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# **Corticosterone responses to stressors and the regulation of the hypothalamic-pituitary-adrenal axis in Japanese quail**

A thesis presented  
in partial fulfilment of the requirements  
for the degree of  
Doctor of Philosophy  
in Physiology

at Massey University, Palmerston North  
New Zealand

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2003

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## Abstract

Corticosterone is the major adrenal glucocorticoid in birds. It is secreted in response to stressors, with plasma concentrations typically rising to a peak within 10 to 15 minutes and then declining over 30 to 60 minutes once the stressor is removed. The increase in corticosterone is thought to help the animal to adjust to the stressor, although corticosterone may also inhibit the reproductive axis. The corticosterone response to a stressor varies between individuals, although the level of the hypothalamic-pituitary-adrenal axis at which this variation arises in birds has not been identified.

The goals of this research were to determine in Japanese quail (*Coturnix coturnix japonica*): (1) the effects of corticosterone and of various stressors on sex steroid secretion; (2) corticosterone responses to 5, 10 or 15 min exposure to manual restraint and 15 min exposure to different stimuli; (3) quantifying individual variation in the corticosterone response; and (4) whether individual variation in the corticosterone response to stimuli used in goal 2 is regulated by differences in pituitary or adrenal sensitivity to corticotropin releasing factor (CRF) and adrenocorticotrophic hormone (ACTH) respectively.

A prolonged elevation in plasma corticosterone concentrations can inhibit reproduction. The effects of a short elevation in corticosterone are less understood, so the relationship between corticosterone and sex steroid secretion in quail was characterised by administering 1.2 mg corticosterone injections. Corticosterone treatment stimulated an increase in plasma corticosterone, while testosterone declined in both corticosterone-treated and control birds. Plasma LH was unaffected by challenge with corticosterone. Collectively, these data suggest that repeated handling associated with frequent blood sampling inhibited testosterone secretion directly at the testis.

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Corticosterone responses to a variety of novel stimuli were characterised. Manual restraint for 10 or 15 min caused a significant response whereas restraint for 5 min or less did not lead to an increase in corticosterone 15 minutes from the start of the stressor. Corticosterone responses to 15 min of mechanical restraint varied between birds whereas 15 min of manual restraint elicited a maximal plasma corticosterone response in all birds. Manual and mechanical restraint caused declines in plasma testosterone of a similar magnitude. There was more variation within than between birds in their corticosterone response to mechanical restraint. Despite this, the general pattern of the corticosterone response was repeatable for individuals.

Quail with low or high plasma corticosterone responses to 15 minutes of mechanical restraint were injected intrajugularly with a dose of ACTH that stimulated a sub-maximal corticosterone response. The plasma corticosterone response to ACTH did not differ between birds with low or high corticosterone responses to mechanical restraint, indicating that variation in corticosterone responses to restraint did not arise at the level of the adrenal gland. A preliminary study showed that injections of ovine CRF stimulated corticosterone secretion. However, CRF did not consistently stimulate an increase in plasma corticosterone in these birds and hence it was not possible to determine if pituitary responsiveness to CRF differed between birds with low or high corticosterone responses to restraint. These results indicate that variation in the corticosterone response between individual Japanese quail arises above the level of the adrenal gland in the HPA-axis, and may occur at the pituitary gland or due to differences in activation of neural pathways in the brain.



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## CERTIFICATE OF REGULATORY COMPLIANCE

This is to certify that the research carried out in the Doctoral Thesis entitled:

**“Corticosterone responses to stressors and the regulation of the  
hypothalamic-pituitary-adrenal axis in Japanese quail”**

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- (a) is the original work of the candidate, except as indicated by appropriate attribution in the text and/or in the acknowledgements;
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## Acknowledgements

I would like to thank my supervisor, Dr. John Cockrem, for his support, guidance, encouragement, and the opportunities to travel to Japan, India, Scotland and Antarctica during my studies. Thanks also go to Prof. Tim Parkinson for his constructive criticism and insight during my research.

This research was supported by funding from the Institute of Veterinary, Animal and Biomedical Sciences (IVABS) Postgraduate Research Fund. Personal financial support was provided by the Massey University Scholarship Committee. A special thanks to Prof. Hugh Blair and Allain Scott of the IVABS Postgraduate Research Office.

Many thanks go to past and present members of the Conservation Endocrinology Research Group; Janis Bridges, Jane Candy, Janie Girling, Guy Hessel, and Raewyn Wheeler for their help and ideas over the years. Thanks also go to numerous students and staff in the Institute of Veterinary, Animal and Biomedical Sciences for their support.

I am grateful to Professor Susumu Ishii (Department of Education, Waseda University, Tokyo, Japan) for his kindness and hospitality during my visit to his laboratory in Tokyo. I would also like to thank Dr. Motoshi Kikuchi (Waseda University) who assayed blood samples for gonadotrophins and thyroid hormones, and Dr Richard Talbot (Roslin Institute, Midlothian, United Kingdom) who assayed plasma prolactin. I would like to acknowledge the advice, comments, and hospitality of Dr. Tim Boswell, Dr. Ian Dunn, and Prof. Peter Sharp during my stay at the Roslin Institute. Thanks go in particular to Tim for helping to get the quail *c-fos* mRNA assay setup when all looked lost.

I am indebted to my fellow students, Ellen Bennett, Emma Hawke, Sharon Henare, David and Sarah Simcock, and Mhairi Sutherland. Thank you for all the help with my experimental work, but also for the years of encouragement through the thick and thin, the great laughs we've all had, and especially the friendships. Good luck to all you guys!

Finally, I thank my parents and my brother, whom I will always be indebted to for their support and encouragement. Last but not least, appreciative pats and hugs go to my dogs Marley and Yuki for the stress relief and reminding me who gave them their mischievous streaks.

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