

SEASONAL CHANGES IN PREEN WAX COMPOSITION OF MARINE BIRDS

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Marine shorebirds live in environments with low temperatures and often high wind speeds. Their plumages keep their body heat inside and wing feathers make them fly and are required to escape from live-threatening predators. Thus, it is important for birds to maintain their plumage. One of the aspects of plumage maintenance is the application of waxes onto the feathers. Wax compounds are synthesised in a small gland at the base of birds' tail, the preen gland. The secreted waxes are distributed over the plumage through preening with the bill. The hydrophobic nature of the waxes might aid in keeping birds' plumages waterproof. Our research shows that the waxes might also protect feathers against malicious bacteria and temporally even keep foxes and other predators away from the nest with eggs.

Birds maintain their plumage by the application of preen waxes from the preen gland. There are a lot of chemical studies on the often complex composition of the preen wax secretions of many species.

Despite considerable knowledge of the species-specific chemical composition of the waxes, much remains unknown about their function(s). It is generally assumed that preen wax keeps feathers waterproof, but an expected positive correlation between size of the preen gland and the degree of birds' contact with water has never been found. Here we briefly review our chemical studies as well as experimental work on the function of preen waxes in red knots, a marine shorebird that winters in tropical and temperate intertidal areas and reproduces on the tundra in the high Arctic.

Seasonally changing preen wax compositions

Small amounts of preen wax can directly be collected from birds'

preen gland by use of a cotton bud. The preen wax composition of red knots appeared to change with season. In spring, when the shorebirds are fully prepared to depart on a long-distance flight to the arctic breeding grounds, complex preen wax mixtures usually consisting of so-called 'monoesters' are replaced with mixtures solely consisting of 'diesters'. Diesters are generally larger molecules than monoesters and therefore less volatile and probably more difficult to smear onto the plumage. It now became interesting not only to find out what the functions of preen waxes are, but also to find a functional explanation for the seasonal shift in preen wax composition.

The shift in preen wax composition took place just before departure to the Arctic and diester secretions were first found in a red

knot in early June in arctic Canada when the birds were involved in mate choice and courtship during which they display their red plumage to impress possible mates. It was therefore hypothesised that the diester preen waxes were of use for the birds during reproductive behaviour. A function during the migratory flight was excluded because red knots departing to and after arrival at a stop-over site on the east coast of the United States secreted the usual monoester preen waxes.

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The collection of preen waxes from the preen gland of a red knot by use of a cotton bud. Photo by Jeroen Reneerkens.

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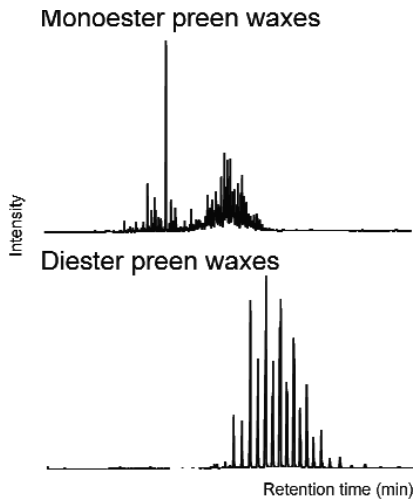


Fig. 2. Gas chromatograms of monoester and diester preen waxes of red knots. The higher retention time (x-axis) of diesters is indicative of a lower volatility than monoesters.

Colour, protection or smell?

Some experimental tests.

Because of the timing of the preen wax shift, we thought that a coat of diester preen waxes would increase the redness or shininess of the plumage and thereby function as a kind of 'avian make-up'. However, by use of spectrophotometry, no colour change could be measured after the shift in wax composition. It appeared also that diester preen waxes were not only secreted during the short period of courtship, but also during the following period of incubation of eggs. Interestingly, only those birds that were actually involved in incubation, secreted diesters during the breeding period. For example, in ruffs of which only females breed, it is also only the female in which preen wax composition shifts to diesters. The showy males of this species surprisingly secreted no diester waxes at all. This suggests



Photospectrometry of the plumage of a red knot. Photo by Jeroen Reneerkens.

that the diester waxes are especially important when the birds are incubating their eggs. Because feather-degrading bacteria that damage birds' plumage are active under warm and humid conditions (which occur in the nest of a breeding bird) it was suggested that

diester preen waxes might offer a better protection against bacteria. An experiment with feathers of red knots showed that feathers with preen waxes were less degraded than feathers without preen waxes. However, the chemical composition of the waxes did not matter.



Breeding red knots secrete diesters. Photo by Jeroen Reneerkens.

As shorebirds are ground-breeders, another aspect of incubation is the threat of losing a clutch to mammalian predators, such as arctic foxes. Although the plumage of shorebirds is very well camouflaged, foxes often search for prey by smell. We used a sniffer dog to test the idea that less volatile diester preen waxes are more difficult to find by predators than monoester waxes. We varied the amount as well as the composition of the preen waxes. After several trials it appeared that the dog was less often able to locate diester waxes than monoester waxes. This suggests that diester preen waxes reduce shorebirds' smell when incubating and thereby reduce predation risk.

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A sniffer dog using its nose to find small amounts of preen waxes of red knots. Photo by Jeroen Reneerkens.