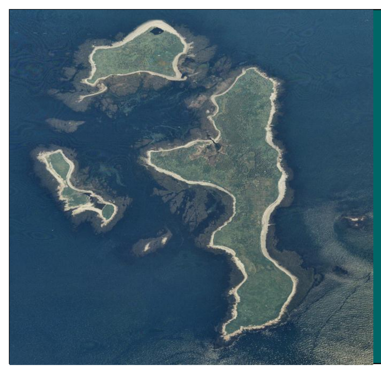


The Heat is On: Temperature and an Incubating Seabird

C.L. O'Connell[1], R.A. Mauck[1]

[1]Kenyon College, Gambier, OH

Global Temperature and

•Global climate change has increased summer air (Fig. 1) and sea surface temperatures at a Leach's storm-petrel (*Oceanodroma leucorhoa*) colony at Kent Island, in the Bay of Fundy, Canada.

•These data have been linked to this colony's reproductive success (Figs. 2 and 3)[1].

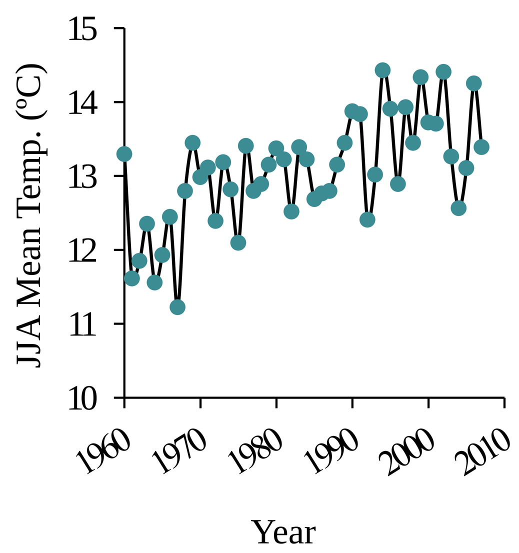


Figure 1. Mean annual air temperature at Kent Island from 1960 to 2010.

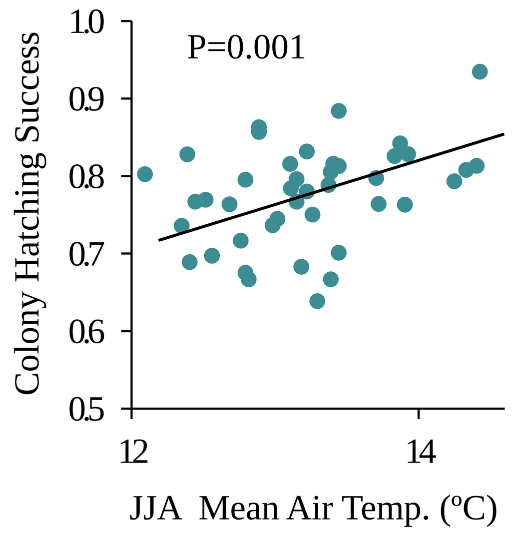


Figure 2. Mean annual hatching success (1955-2007) increases with air temperature.

•Over a 44-day day incubation period, storm-petrel partners alternate incubation bouts.

•One adult fasts in an underground nesting burrow (Fig. 4) while its mate forages at sea (Fig. 5)[2].

Figure 4. Storm-petrel Burrow.

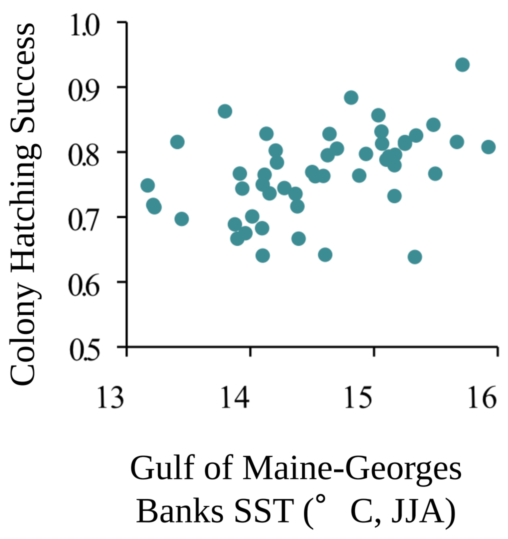


Figure 3. Mean annual hatching success from 1955 to 2007 increases with SST.

