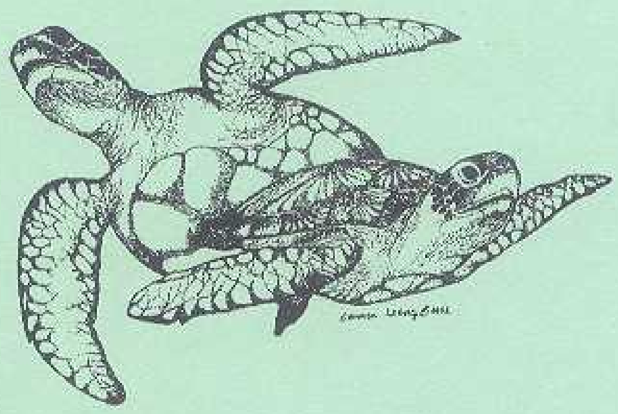
NOAA Technical Memorandum NMFS-SEFSC-536

PROCEEDINGS OF THE TWENTY-THIRD ANNUAL SYMPOSIUM ON SEA TURTLE BIOLOGY AND CONSERVATION



"Living with Turtles"

17 to 21 March 2003, Kuala Lumpur, Malaysia

Compiled by: Nicolas J. Pilcher

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, FL 33149, USA

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U.S. DEPARTMENT OF COMMERCE
Carlos M. Gutierrez, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Conrad C. Lautenbacher, Jr., Administrator

NATIONAL MARINE FISHERIES SERVICE
William T. Hogarth, Assistant Administrator for Fisheries

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ENERGY EXPENDITURE OF MEDITERRANEAN LOGGERHEAD SEA TURTLE EMBRYOS

Karen A. Reid[1], Dimitris Margaritoulis[2], and John R. Speakman[1]

[1] *University of Aberdeen, School of Biological Sciences, Tillydrone Ave., Aberdeen, AB24 3TZ, Scotland, UK.*
[2] *ARCHELON, the Sea Turtle Protection Society of Greece, Solomou 57, Athens, Greece*

The rate of embryonic development in oviparous reptiles is determined by environmental factors, primarily incubation temperature. During their development sea turtle embryos utilise a limited energy store deposited in the egg yolk, and any residual yolk at the time of hatching may provide a valuable energy store for the hatchling. Minimising energy use during development may therefore influence hatchling fitness. Eggs incubated at hotter temperatures develop faster, but energy expenditure is also greater at higher temperatures. An interesting question touched on by recent studies, is how these two features interact to define the total costs of embryonic development.

During 2002 in Kyparissia Bay (mainland Greece) we collected 90 eggs laid by two *Caretta caretta* females on the morning after deposition. The eggs were divided into boxes of ten, and incubated artificially on moist vermiculite at 27.5°C, 29.9°C, and 31.8°C. Each incubator contained three boxes of ten eggs. Measurements of oxygen consumption and carbon dioxide production of the developing embryos, using open-flow respiroetry, were first carried out on day ten of the incubation. Further measurements were performed on each box of eggs at approximately three-day intervals throughout the incubation duration, under temperature conditions similar to their incubator. The volume of oxygen consumed, carbon dioxide produced, respiratory quotient (RQ), daily energy expenditure, and incubation duration of the developing embryos were subsequently calculated for each temperature treatment. For the purpose of this analysis, incubation duration was defined as the number of days which elapsed between laying date (taken as the morning after the eggs were laid) and the day of first pipping. Hatching success was high (97%) for each temperature treatment. All hatchlings were subsequently released.

At all three temperatures, oxygen consumption and carbon dioxide production increased rapidly during the second half of incubation, peaked, and declined towards hatching. Maximum rates of oxygen consumption were highest at 31.8°C, and lowest at 27.5°C. Incubation duration was dependent on incubation temperature, and total energy expenditure of the developing embryos declined with increasing incubation temperature. Embryos developing at 27.5°C consumed a total of 31,727 J during their incubation, embryos at 29.9°C consumed 29,453 J, and at 31.8°C consumed 27,897 J. Lower incubation temperatures, and subsequently longer incubation durations, were therefore more energetically expensive for developing embryos.

RQ declined significantly as incubation progressed, suggesting that embryos do not use yolk constituents proportionately throughout incubation. RQ values indicated that yolk carbohydrate was utilised initially, followed by protein, and finally fat. It is important to remember that RQ values provide only an indication of substrate utilisation, and that more adequate testing is required to verify these findings. We suggest that (as there was no temperature or temperature-time effect on RQ) embryos incubating at higher temperatures utilise relatively little fat during development, but may use up more protein, while embryos incubating at lower temperatures use up considerably more fat.

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