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Measuring the Rate of Heat Loss in Wild Bottlenose Dolphins (*Tursiops truncatus*)

Environmental Issue

Global mean surface temperatures have increased since the late 19th century and are predicted to continue to rise over the next century. These global changes in environmental temperature could have profound impacts on a multitude of organisms, including marine mammals. However, to date, there are few studies that have investigated thermoregulatory function in, or the effects of thermal stress on, any wild cetacean (whale, dolphin, or porpoise). There are also no data available to describe how wild cetaceans respond physiologically to changes in ambient temperature that might be experienced diurnally, seasonally, or during extended migrations. Without these baseline data, there is no way to understand how long-term changes in global temperature or thermal stressors may affect populations of marine mammals.

Scientific Approach

Two complementary approaches will be used to examine bottlenose dolphin thermoregulation in environments with large differences in ambient temperature.

APPROACH 1: To determine how whole body conductance changes with seasonal changes in environmental temperature, non-invasive measurements of heat flux (a rate of energy transfer per unit area), skin surface temperature and blubber thickness will be collected from wild bottlenose dolphins resident to Sarasota, FL.

APPROACH 2: To elucidate patterns of body size and shape that may influence thermal function across a broad latitudinal and environmental temperature gradient, morphometric measurements of body mass, length and body and appendage surface areas will be collected from wild bottlenose dolphins across the U.S. (southeast, mid-Atlantic, northeast) and Scotland.

Approach 1 is discussed in more detail below.

Methods

Temporary dolphin restraint - Sarasota, FL

Bottlenose dolphins utilize their appendages (dorsal fin, pectoral flippers, flukes) as thermal windows to either dissipate or conserve heat. In contrast, the body wall, insulated by blubber, is a relatively static thermal surface. To quantify heat loss across these surfaces, heat flux (HF), skin surface temperature (T_s), and ΔT (equals T_s - T_{water}) were measured simultaneously at 6 body sites (see below). Blubber thickness across the body wall was also measured. These measurements were collected during health monitoring events for wild bottlenose dolphins resident to Sarasota Bay, FL (NOAA Permit No. 522-1569).

Sites where HF and T_s were measured

Hypothesis

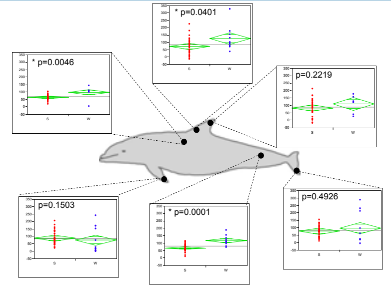
Whole body conductance and HF across the body surfaces of wild bottlenose dolphins will increase in summer, relative to winter, with an increase in environmental temperature, and a decrease in blubber thickness.

Preliminary Results

To date, HF, T_s, ΔT and blubber thickness data have been collected during five health monitoring events in two seasons:

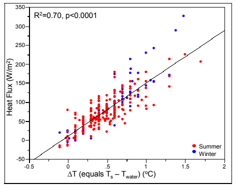
Season/Year	Mean Water Temp.	# of Dolphins
Summer (Jun. 02, 03, 04)	30.2 ± 1.1°C	38
Winter (Feb. 03, 04)	17.1 ± 1.4°C	13

mean blubber thickness in winter > in summer ($p<0.0001$)



Overall, HF values (in W/m²) were higher in winter (W, right side of charts) than in summer (S, left side of charts) due to significantly higher HF values at the base of the dorsal fin, flank and tailstock (see figure).

ΔT's were significantly related to HF. However, an increase in T_s does not appear to be the only factor driving an increase in heat loss. For example, for a 1.5°C ΔT, HF in summer was ~225 W/m², whereas HF in winter was ~325 W/m² (see figure).



Impact

Surprisingly, HF was lower in summer than in winter, despite similar ΔT's and thinner blubber, suggesting that Sarasota dolphins may use other mechanisms, such as respiratory heat loss, to dissipate body heat in warm, sub-tropical waters. These data provide important baseline values as we consider the effect of rising environmental temperatures on marine homeotherms.

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