

NOTE

Thermoregulatory Extension of Feet in Flying Sooty Terns

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Abstract—Sooty Terns (*Sterna fuscata*) on Rose Atoll, American Samoa, extended their feet to keep cool.

Laboratory and wind tunnel experiments have illustrated the effective usage of exposed tarsi and feet in dissipating heat from thermally-stressed birds (Steen & Steen 1965, Tucker 1968, Baudinette et al. 1976). Several recent field studies have demonstrated correlations of feet-extension into the air stream during flight with high temperatures. Frost & Siegfried (1975) observed 10 species of birds in South Africa flying with legs extended when ambient temperatures exceeded 36°C; Bryant (1983) studied 17 species in Malaysia exhibiting similar behaviors, and Udvardy (1983) quantified this behavior in four species of hummingbirds in California. This behavior has been documented in the wild for only one species of tern (Bryant 1983).

Howell & Bartholomew (1962) and Dinsmore (1972) discuss heat loss behaviors of incubating Sooty Terns (*Sterna fuscata*). These behaviors include shading the eggs and feet, elevating the scapular feathers, abducting the wings to expose thinly feathered areas, belly-soaking, foot-wetting, and panting. MacMillen et al. (1977) concluded that Sooty Terns are not especially proficient at evaporative cooling and seem to rely on behavioral thermoregulation to prevent overheating. During a brief stay near a Sooty Tern colony on Rose Atoll, it was apparent that the adults were employing an additional thermoregulatory behavior—those entering and exiting the colony flew with extended legs and feet during the hottest part of the day.

Methods

I recorded time of day, ambient temperature in the shade, and the position of the feet of adult Sooty Terns flying toward and exiting the nesting colony on Rose Atoll (14° 33' S, 168° 9' W), the easternmost island of American Samoa, on 27-29 September 1992. Adults were attending chicks from approximately one week of age to fledgling age. I excluded terns soaring above and into the colony that were clearly using their feet as brakes. Birds tabulated were those engaged in flapping flight. Gradations of exposure were visible from just exposing toes at the surface of the contour feathers to fully exposed toes and tarsi with toes spread

(exposing the webbing). To reduce ambiguity, I simply recorded the position of the feet as exposed or not exposed.

Results

Between 0600 and 1830 on 27–29 September 1992, I recorded the position of the feet of 1,437 adult Sooty Terns entering and leaving the nesting colony on Rose Atoll. Maximal percentages of birds flew with extended feet during the middle of the day when temperatures were highest and solar radiation was greatest. When mean ambient temperature exceeded 30.1°C, over 80% of all birds flew with extended feet and tarsi (Fig. 1). During early morning (0600–0700) and late afternoon (1800–1830), when ambient temperature was less than 28°C, less than 40% of the birds flew with exposed tarsi and feet. A regression of percent feet down versus ambient temperature was highly significant ($r = 0.873$, $P = 0.000$), while regressions of ambient temperature against time of day ($r = 0.435$, $P = 0.105$) and percent feet down against time of day ($r = 0.319$, $P = 0.246$) were not significant.

Discussion

Because of the white sand/coral substrate, low latitude (14° S), and sparse cloud cover, insolation at Rose Atoll can be intense. Incubating and attending terns, boobies, and frigatebirds frequently exhibited heat stress behaviors (pant-

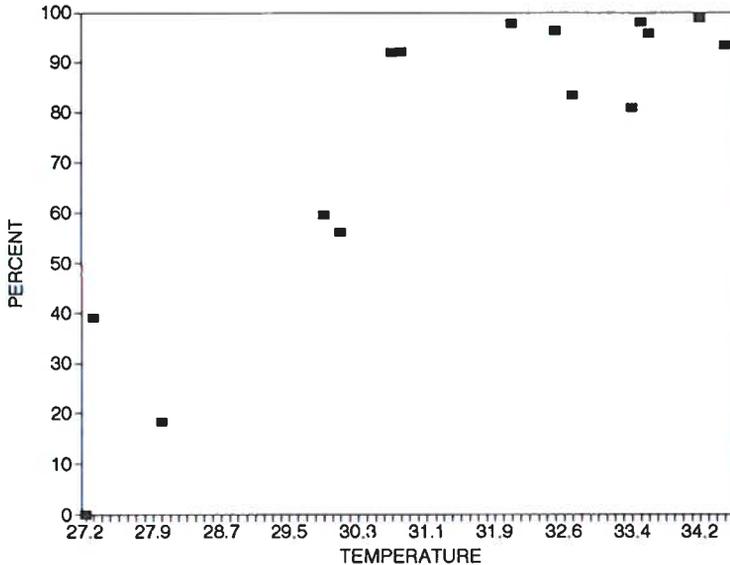


Figure 1. Percent of Sooty Terns flying with extended feet at various ambient temperatures (°C).

ing/gular fluttering, elevated scapulars, and drooped and extended wings) at the nest site. In addition, flying Sooty Terns extended their exposed tarsi and webbed toes into the shaded air stream below their bodies during the heat of the day. Sooty Terns foraged great distances from the nesting colony and were engaged in transporting food to the young during these observations; both factors would add to the heat load acquired by flying terns. An adult Sooty Tern flying toward this colony was seen 100 km west of Rose (no other nesting islands are in the area) on 1 October 1992. In addition, the terns encountered a gauntlet of pirating Great (*Fregata minor*) and Lesser Frigatebirds (*F. ariel*) over Rose Atoll. Flight maneuvers to evade the frigatebirds undoubtedly led to increased heat loads.

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