

Biology of the south-west carpet python (*Morelia spilota imbricata*): is there evidence for mesopredator release in response to fox baiting?

This thesis is presented for the degree of Doctor of Philosophy

By

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"In the end we will conserve only what we love.
We will love only what we understand.
We will understand only what we are taught."

Baba Dioum, 1968

I declare that this thesis is my own account of my research and contains as its main content of work, which has not previously been submitted for a degree at any tertiary education institution

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ABSTRACT

The complexity of ecological networks and ecosystem function has been debated amongst ecologists since the early 1900s. Increasing anthropogenic interference to ecosystems, including habitat loss through land clearing and introduction of exotic species, have provided additional complexity to the functioning of native ecological networks. Greater understanding of such complex and dynamic ecosystems is informed by gaining recognition of the role of top-order (apex) and mesopredator (lower-order, usually smaller-sized) species in the regulation of energy transfer within an ecosystem. This thesis investigates the mesopredator release hypothesis (MRH) by examining the biology of the Near-Threatened south-west carpet python (*Morelia spilota imbricata*) as a native mesopredator species to a population control program of an apex exotic species, the red fox (*Vulpes vulpes*).

Conventional methods, including mark-recapture studies, to quantify population trends of *M. s. imbricata* are impractical in this cryptic species, which cannot be trapped by enticement. Focal animal studies examining the ecology, physiology, and behaviour of pythons through radiotelemetry monitoring were carried out between 2006 to 2008, in fox baited and unbaited areas of coastal woodland and in fox baited areas of the northern jarrah forest in south-west Western Australia. Pythons were initially captured after they had ingested a radio-collared western ringtail possum (*Pseudocheirus occidentalis*, n=14) or through opportunistic sightings (n=32). Forty-six pythons were surgically implanted with radiotransmitters into their coelomic cavity under anaesthesia; where body size permitted, temperature data loggers were also attached to the transmitters. Initially pythons were able to expel the implanted radiotransmitters. A novel technique was developed to prevent radiotransmitter expulsion involving anchoring the radiotransmitter to the rib-cage of the python with a non-dissolvable

suture. Implementation of this technique led to the successful retention of all the implanted devices, and this surgical implantation technique has been published as an independent study (see Chapter 3).

Haematological and biochemical analyses were undertaken to investigate whether there were any health effects of surgically implanting the radiotransmitters. Blood samples from 43 wild-caught *M. s. imbricata* were collected into lithium heparin from the ventral coccygeal vein at various stages over the study. Reference ranges are reported for 35 individuals. Since pythons had radiotransmitters surgically implanted, repeated sampling of the same individuals could be carried out allowing further investigations of how various factors (study site, season, sex, time in captivity and the presence of haemogregarine parasites) affect haematology and biochemistry measures. There was no significant effect of sex, time in captivity or the presence of a haemogregarine parasite on blood parameters. Erythrocyte measures were influenced by study site, season, stage of radiotransmitter implantation and time in captivity. In terms of leucocytes, only basophil numbers were influenced by the python's anaesthetic state and stage of radiotransmitter placement. Albumin, globulin (and the ratio between the two) and calcium and phosphorous were influenced by season, anaesthetic state, and the stage of radiotransmitter placement. No intrinsic or extrinsic factors appeared to affect creatinine kinase, aspartate aminotransferase, uric acid, or total protein. This study demonstrates that various factors including season, time in captivity, location and anaesthetic state will influence blood parameters of *M. s. imbricata*. Because these animals are increasingly common as pets, veterinarians should be aware of the influence of these factors when diagnosing the health status of individuals. This haematological investigation has been published as an independent study (see Chapter 4).

To measure the physiological and behavioural response of *M. s. imbricata* to fox control, weekly radiotelemetry monitoring of animals at the study sites was carried out

over the three years. Body condition changes, age differences, and mortality events, were assessed to determine differences in the survivorship of pythons. Counterintuitive to the MRH, higher mortality rates and faster body condition declines occurred at the fox baited sites.

