greater cane rat (*Thryonomys swinderianus*), the East African root rat (*Tachyoryctes splendens*) and the Cape mole rat (*Georychus capensis*). Upon investigation of the cholinergic, catecholaminergic, serotonergic and orexinergic systems in all five species I found that there was no discernible difference in the complement and number of nuclei in these systems despite very large differences in brain size, other phenotypes and natural history. The only real difference seen was in the pygmy mouse, where cortical cholinergic neurons were present and the A6 locus coeruleus had a different appearance to that seen in non-Murid rodents. These sleep-associated nuclei, which are responsible for the generation and regulation of both wake and sleep states appear to show strong similarities in the neurophysiological expression of wake and sleep across mammals. Furthermore I investigated the calcium-binding proteins parvalbumin, calbindin and calretinin as a means to investigate the GABAergic system associated with the above mentioned sleep-related nuclei. There was a global consistency in this system across species and thus it does not appear that the GABAergic neurons play a substantial role in the amount of time spent in a particular state, and appear to be more involved in the production and maintenance of a state than global amounts of time spent in a state. I investigated sleep physiology in two of the five species – the Cape mole rat and the East

African root rat. I found that the Cape mole rat compared most favourably with the giant Zambian mole rat previously studied. While on average over a 24-hour period, the East African root rat spent only 2.2 h in sleep (both non-REM and REM), this being the least amount of sleep recorded in any rodent, or indeed any mammal, studied with electrophysiological methods to date. This thesis has therefore shed light on the role played by the sleep-related nuclei in the global picture of sleep, but with the discovery of the root rat as the shortest sleeper there are many new questions to ask.