THE ROLE OF LONG-ACTING CONTRACEPTIVE IMPLANTS TO MANAGE HIGHLY-VALUED MARSUPIALS IN AUSTRALIA

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Introduction

Over the last two decades, wildlife management agencies in Australia have been faced with a new challenge; to manage overabundant native marsupial species within a socio-political climate that often demands the use of non-lethal control methods. This changing social ethos has driven research and development of new bio-technological approaches to wildlife management that aim to reduce/regulate population size by reducing the reproductive capacity of the population (i.e. fertility control). The fertility control field of research has been driven by the notion that it is more humane to prevent the birth of new animals in overabundant populations, thereby limiting population growth, rather than allowing reproduction to occur unabated and subsequently needing to cull individuals.

Overabundant koala and kangaroo populations – the need for non-lethal control

In Australia, the management of overabundant koala and kangaroo populations can be highly contentious. Although the koala (*Phascolartos cinereus*) is classified as *Vulnerable* within some areas of Australia, and was recently included on the National Threatened Species list in some regions, there are numerous koala populations within the south of their range which have exceeded the carrying capacity of their environment, causing widespread tree defoliation and habitat degradation {Menkhorst:2008wl}. The prevailing social attitude towards koalas, both nationally and internationally, has resulted in the rejection of lethal control techniques from all levels of government in all States of Australia.

Kangaroo populations are generally believed to have increased throughout their range since European settlement. In rural areas, regulated culling programs allow for commercial and non-commercial harvesting to manage these populations. However, on the east coast of Australia, particularly near urban centres, culling is logistically difficult and socio-politically unacceptable {Herbert:2007uu}. As such, these kangaroo populations (usually eastern grey kangaroos, *Macropus giganteus*) need to be managed by alternative means.

Fertility Control

To date, large-scale fertility control operations have predominantly utilised laparoscopic surgical sterilisation techniques, particularly in the case of overabundant koala populations {Duka:2005it} and for kangaroo populations to a much lesser extent {Herbert:2004wt}. Thousands of female koalas have undergone tubal ligation surgery in Victoria and South Australia over the last 15 years. However, the invasive nature of surgical sterilisation, along with the high cost, has meant that scientists and wildlife managers have been investigating alternative, non-surgical, approaches to fertility control. Three candidate contraceptive options have been investigated in this vain – steroidal and non-steroidal contraceptive implants and immunocontraception {Herbert:2010tn}. In this paper, I will focus on one such contraceptive technique, a non-steroidal contraceptive implant.

Suprelorin® is the trade name for a long-acting contraceptive implant, containing the gonadotrophin-releasing hormone (GnRH) agonist deslorelin. This product has been developed by a local Australian biotechnology company (Peptech Animal Health) and is registered as a treatment for prostatic hyperplasia in dogs. This implant, which inhibits reproduction in male and female dogs, also successfully inhibits reproduction in females of a range of marsupial species including koalas, eastern grey kangaroos and tammar wallabies (*M. eugenii*). Initial investigations of this implant in marsupials extensively characterised the effects on their reproductive physiology, where it was found that Suprelroin inhibits reproduction by shutting down the production of hormones from the pituitary. The downstream effects are inhibition of follicular development and disruption of oestrous cycles, so that females are in a permanent state of anoestrus whilst the implant is still releasing its active ingredients {Herbert:2010tn}. Contraception generally lasts for approximately 18 months in most species and captive trials have not detected any negative behavioural side-effects in kangaroos {Woodward:2006fh}. This implant was initially formulated with hand-injection of individual animals as the method of administration, and therefore requires animal capture.

Field Trials
Over the last five years, researchers associated with the Koala and Kangaroo Contraception Program have trialled this contraceptive implant in different marsupial species under various field conditions. This includes koalas on French, Raymond and Kangaroo Islands; eastern grey kangaroos in the peri-urban areas of Melbourne; western grey kangaroos (*M. fuliginosus*) in peri-urban areas of Perth; black-flanked rock wallabies (*Petrogale lateralis*) in the Western Australian (WA) wheat belt and tammar wallabies on the Abrolhos Islands, WA {Herbert:2007uu}. This research has highlighted some of the key issues that influence the likely efficacy of this contraceptive approach to management of free-living marsupial populations.

Contraceptive Longevity
There are significant differences in the contraceptive duration between different marsupial species, which will clearly influence efficacy. These variations need to be considered within the context of the seasonality of breeding and the reproductive lifespan of the species/population to determine overall efficacy and cost efficiency. For example, in seasonally breeding species, it may be possible to time implant administration such that an 18 month period of contraception effectively inhibits breeding for two consecutive breeding seasons, thereby effectively achieving reproductive suppression for a period equivalent to two years.

There are also significant variations in reproductive lifespan both within and between species. In marsupials, it is not clear to what extent reproductive senescence occurs, and so in most cases reproductive lifespan is generally equated to the period of time between puberty and death. This can vary dramatically between different populations of the same species, and even within the same population temporally. These variations between/within populations usually reflect local resource availability, which in very broad terms could be considered a function of nutrient availability, substrate, prevailing climatic conditions and the density of animals within the population.