Information on reproductive output was gathered to investigate whether pythons had a greater fecundity in the presence of fox baiting. Adult females were regularly palpated and any mating events were recorded. This intensive animal monitoring suggested that there were higher rates of reproductive output at the fox baited coastal woodland area. However, there were also very high rates of female mortality following parturition at this study area, which may negate or slow overall population increases, particularly as pythons are capital breeders and require an accumulation of body reserves to be reproductively successful.

As pythons and foxes share similar prey resources, it was predicted that there would be greater diversity of prey consumed by pythons at the fox baited site. This prediction was investigated through diet analysis of 47 scats collected from 24 individuals at the coastal fox baited and unbaited sites. The ability to collect numerous scats from all individuals was limited given pythons have very low metabolic rates in comparison with endothermic carnivores (e.g. cats), and that they spend long periods over winter months inactive, often sequestered in tree hollows. Although sample size varied between the fox baited and unbaited site, the analysis indicated that the diversity of prey consumed by pythons across treatment areas was similar.

Pythons were assessed for potential behavioural avoidance to the presence of foxes. Pythons at the fox baited sites did not show temporal segregation during hunting to avoid the intraguild killer, as there was no difference in the proportions of diurnally-active prey or nocturnally-active prey in the diets of pythons at either site. However, a higher proportion of pythons at the unbaited site were observed in the most cryptic

microhabitat (tree hollows) more often than pythons at the baited sites and also used tree hollows for longer over winter. However, in contrast to predictions for landscape-mediated avoidance (to avoid potential exposure to foxes), pythons at the unbaited site were seen more often in the most exposed body position (stretched) compared to pythons at the baited site.

Focal animal monitoring through radiotelemetry also allowed further investigation into python ecology, physiology and behaviour. Through dietary analysis coupled with thermal biology, a current foraging theory in snake biology was challenged: I tested whether the temporal window for foraging by smaller-sized snakes (which have a low thermal inertia and therefore cool rapidly at nightfall when air temperatures fall and opportunities for basking are reduced) is restricted to diurnal hunting, cf. larger-sized snakes that may better retain body heat (higher thermal inertia). There was no evidence that having a small body size thermally-restricted the temporal window for ambush foraging in *M. s. imbricata* as hourly measures of heating and cooling (rates of change in python body temperature) were not different from those of larger-bodied snakes. Small pythons were able to successfully hunt on crepuscular and nocturnal prey species such as small carnivorous marsupials as indicated through scat analysis. This study has been published as an independent study (Chapter 5).

As habitat selection can influence many physiological facets of animal life, the thermal conditions of microhabitat retreat sites may be very important for ectotherm physiology. The use of tree hollows by pythons over winter was investigated for possible thermal advantages over the alternative microhabitat resources. Temperature data loggers were placed within a range of microhabitats and were coupled with recordings of python body condition and temperature as well as air temperature. When sequestered in tree hollows, pythons had colder daily average and maximum body temperatures (cf. pythons that used other microhabitats), but this did not give them a

metabolic advantage (in terms of body condition scores) over winter. It was found that a greater proportion of pythons at the unbaited study site used tree hollows as winter retreats more, and for longer, compared with pythons at the baited coastal woodland site, suggesting that foxes may influence this microhabitat selection behaviour in pythons. Tree hollows provide a critical refuge over winter when python body temperature is low and their responsiveness is limited, rendering individuals extremely vulnerable to predation by terrestrial predators such as the introduced red fox. As a result of land clearing practices, habitat fragmentation, and competition with other hollow-using species it is very likely that tree hollows are a limited resource for pythons. This study indicates the conservation importance of tree hollows for *M. s. imbricata*. This study has been published as an independent study (Chapter 6).

This PhD research is the first attempt to quantify the impact of removal of an apex predator (the red fox) upon a native snake species. This was achieved by intensive focal animal monitoring and outlines the functional and numerical responses of this ectothermic species to the potential change in prey density as a consequence of removal of the fox. This study also investigates additional biological information essential to predict any future responses of other temperate ectothermic species to wide-spread control of introduced or native apex predators.

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