

EFFECT OF SURFACE TEMPERATURE ON THE TEMPERATURE HOMEOSTASIS AND EMBRYONIC SURVIVAL OF A GROUND-NESTING SHOREBIRD ALONG A THERMAL GRADIENT ACROSS SRI LANKA

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Urbanization and deforestation are two main reasons for the rapid rise in earth's surface temperature across the globe. Although the life on earth depends on earth's temperature for its survival, the life that associates with its surface, such as ground nesting shorebirds (Order Charadriiformes), could have a greater sensitivity to the alterations of the earth's surface temperature. Using an automated data logger critically evaluated the effect of ground temperature on temperature homeostasis of the egg of a ground-nesting shorebird (Red-wattled Lapwing (*Vanellus indicus*)) found in a wide range of environments, from city parks and parking lots to undisturbed forested wetlands, in varied ground temperature regimes. Measured the egg temperature (T_E ; off the egg shell), ground temperature (T_G ; 1cm below ground near the nest) and air temperature (T_A ; 10cm above ground near the nest) in 5 minutes intervals for up to 72 hours in 29 eggs of 17 nests in six locations; Colombo, Mannar Island, Puttalam, Galle, Kandy, and Bibile. We observed the parent behavior from ~50m away from the nest using binoculars. We also measured the clutch size and the substrate of the nest. To set the thermal end points, a set of fertilized chicken eggs were incubated in an incubator under laboratory conditions at 42°C (high temperature), 22°C (low temperature) and 37°C (control).

The mean egg temperature under parental incubation ($35.7^{\circ}\text{C} \pm 1.6$) is significantly different from that of the absence of parental incubation ($33.9^{\circ}\text{C} \pm 5.1$; $t_{196} = 4.27$, $p < 0.05$). When the egg exposed to an extreme low temperatures ($<20^{\circ}\text{C}$) or to an extreme high temperatures ($>42^{\circ}\text{C}$), the survivorship of the developing embryo drops under laboratory conditions. The Colombo municipality area had the highest daytime temperatures ($T_G = 50.7^{\circ}\text{C}$, $T_A = 33.7^{\circ}\text{C}$). Peradeniya University, another urban area had the second highest temperature ($T_G = 42.0^{\circ}\text{C}$, $T_A = 30.8^{\circ}\text{C}$).

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However the Mannar Island had mild temperatures and narrow daily temperature fluctuation when compared with urban areas. Mannar provides the optimum temperatures for embryo development (33–36°C), this may be probably a reason for many species of ground nesting birds to breed in large numbers in Mannar. The lowest temperatures were recorded in the foothills in Bibile ($T_G = 23.7^\circ\text{C}$, $T_A = 24.5^\circ\text{C}$). According to our data, lapwings did not breed in areas where T_G had dropped below 20°C. We also found that the bottom substrate of the nest (pebble, sand etc.) has a significant impact on the nest microclimate and embryonic survival ($F(2, 196) = 268.5, p < 0.05$).

We found extremely high surface temperatures at urban areas when the habitat is altered with stone and pebbles (e.g. Nawala Wetland Park). Stone and pebbles had increased the nest temperature in natural nests as well. Grass and sand provided the optimum temperatures for the survival of embryos in the studied nests throughout the island. Urban landscapes showed high daily fluctuation in ground temperature, which resulted in nest failure due to exceeding of the tolerant range (33–40°C). Our findings exposed an overlooked aspect of the urban landscape that affects the wellbeing of the life associating with it, where future blue-green planning should pay a more careful attention.