Absence of Wing-spreading Behavior in the Antarctic Blue-eyed Shag (*Phalacrocorax atriceps bransfieldensis*)

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Wing-spreading in cormorants (Phalacrocoracidae) and Anhingas (Anhingidae) is a commonly observed posture, which has been related to their wettable plumage (Owre 1967) and the need to dry flight feathers after swimming (McAtee and Stoddard 1945, Clark 1969, Francis 1981). Observations of the wing-spreading behavior of the Great Cormorant (*Phalacrocorax carbo*) during fog and rain (Townsend, in Bent 1922), of a dry Reed Cormorant (*P. africanus*) (Curry-Lindahl 1970), and of the Flightless Cormorant (*Nannopterum harrisi*) (Snow 1966) raise questions, however, about plumage wettability and whether or not the behavior might serve another function, such as thermoregulation (e.g. Clark 1969, Curry-Lindahl 1970, Kahl 1971) or communication of successful foraging attempts (Jones 1978).

From January 1979 to March 1980 we studied Antarctic Blue-eyed Shags at Palmer Station, Antarctica (64°46′S, 64°03′W), where approximately 800 shags were resident most of the year. We never observed these shags in spread-wing postures during 3,000 bird-hours of scheduled observations nor during many additional hours of unscheduled observations. The lack of wing-spreading behavior in this population lead us to compare the water repellancy of the plumage of Antarctic Blue-eyed Shags with that of other cormorants and water birds. We examined the normal pennaceous portion of the dorsal surface of breast feathers with a light microscope. This yielded information on feather wettability based upon a liquid repellancy index $[(r + d)/r]$ for feathers developed by Rijke (1967, 1968, 1970) in which half the spacing between barbs (d) and the barb radius (r) represent properties of a porous surface. Hailman (1969) has reviewed the limitations of the model, however, and Elowson-Haley (pers. comm.) is currently investigating the model's applicability.

After comparing our technique with Rijke's (1967) and finding them similar, we calculated an index value of 3.8 for the Antarctic Blue-eyed Shag. If Rijke's (1967) model is valid, lower index values indicate decreased water repellancy or increased wettability due to capillary action. Therefore, compared with Rijke's (1967) calculations, our index value indicates that the Antarctic Blue-eyed Shag has more wettable plumage than the Mallard (*Anas platyrhynchos,* 5.9) and as wettable, if not more wettable, plumage as the Great Cormorant (4.8), Darter (*Anhinga rufa,* 4.5), and Reed Cormorant (4.3).

If the Antarctic Blue-eyed Shag has typical cormorant plumage, why does it lack wing-spreading behavior? Perhaps the answer lies with the Antarctic Peninsula's climate. Palmer Station has a mean annual temperature of 1.5°C with means of 3°C in summer and −10°C in winter (U.S. Antarctic Program Personnel Manual). With ambient temperatures frequently below freezing and a high relative humidity, spread wings would promote heat loss and probably not aid drying by evaporation. Low temperatures should, therefore, select for reduced wettability (i.e. water repellancy), and indeed, as shags left the water after bathing, they appeared fairly dry after a vigorous shaking. It was clear that water had not deeply penetrated the plumage.

Three reports offer explanations of the lack of water penetration into the plumage. Rijke (1970) hypothesized that lower index values indicated closer barb spacing resulting in smaller spaces for water to penetrate. Therefore, while the first layers of feathers may become wet by capillary action, greater pressure will be required before successive layers dampen. Snow (1966) offered a similar explanation for dry inner plumage in the Flightless Cormorant. Citing Fabricius (1958), she hypothesized that air trapped in dense plumage repelled water. Casler (1973) supported Snow's (1966) hypothesis, observing that distal portions of cormorant feathers were modified to retain water, but an air layer was retained next to the skin. For an Antarctic Blue-eyed Shag, wettable surface plumage would be more hydrodynamic due to less buoyancy and drag while swimming, and lack of water penetration would prevent icy water from contacting the skin.

We hypothesize that it is not necessary for the Antarctic Blue-eyed Shag to spread its wings for drying, and, indeed, the posture may be disadvantageous in continually cold climates. This also suggests that wing-drying before flight may not be necessary for other cormorants with similar plumage, although wing-spreading behavior may be beneficial in more temperate climates where ambient temperatures promote drying and heat retention. Within the contexts of thermoregulation, several authors (e.g. Hauser 1957, Lanyon 1958, Goodwin 1967, Clark 1969, Kennedy 1968, Kahl 1971, Schreiber 1977) have observed spread-wing posture, or behavior similar to spread-wing posture, in various birds to gain or lose heat. Only Curry-Lindahl (1970), however, has presented evidence supporting this hy-

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pothesis for cormorants. Indeed, Siegfried et al. (1975) and Berry (1976) believed that heat gain was only a secondary function of the behavior in the Cape Cormorant (*P. capensis*) and that wing-drying was the primary reason. It seems that the spread-wing posture can serve either or both functions in cormorants, depending on environmental conditions, but that neither is essential to the Antarctic Blue-eyed Shag. New Zealand species of Blue-eyed Shags also do not spread their wings after exiting the water (G. van Tets pers. comm.).

While the explanations of wing-spreading in cormorants remain unsubstantiated, the observations point to the complex relationship between behavior and the environment. Having a widespread distribution, cormorants have adapted to many habitats, but none colder year-round than the Antarctic Peninsula. As the southernmost cormorant, the Antarctic Blue-eyed Shag demonstrates a behavioral adaptation by its lack of the spread-wing behavior typical of its family. This adaptation promotes heat retention in the Antarctic climate, while the cormorants' hydrodynamic plumage is retained.

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