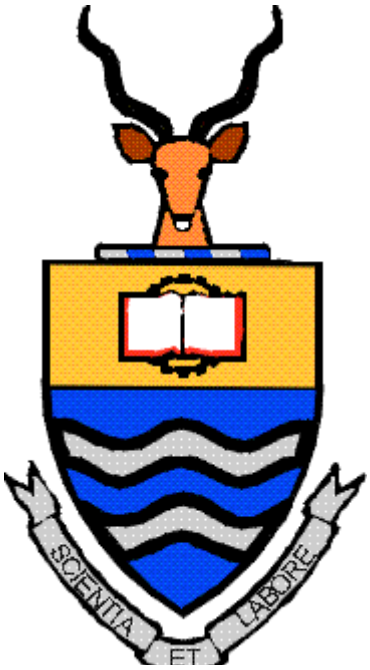
Anatomical aspects of the domestic ferret and banded mongoose brain – small brained representatives of the caniform and feliform carnivoran lineages: a case study in evolutionary neuroanatomical plasticity



Sashrika Pillay-Addinall

385522

This thesis is submitted in fulfillment of the requirements for the degree of Doctor of Philosophy

SCHOOL OF ANATOMICAL SCIENCES

UNIVERSITY OF THE WITWATERSRAND

JOHANNESBURG

October, 2020

Abstract

The banded mongoose and domestic ferret are species belong to the two diiferent suborders within the order Carnivora, the feliforms and caniforms respectively. They lasy shared a common ancestor over 50 million years of evolution, have undergone distinctly different evolutionary trajectories, and yet they display similar morphophysiological and behavioural traits. Thus, analysis of brain morphology of these two species may provide insight into, and enhance our knowledge of, the evolution the brain in mammals (Manger, 2005). The revelation of evolutionary processes may help to understand the processes experienced during human brain evolution. By examining species within the same mammalian order, specifics of what stays the same and what changes can be determined within set phylogenetic limits, and how this stasis or variance relates to a more generalized picture of brain evolution. To this end the current thesis provides a comprehensive architectural and chemical neuroanatomical analyses of portions of the central nervous system of the of both the banded mongoose and domestic ferret, including qualitative and quantitative analyses of the organization and morphology of the cholinergic, catecholaminergic, serotonergic and orexinergic nuclear systems, the hippocampal formation, diencephalon, and amygdaloid body. The studies forming this thesis revealed that overall the general architecture and nuclear organization of the component parts of the central nervous system investigated are similar to those observed in other mammals. These findings raise a strong argument for the strong influence of phylogenetic constraints in the conservation of the general morphology of the mammalian brain across significant phylogenetic distances. Despite this, many specialized features and differs in the chemoarchitecture were noted between the banded mongoose, domestic ferret, and other mammals. A few of these that are of particular interest are the unusual features of some of the nuclear clusters associated with the cholinergic and serotonergic systems that appear to be associated with the functional

demands to cope with the life stressors experience by carnivores, the unique visual system, thalamic reticular nucleus and the periamygdaloid cortex of the corticomedial nuclear complex in the amygdala found in the domestic ferret, that may be features specific to the family Mustelidae. These observations indicate that interesting avenues for developing a greater understanding of the behaviour of these two species, and other carnivores, should focus on the functional aspects of these areas of the brain. Moreover, investigation of these unique features may yield a wealth of knowledge that will help us understand the extent to which adaptive evolutionary plasticity exists in the context of mammalian brain evolution.