Ease of Capture
As the Suprelorin contraceptive implant currently requires animal capture for administration, the ease with which animals can be captured will dramatically affect efficacy. We have conducted trials and/or extensive animal capture for multiple populations of koala, eastern grey kangaroo and tammar wallaby, and have found that the ease of capture varies greatly between populations.

In the case of koala, ease of capture (and ease of finding individual animals) varies greatly, predominantly in relation to tree height and canopy cover. On some of the smaller islands off the Victorian coast, the trees are much smaller than in other areas, which means that animals are generally easier to find and it is relatively easy to facilitate capture from the ground, or with minimal climbing. Conversely, on some areas of Kangaroo Island, animals can be difficult to locate, despite intensive search effort, and often reside in large trees > 20m height. This means there is intensive search effort and that climbing to effect capture is more time consuming, sometimes impossible, and more dangerous for staff.

For eastern grey kangaroos, catchability varies in different habitats and is predominantly related to the degree of habituation to humans. At one extreme, kangaroo populations residing on golf courses tend to be extremely habituated to people, thereby facilitating ease of capture using immobilisation drugs injected from a pole syringe. At the other end of the scale are populations that either have had little interaction with humans and/or have had negative interactions with humans, particularly in areas of extensive habitat. In these populations, it can be exceptionally difficult to get within sufficient distance to safely attempt to dart animals, meaning that the time required to dart (and hence capture) an animal makes the process prohibitively expensive.

In terms of smaller macropod species, we have experienced varying degrees of capture success in different tammar wallaby populations. In habituated island populations, which are perhaps used to associating people with additional food sources, capture efficiency is relatively high (e.g. North Island within the Abrolhos archipelago). Catchability also varies in relation to local resource abundance. In populations that were subject to exceptionally harsh conditions, with little free-standing water and poor vegetation quality, animals readily entered traps (e.g. East Wallabi Is.). At the other end of the spectrum, in populations where there is abundant food and negative interactions with humans (through culling operations), trapability is quite low.

Overall Management Objective
The overall management objective can vary markedly between populations, from limiting population growth and stabilising the population at the current density, to achieving a significant reduction in density. In these two different scenarios, the proportion of animals within the population that need to be treated varies, with a greater proportion of animals needing to be treated to reduce the population density as opposed to limiting additional population growth.

Timeliness of Action
Fertility control does not have immediate effects on the population. As it does not involve removal of adult animals, there is a lag time between initiation of treatment and a detectable decline in the population. Assuming sufficient numbers of individuals are treated, fertility control may achieve a significant reduction in population recruitment rate from the next breeding season, but a reduction in population density will not occur until the mortality rate exceeds the birth rate within the population. As such, the timeliness with which fertility control is applied is key to achieving the desired population density, which ideally means that fertility control should be applied earlier in the population growth phase than traditional control techniques, such that the population does not actually reach detrimentally high population densities and limiting population growth will be sufficient to minimise population impacts.

Cost Efficiency
To determine the relative cost efficiency of various fertility control operations in different environments requires a detailed cost-benefit analysis. In very crude terms, at the individual animal level, this cost-benefit analysis needs to take account of:

- Cost of administering fertility control, including time to locate animals for treatment, animal capture costs (e.g. immobilisation drugs, darts, climbing gear), cost of the actual fertility control agent (e.g. contraceptive implants, cost of surgical sterilisation etc.), time until return of the animal to the site of capture
- Net period of infertility (or time between successive treatments if ongoing control is desirable), which may be equivalent only to the contraceptive longevity, or include an additional lag period associated seasonal anoestrus
- Reproductive lifespan of females within the population

The two later factors, net period of fertility control and reproductive lifespan of females, can then be used to determine the number of times within a lifetime that an individual female would need to be treated if the aim is to achieve long-term reproductive suppression akin to permanent sterilisation. This figure can then be multiplied by the cost of a single administration. Clearly this is a slightly simplistic view of cost efficiency, as it only focuses on the reproductive potential of the individual animals and does not take account of the number of animals that need to be treated to achieve the desired damage mitigation outcomes, which will change over time as the population density and interaction with the environment changes. Also, it does not take account of likely changes in the efficiency of animal capture as population density declines and/or individual animals become more wary of animal capture operations. However, it does provide a rough ballpark figure of the relative cost of different fertility control methodologies to achieve long-term reproductive suppression and at least draws attention to some of the key variables in determining the cost of different methods.

Recent Technical Advances in Contraceptive Technology

Over the last five years significant advances have been made with the development of a prototype dart to facilitate remote delivery of the Suprelorin contraceptive implant, which will thereby enhance the potential efficacy of this approach for the management of free-living populations by reducing the cost of administering an individual implant.

Conclusions

Over the last two decades significant advances have been made within the fertility control field, such that there are contraceptive products that are readily available for use in free-living marsupial populations. These advances have included enhancing contraceptive delivery techniques to improve the efficacy of more widespread application under field conditions. Despite these advances, there are still clear limitations to the types of situations in which this management approach can be utilised. We therefore need to conduct scientifically informed field trials utilising available fertility control agents to facilitate the development of clear guidelines to highlight the applicability of this form of control for different types of populations and to ensure the judicious use of this approach to population management.