•This project aims to help better understand how a long-lived incubating seabird may respond to a change in climate.

Variation in Temperature

How are ambient and burrow temperatures related?

METHODS

•iButton™ temperature loggers were programmed to log temperatures every 10 minutes[4].

•To assess internal temperatures within and between burrows, we placed an iButton™ 6" into the tunnel of 49 burrows (Fig. 13).

•We documented burrow temperature during four time periods between June 11th to July 26th.

RESULTS

•Burrow temperatures (x=12.789° +/-1.095°) change with ambient temperatures (x=14.359° +/-1.402°) (Figs. 7 and 8).

• Relative burrow temperatures remain constant over time (Fig. 9).

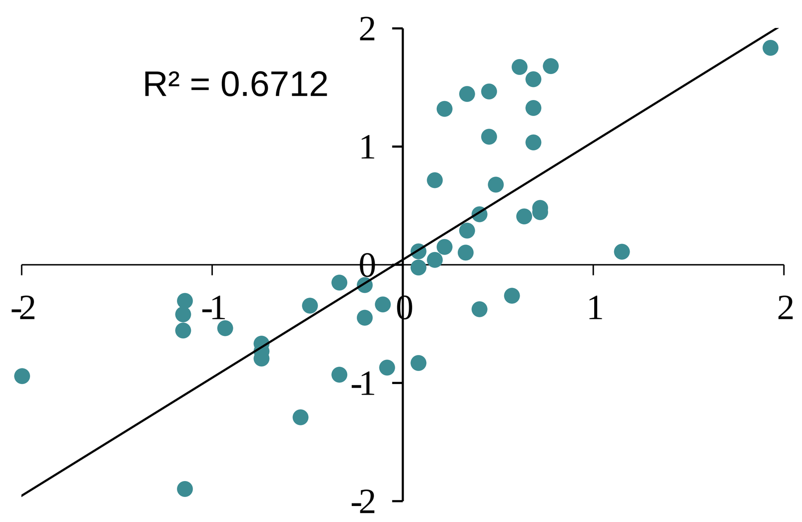
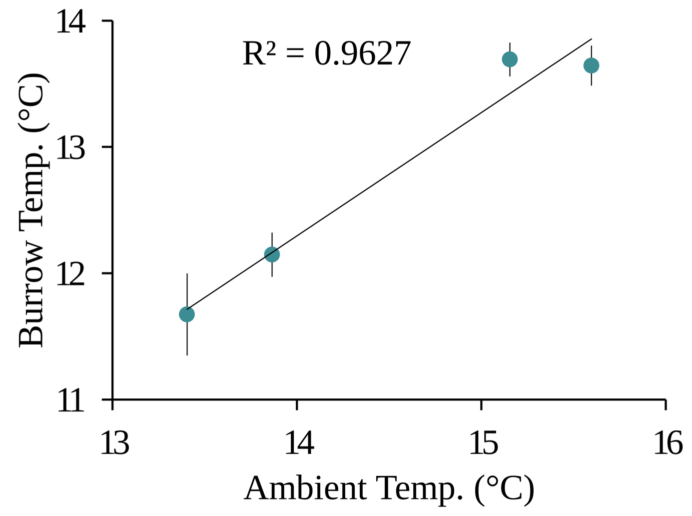


Figure 9. Consistency of normalized burrow and ambient temperatures across time periods (Pearson Rank Correlation, N=49 burrows, p<0.0001).

Figure 7. Relationship between mean ambient and mean burrow temperatures across 5-7 day time periods within 6/21/12 to 7/26/12 (N=4 time periods, error=sem).



