Maternal Effects in the Green Turtle (*Chelonia mydas*)

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I certify that all material in this thesis which is not my own work has been identified, and that no material has previously been submitted and approved for the award of a degree by this, or any other university.

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Green turtle covering a clutch of eggs on Long Beach, Ascension Island, UK.

Abstract

In oviparous animals, maternal traits such as the investment of resources in eggs and oviposition site selection are often important determinants of offspring phenotypic quality, and may have an adaptive role in tailoring offspring phenotypes to local environmental conditions. This thesis examines the adaptive significance of two specific maternal traits in the green turtle (*Chelonia mydas*); namely the deposition of fat-soluble antioxidants in egg yolk, and the selection of nest sites via natal homing. Diet-derived, fat soluble antioxidants, such as vitamin E and carotenoids, are ubiquitous components in the eggs of oviparous vertebrates, and are thought to have an adaptive role in buffering embryos and neonates against free-radical induced oxidative stress. However, evidence for such a function in wild populations is lacking. This thesis investigates the proximate sources of variation in yolk antioxidant concentrations in the green turtle, particularly in relation to maternal diet, plasma concentrations and laying sequence, and assesses the functional consequences of such variation for offspring phenotypes. Overall, the results presented suggest that maternal access to dietary antioxidants may be a relatively minor source of variation in egg concentrations in wild populations, and that independent physiological mechanisms may instead regulate the deposition of vitamin E and carotenoids in eggs. However, yolk concentrations of vitamin E and carotenoids did not influence offspring resistance to oxidative stress, and were not tailored to the offspring developmental environment. This was despite evidence that the maternally-provided nest environment strongly influenced offspring exposure to oxidative stress. Taken together, these results question the view that maternal deposition of fat-soluble antioxidants in eggs is an adaptive maternal effect to compensate for the risk of oxidative stress in offspring. Secondly, I investigated the adaptive significance of reproductive homing behaviour in green turtles. Female sea turtles generally return to nest at the particular site where they themselves were born (‘natal homing’), meaning that the offspring developmental environment may closely resemble that experienced by the mother. I therefore tested the hypothesis that natal homing facilitates the adaptation of developmental tolerances to specific environmental regimes. Using a common-garden rearing experiment I show that the offspring of females nesting on a naturally hot beach have markedly improved viability and growth at high incubation temperatures compared to the offspring of females from a nearby cooler beach. This disparity was not related to maternal provisioning of antioxidants or other key resources in eggs. These results suggest that natal homing may significantly increase maternal and offspring fitness by maintaining a stable selective environment across generations for the evolution of key fitness traits.

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