

The parent trap: breeding black guillemots (*Cepphus grylle*) in better body condition have higher levels of lipid peroxidation

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Summary

Honest signals, such as plumage color in cardinals, advertise current individual quality.

Increased oxidative stress is a cost of parenting, and is involved in the energetic tradeoff between annual reproductive effort and longevity.

We investigated whether foot color in a population of wild seabirds is indicative of oxidative stress and may be used as an honest signal of body condition.

Our results demonstrate that guillemot foot color becomes less red after the mate selection period. The responsiveness of foot color to environmental or life history situations suggests that guillemots may potentially use foot color to signal current quality. Also, antioxidant activity may help mediate foot coloration.



Black guillemot (*Cepphus grylle*)

Predictions

- Guillemot foot color redness will negatively correlate with catalase activity and lipid peroxidation (LPO).
- Catalase and LPO will positively correlate.

Measuring Redness



We took white-balanced digital photographs of guillemot feet under controlled lighting conditions and camera-to-foot distance. We normalized all digital photographs against a 24-color checker (GretagMacbeth, New Windsor, NY) using CieLab values. In Photoshop 7.0 (Adobe, San Jose, CA) we analyzed the CieLab values of each foot web and combined these into one number using principal component analysis.

Measuring Oxidative Damage

In July 2006 we captured adult black guillemots (*Cepphus grylle*) on their nests at Kent Island, a wildlife preserve and research station in New Brunswick, Canada. We collected 300-500uL blood samples from the brachial vein. We separated plasma and erythrocytes by centrifugation, added storage buffer to erythrocytes, and stored both at -20°C until used.

Catalase activity was measured in triplicate with the Catalase Assay Kit (Cayman, Ann Arbor, MI). We measured the activity of catalase in 20uL of a 1:10 dilution of erythrocyte lysate, using Purpald as a chromagen.

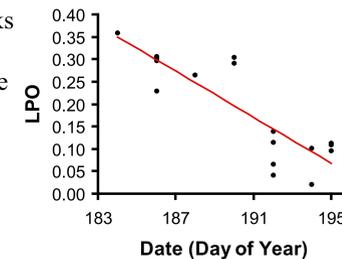
LPO was measured in triplicate with the BIOXYTECH LPO-586 kit (OxisResearch, Portland, OR) according to the MDA+HAE procedure, which we adapted for 96-well plates.



Lipid peroxidation (LPO) decreases during the incubation period

We found that LPO levels decreased over two weeks during incubation and chick rearing. This suggests that adults are under less oxidative stress later in the incubation period, or are better able to resist the same amount of stress.

We did not see a correlation between LPO and catalase.

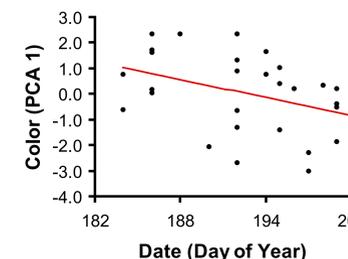


Foot redness decreases during the incubation period

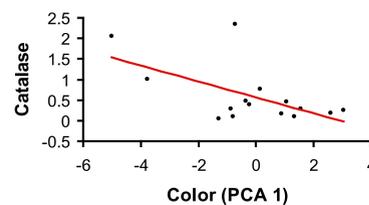
Over a two week period, foot redness decreased. Guillemot feet were darker and yellower earlier in the collection period; later, feet were lighter and more blue-green.

Assuming that yellow-red feet have higher concentrations of carotenoids than blue-red feet, we have two hypotheses to explain this finding:

- Because of a **change in the available diet**, guillemots had lower amounts of carotenoids to invest into foot coloration.
- **Foot coloration loses intensity after mate selection.**



Catalase decreases as foot redness increases



Birds with redder feet have lower catalase activity. This suggests that the quantity of carotenoids deposited in feet may be related to the activity of other antioxidants.

If catalase activity is highest when oxidative stress levels are elevated, then coloration of feet may advertise quality in terms of oxidative stress resistance.

If so, these results support the hypothesis that foot color is a reliable signal for individual quality in guillemots.

Future Work

• Future studies should **analyze the effects of reactive oxygen species on other cell components**. Our lab plans to assay the same blood samples analyzed in this study with the COMET assay, which measures **DNA breakage** as an indicator of oxidative damage.

• We are also interested in **whether foot redness correlates with circulating levels of carotenoids** in the blood.

• This study has been useful in the development of another research project in our lab: **whether plumage and beak redness in cardinals advertise the individual's level of oxidative stress**. Carotenoid-based coloration in cardinals is known to be a sexual signal indicative of individual quality in terms of characteristics like parenting ability and territory quality.

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Redness of feet may signal body condition in terms of oxidative damage in guillemots.