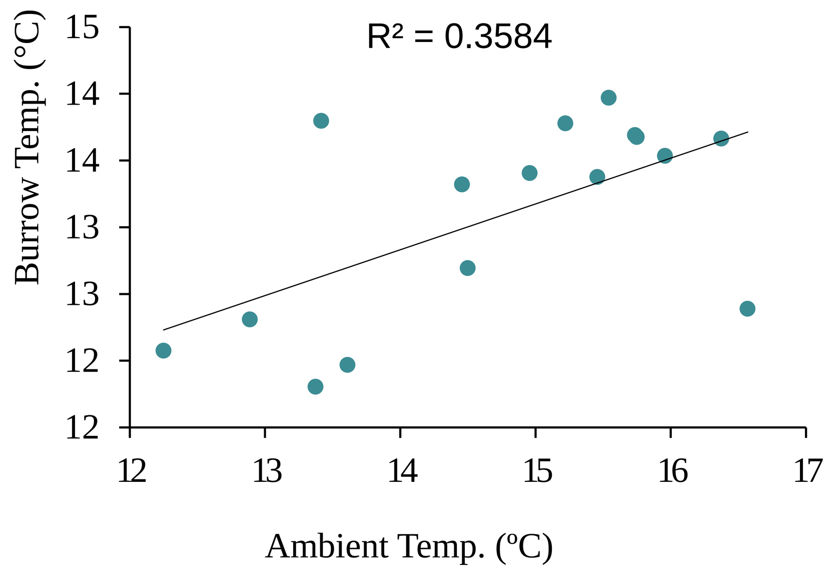


Figure 8. Correlation of daily mean ambient and mean burrow temperatures from 6/21/12 to 7/26/12 (N=15 burrows).

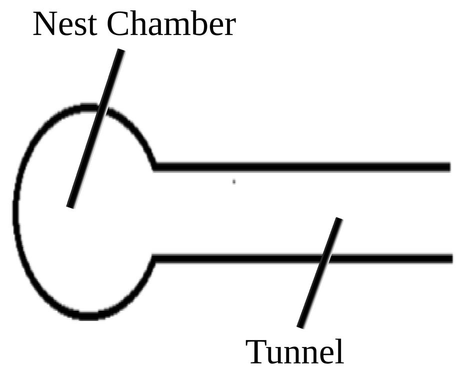
Temperature Manipulation

Can burrow temperature be experimentally manipulated?

BACKGROUND

•Tunnel temperature is a reliable index of nest chamber temperature in empty burrow (Figs. 13 and 14).

Figure 13. Stylized burrow diagram.



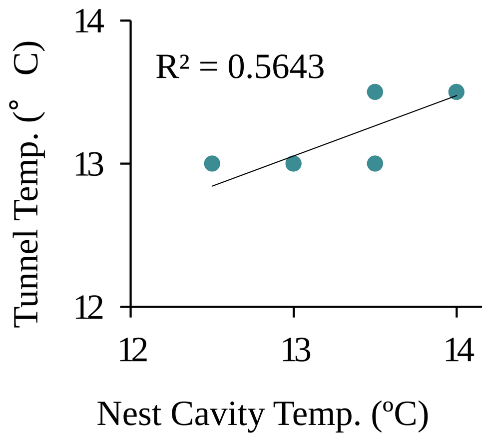


Figure 14. Comparison of tunnel and nest chamber temperatures logged during a 24-hour period between 7/15/12 to 7/16/12.

METHODS

•I selected 8 unoccupied burrows with similar nest chamber dimensions, tunnel length and average percent humidity[8].

•I placed 3 iButtons (see 'Temperature Assessment') within each burrow:
- •6" outside the burrow
- •6" into the tunnel
- •in the center of the nest cavity

Figure 15. O.E.M. Heat Cable.

•I selected three burrows that logged similar temperatures for one night.

