

# Antarctic Science Bursary Progress Report

## Project title:

Growth and ageing in Adélie penguin chicks facing different environmental conditions

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## Project aim:

The objectives of this project were to test the effects of contrasting environmental conditions on the early-life of Adélie penguin chicks. To do this, survival, body condition, plasmatic parameters, oxidative damage, and telomere length were determined.

## Introduction

When breeding under conditions of limited food availability, animals may reduce offspring provisioning to avoid abandonment of the breeding effort, with negative consequences on offspring growth rates. Poor early-life conditions have been related to accelerated ageing through increased oxidative stress and telomere (highly conserved sequences at the end of chromosomes) erosion (Tarry-Adkins et al. 2013). Physiological stress, through the activation of the hypothalamic-pituitary-adrenal axis and consequent stress hormone (glucocorticoids) release, may also accelerate the ageing process (Hausmann & Marchetto 2010). While experiments carried out under controlled environmental conditions can help understanding the proximate mechanisms underlying the growth-ageing relationship, studies examining the effects of a bad early-life conditions on physiological parameters during growth in a naturally fluctuating environment remain scarce (Geiger et al., 2012). Adélie penguin (*Pygoscelis adeliae*) is widely distributed in Antarctica and its obligate association with pack ice makes it an interesting species to monitor the ecological consequences of environmental changes on bird physiology and survival in polar regions. The objectives of this study were to describe the effects of contrasting environmental conditions on the early-life of Adélie penguin chicks, in terms of body mass and size, stress hormone (corticosterone), antioxidant defences, oxidative damage, and telomere length.

## Method

This study was carried out during two consecutive austral summers with contrasting sea-ice conditions at Dumont d'Urville in Antarctica (66°40'S, 140°01'E), between December and February of 2010-2011 and 2011-2012. The protocol was approved by an ethics committee and authorised by the French Southern and Antarctic Lands. 20 nests in 2010-2011 and 90 nests in 2011-2012 were monitored. 24 chicks hatched on 15 nests and 73 on 49 nests in December of 2010 and 2011, respectively. The number of chicks per nest was monitored once a day from hatching until the end of the chick-rearing period. Chicks were sampled, weighed and measured 5, 20, and 42 days after hatching, and also (except sampling) at the beginning of the crèche stage. Plasma was assayed to determine corticosterone and non-enzymatic antioxidant capacity levels. Genomic DNA was extracted from red blood cells for sex determination, DNA oxidative damage, and telomere length measurements. Because of either

low plasma volume or DNA of poor quality for a few birds, some parameters could not be systematically assayed.

### **Preliminary results**

We observed increased oxidative stress levels, but not accelerated telomere erosion, in chicks growing in a year of extended sea-ice conditions. However, chicks that survived had a good body condition, and appeared to suffer no long-term consequences of harsh environmental conditions.

### **To be completed**

Upon completion of the statistical analyses (mixed modelling, Cox regression to assess whether a particular phenotype is associated with higher survival), a manuscript will be prepared and submitted.

### **Conclusion and future work**

These results suggest that the earlier costs of compensatory growth may consist of increased oxidative damage, and that ageing through reduced telomere length may occur later. It would be interesting to measure long-term effects of extended sea-ice conditions and consecutive nutritional restrictions during growth, however this would require monitoring hundreds of birds, which do not return on land until 3-5 years after they were born. An alternative explanation would be that Adélie penguin chicks are resistant to deleterious oxidative effects through mechanisms that remain to be elucidated.

### **Outcomes**

Thierry AM, Amélineau F, Boureau M, Class B, Couchet M, Zahn S, Criscuolo F & Raclot T. Growing in Antarctica: effects of extended sea-ice conditions on Adélie penguin chicks. XI<sup>th</sup> SCAR Biology Symposium. July 2013. Barcelona, Espagne (oral communication)

Thierry AM, Amélineau F, Boureau M, Class B, Couchet M, Criscuolo F & Raclot T. When penguins make the best of a bad situation: how severe environmental conditions affect Adélie penguin chick growth, physiology, and survival. Doctoral School Day. December 2012, Strasbourg, France (poster communication)

Manuscript in preparation: Thierry AM, Amélineau F, Boureau M, Class B, Couchet M, Criscuolo F & Raclot T. Harsh environmental conditions stress the importance of good physiological parameters to survive in Adélie penguin chicks

### **Acknowledgments**

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### **References**

- Geiger, S., Le Vaillant, M., Lebard, T., Reichert, S., Stier, A., Le Maho, Y., and Criscuolo, F. (2012) Catching-up but telomere loss: half-opening the black box of growth and ageing trade-off in wild king penguin chicks. *Molecular Ecology* 21, 1500-1510.
- Hausmann M.F., Marchetto N.M. 2010 Telomeres: linking stress and survival, ecology and evolution. *Current Zoology* 56, 714-727.
- Tarry-Adkins J.L., Martin-Gronert M.S., Fernandez-Twinn D.S., Hargreaves I., Alfaradhi M.Z., Land J.M., Aiken C.E., Ozanne S.E. 2013 Poor maternal nutrition followed by accelerated postnatal growth leads to alterations in DNA damage and repair, oxidative and nitrosative stress, and oxidative defense capacity in rat heart. *The FASEB Journal* 27(1), 379-390.