



# smear CAMPAIGN

## Hoopoe eggs and their bacterial barrier

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Science is only beginning to understand some of the mutually beneficial ways in which birds interact with bacteria and other denizens of the microscopic world. A novel symbiotic relationship between bacteria and the Eurasian Hoopoe *Upupa epops* has recently been uncovered by ornithologists and microbiologists from the University of Granada in Spain.

Hoopoes are well known among ornithologists for the foul-smelling secretion that females and nestlings produce from their uropygial (or preen) glands, particularly when they are disturbed. There are some intriguing aspects to the breeding biology of these birds, including the fact that breeding females appear to use their bills to smear this uropygial gland secretion onto their eggs, the function of this behaviour being unclear until now. The researchers, several of whom have worked extensively on hoopoes over the past decade, took a closer look at this peculiar behaviour.

Working at a site in southern Spain where hoopoes and several other species breed in nest boxes, they elucidated the significance of the secretion using several complementary approaches. One involved comparing the outer surfaces of hoopoe eggs with those of the eggs laid by scops owls, rollers, starlings, doves and sparrows. The surface of hoopoe eggs, they discovered, is not smooth like that of other species, but densely covered

with pits that make up around a third of the total surface area. When the female smears her uropygial gland secretion onto the egg, these pits become filled, their function apparently being to maximise adhesion of the secretion to the egg's surface.

Another part of the study involved experimentally preventing some of the breeding females from transferring uropygial gland secretion to their eggs; the team devised a way to attach a narrow-gauge catheter to the uropygial gland and thereby cause the secretion to drain into a small plastic tube attached to the bird with an adhesive bandage. This manipulation vastly reduced the quantity of secretion present on eggs, which in turn resulted in far lower densities of symbiotic bacteria belonging to the genus *Enterococcus*, which occur in the uropygial gland and are hence transferred to the eggs. In contrast, the density of two other bacterial genera, *Staphylococcus* and *Enterobacteriaceae*, remained unchanged compared to the eggs of females that had unrestricted access to their uropygial gland.

Members of these two last-mentioned bacterial genera are well-known pathogens and sources of mortality for avian embryos, and the most intriguing result of the study emerged when the researchers examined correlations between bacterial densities and hatching success. Among females whose access to their uropygial gland was not



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*African Hoopoe Upupa africana. The uropygial gland secretion hoopoes smear on their eggs provides a barrier against potentially harmful bacteria.*

experimentally curtailed, hatching success was significantly related to the density of *Enterococcus* bacteria in the uropygial gland secretion. Likewise, hatching success was related to the amount of these bacteria present on the eggshells. In other words, the symbiotic bacteria in the uropygial gland secretion appeared to directly increase the chances of the embryos surviving to hatching.

These fascinating results reveal that symbiotic bacteria in the hoopoes' uropygial gland secretion, which the females transfer to the eggs' surface, provide the embryos with protection from disease-causing bacteria. This study, in addition to uncovering a novel symbiotic interaction between birds and bacteria, provides the answer to an intriguing aspect of the hoopoes' breeding biology.

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*Reference: Martín-Vivaldi, M. et al. 2014. 'Special structures of hoopoe eggshells enhance the adhesion of symbiont-carrying uropygial secretion that increase hatching success.' Journal of Animal Ecology 83: 1289-1301.*