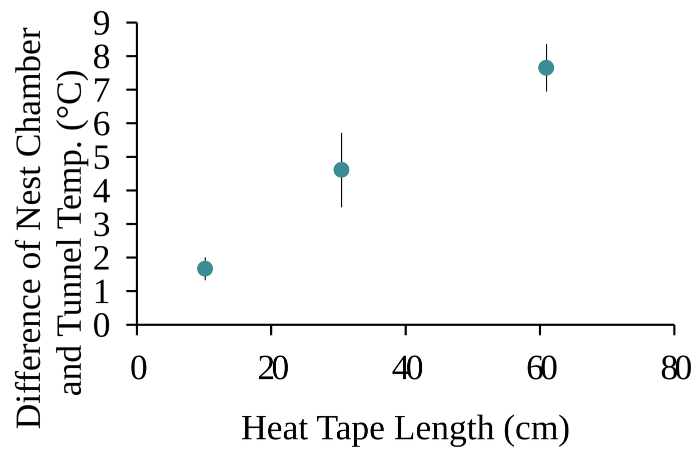
•I placed 10.16-60.96cm lengths of heat cable (O.E.M. 12V DC Heat Cable, 5 wt/ft, Fig. 15) in the center of each nest cavity[9].

•I recorded temperatures as above.

RESULTS

▪These methods allowed for successful heat manipulation of burrows. A biologically relevant temperature increase can be acquired (Fig. 16).

Figure 16. The relationship of wire length to temperature increase within the nest chamber (N=3 lengths, error=st.dev.).



Storm-Petrels and Geolocators

Is there a successful method for geolocator attachment?

BACKGROUND

•What little is known about storm-petrel foraging has come from geolocator technology (Fig. 5)[1].

METHODS

•We made 'geo-dummies' imitating the size and weight of currently available geolocators.

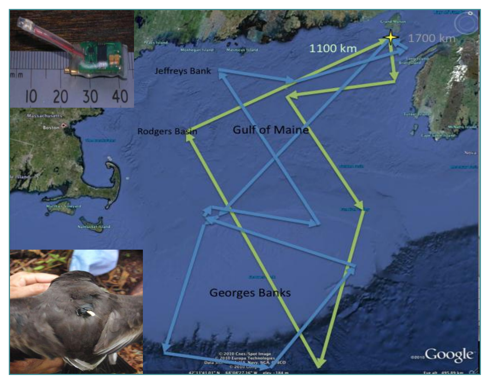
•Each contained a PIT tag.

•Feathers below the neck and between the wings were trimmed to ~2cm.

•Dummies were glued with Loctite® Extra Time Super Glue to a layer of chiffon which was glued to the trimmed area[3].

•We recorded the time and date a PIT tag was detected by PIT scanners outside burrow entrances.

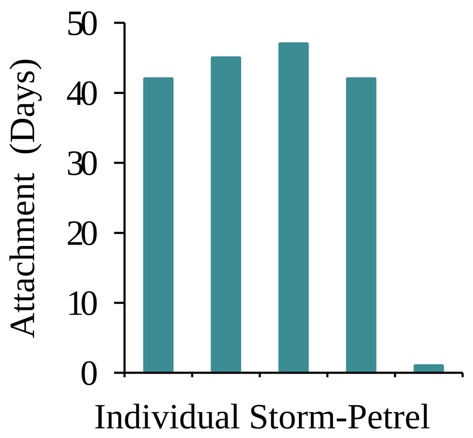
Figure 5. 2010 Leach's storm-petrel geolocator foraging data.



RESULTS

•4 of 5 dummies stayed attached for at least 42 days (Fig. 6).

Figure 6. Longevity of geolocators attached during the first week of June 2012.



Ptilochronology

Do warmer burrow temperatures affect the nutritional status of incubating storm-petrels?

BACKGROUND

•Nest temperatures may influence the costs of incubation by affecting metabolic costs of the brooding parent[5].

•Ptilochronology uses feather growth as an index of nutritional quality: growing a feather reflects available energy[6].

•We predicted warmer burrow temperatures would lower metabolic costs of incubating storm-petrels, increasing their available energy for feather growth.

METHODS

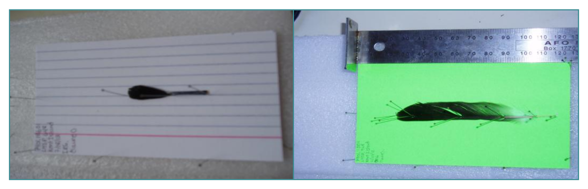
•We collected the original outer right retrix (OR6) feathers from102 incubating storm-petrels beginning 10 days after eggs were laid.

