Conservation endocrinology - applying scientific knowledge to a practical problem

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Over the last ten years, conservation managers have become increasingly aware of the relevance of endocrinological knowledge to animal conservation. By corollary, endocrine scientists have also become aware of the potential applications of their research. For example "Environmental & Conservation Endocrinology" was the overall theme of the Third World Congress of the Asia & Oceania Society for Comparative Endocrinology in 1996. Among the special symposia were sessions on Environmental Endocrine Disruptors, Natural and Captive Breeding of Endangered Species, and Endocrinology of Seasonal Breeding in Birds. In this paper I will first outline some of the ways in which endocrine science may be applied to the conservation of avian species, and, second, summarise some case studies that have been reported in the scientific literature.

As species numbers fall, conservation managers must sometimes become very creative in the ideas and techniques that they employ. They may need to apply principles from nutrition, stress physiology, behavioural ecology, genetics or veterinary medicine in their attempts to conserve endangered species. However, they are necessarily working with a small number of animals; they may not have the luxury of being able to set sample sizes for experimental protocols, and may have to work with very limited data. The quality of any scientific information generated at this stage may become an issue. There is also the ultimate ethical debate of whether or not any resources at all should be put into saving individual species that are very near extinction.

Generally, reproductive endocrinology has been most utilised in conservation because, of course, reproduction is essential for the survival of any species. Captive breeding is often used as a means of supplementing reproduction in the wild, the intention being that resulting offspring may be reintroduced to an area in which the species is now extinct or extremely rare (eg orange-bellied parrots; kakapo). Some very complex reproductive technologies are now being applied to endangered mammals such as pandas. Although work on avian species has yet to reach such technological heights, comparative endocrinologists can provide relevant information in such areas as:

- the timing of annual gonadal cycles;
- assessment of the activity of the reproductive axis (eg providing information on the proportion of the population that is reproductively active);
- devising effective hormonal means of stimulating gonadal development;
- devising means of stimulating expression of breeding behaviours in captive individuals;

- determining whether there are deficits in endocrine function that, if identified, may be remedied by artificial hormone treatment (eg failure to mature/show breeding behaviours).

However, especially with captive populations, reproductive physiology cannot be considered in isolation from environmental influences. In particular, endocrine studies may be designed to provide information on:

- interrelationships between stress and the reproductive axis.
- environmental constraints on breeding success, either in the wild or in captivity.

Some specific endocrine techniques that have been applied to conservation-related projects include:

1. ***faecal steroid monitoring***

Steroid levels may be measured in urine or faeces, the collection of which should not stress valuable animals. This non-invasive method of hormone monitoring is gaining wider usage, although it is critical that assays are first validated by comparison with plasma profiles. Often it is hormone metabolites rather than the natural hormones themselves that appear in the faeces or urine. Also, there is an inevitable time lag between the appearance of, say, maximal hormone in the blood and maximal excretion while hormone excretion rates may vary through the annual cycle.

2. ***"hormone replacement therapy"***

It is obviously not acceptable to inject valuable rare animals with hormones when treatment might have to continue for several weeks to mimic, for example, the gradual increase in hormone concentrations at the start of the breeding season. An alternative is to insert "osmotic pumps" under the skin. Pumps containing LH & FSH can be implanted in the peritoneal cavity by a simple surgical procedure and will deliver hormone for several weeks. They have been used successfully in quail to induce breeding out of season, but the technique has not yet been applied to any critically endangered species. So far it has proved difficult to induce ovulation, and there is a risk of the eggs becoming too large for laying due to overstimulation with FSH.

3. ***use of a comparator species for detailed study***

Sometimes it is just not possible to collect sufficient background data from individuals of a critically endangered species itself. An alternative is to collect samples from a closely related, but not endangered species, as a model. Then "single spot" samples from the endangered species can be compared with the more detailed information from the model species, and a plan of action developed.

Case study 1 : **Japanese Crested Ibis, or Toki**

The model species for exploration of reproduction in the gravely endangered toki has been the closely related white ibis. Importantly, comparisons of breeding individuals versus non-breeders suggested that monitoring hormone levels could provide information on hormone deficits in individuals that fail to breed. Limited blood samples were available from toki, but there were

enough to show that general trends did follow those of the white ibis. Faecal hormone monitoring has also been used successfully to pin-point deficits in reproductive function in toki.

REF: Wingfield, John W. et al. (2000). Biology of a critically endangered species, the Toki (Japanese Crested Ibis) Nipponia nippon. Ibis 142: 1-11

Case study 2: the Kakapo

In 1995, there were about 60 birds remaining, about 33 males and 17 females, the youngest of which is about 26. Thus the conservation of this species will require maximising the reproductive output of every female. Measurement of testosterone and estradiol in kakapo droppings through an annual cycle revealed definite annual patterns. The ratio of T:E in faeces was used as a measure of gonadal activity: the ratio will be highest in male birds when their testes are large and their plasma testosterone high. In female birds, the ratio will be lowest during the time of greatest ovarian activity, when plasma estradiol is likely to be at a peak. The ratio of T:E in the kakapo droppings showed a clear annual cycle with a peak in late spring/summer over 2 years, suggesting that the pattern reflects gonadal activity in the males rather than the females.

REF: Cockrem, J. 1995. Non- invasive assessment of the annual gonadal cycle in free-living Kakapo (Strigops habroptilus) using fecal steroid measurements. The Auk 112: 253-257.

Case study 3: Swift Parrot

This species appears to be a classic case of a species that is becoming increasingly rare due to environmental constraints on reproduction. These include habitat loss per se, but also possible nutritional implications of loss of specific feeding opportunities during critical stages of the reproductive cycle. Measurements of sex steroid hormones in plasma have been used to determine the proportion of reproductively active individuals in the population, and such measurements correlated with nutritional status.

REF: Gartrell, B. et al. 2000. Morphological adaptations to nectarivory of the alimentary tract of the swift parrot Lathamus discolor. EMU 100: 274-79