•16-48 days later 79 induced (IR6) feathers were collected from recaptured storm-petrels (Fig. 10).

•Percent daily growth was calculated from feather length measurements (Fig. 11) and compared to the temperatures of their respective burrows.

Figure 10. Extraction of the IR6 feather from a recaptured Leach's storm-petrel.

Figure 11. OR6 and IR6 lengths were recorded using index cards and pins.



RESULTS

•Feather growth rate appears to decrease with temperature (Fig. 12).

•This may indicate that decreased incubation costs result in increased foraging bouts, which could outweigh energy savings[7].

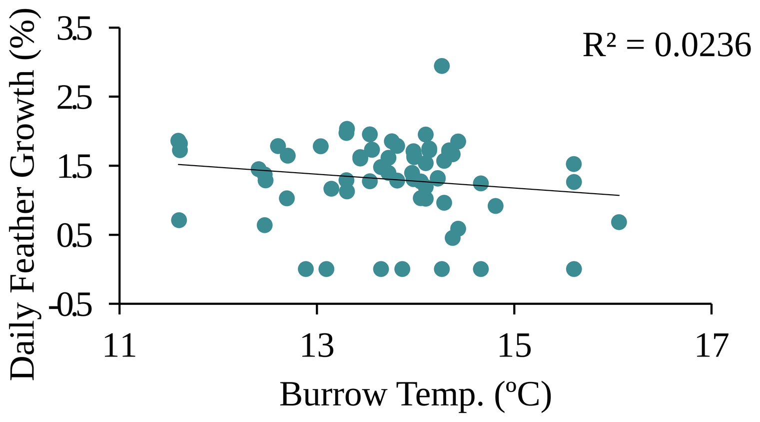


Figure 12. Relationship of % daily growth with burrow temperatures from 7/20/12 to 7/26/12 (P=0.222, N=65 storm-petrels).

Acknowledgements

We thank the volunteers who assisted in field work and brainstorming: Damon and Janet Gannon, Claudia Villars and Elizabeth Brown. This project was supported by the Kenyon Summer Science Scholars Program, and the Bowdoin Scientific Station.

Works Cited

[1]Mauck, R.A., Huntington, C.E., Doherty, P.F., Jr. 2012. Climate, weather, and a long-lived seabird: what can fifty years of data tell us? Annual meeting of the Society of Integrative and Comparative Biology. Charleston, S.C. Mauck 2011.

[2]Mauck, R.A., Zangmeister, J.L., Cerchiara, J.C., Huntington, C.E., Haussmann, M.F. 2011. Male-biased reproductive effort in a long-lived seabird. Evolutionary Ecology Research. 13: 1-15.

[3]Loctite® Porduct Site: http://www.loctiteproducts.com/p/4/2/sg_x_cntrl/overview/Loctite-Super-Glue-Extra-Time-Control.htm.

[4]Maxim Integrated™ Product Site: http://www.loctiteproducts.com/p/4/2/sg_x_cntrl/overview/Loctite-Super-Glue-Extra-Time-Control.htm.

[5]Reid, J.M., P. Monaghan and G.D. Ruxton. 2000. Resource allocation between reproductive phases: the importance of thermal conditions in determining the cost of incubation. Proc. R. Soc. Lond. B. 1438: 37-41.

[6]T.C. Grubb. 1989. Ptilochronolgy: feather growth bars as indicators of nutritional status. The Auck. 106: 314-320.

[7]London, G.A., D.J Levey and S.K. Robinson. 2008. Effects of temperature and food on incibation behavior of the northern mockingbird, *Mimus polyglottos*. Animal Behavior. 76: 669-677.

[8]Fricke. E.C., Blizzard, K.M., Gannon, D.P., & Mauck, R.A. 2012. Model of Burrow Selection Predicts Pattern of Burrow Switching in Leach's Storm-petrel (Oceanodroma leucorhoa). Ibis: in Review.

[9]O.E.M Product Site: www.oemheaters.com/p-6109-12v-dc-heat-cable-5-wft.aspx