Red-billed Woodhoopoes go on the defensive

PREENING POWER

TEXT BY ROSS WANLESS

In the wild, every day is a struggle between life and death. Predators lurk in the shadows, hunting by night, using the minutest sounds and faint trails of scents that waft through the branches, undetected by human noses, to locate their prey. In the woodlands and forests of Africa, one species has hit upon an impressive way of defending itself from the denizens of the dark.

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The Red-billed Woodhoopoe *Phoeniculus purpureus* is an intriguing species. Because it lives in groups, its society is a rich tapestry of interactions, alliances, betrayals and secrets. Its life is played out in the forests and woodlands of sub-Saharan Africa, where it is one of the more conspicuous birds. Its noisy calls echo and resound across valleys, while territorial disputes between neighbours achieve impressive crescendos. One would struggle not to see these birds when walking through any reasonably large tract of forest or well-wooded habitat. The species' raucous cackling gives rise to its Xhosa name, *Hlekabafazi*, which means 'laughing women'.

For almost 30 years biologists have been studying these somewhat bizarre, but ingratiatingly endearing birds. Their intricate lives are unique among birds in a number of ways and, despite an impressive volume of research, they continue to surprise.

An unusual strategy

One of the Red-billed Woodhoopoe's more unusual traits is its need to roost in cavities (usually in trees), a situation complicated by the fact that the birds cannot excavate their own holes. This reliance on other animals' (or nature's) handiwork places them under tremendous pressure. In many areas, there is enormous competition between several cavity-roosting species, and woodhoopoes are always on the lookout for a back-up cavity in their territory.

Woodhoopoes breed communally. In most recorded cases of breeding attempts, the alpha pair breed, and any other members of the group help in the rearing of the brood. The business of helping others to raise young rather than breeding oneself is quite intriguing. At first glance it might not make much sense to expend a lot of time and energy helping to rear another pair's young. Why don't these helpers go off and breed themselves?

Firstly, some year-old birds do manage to establish territories and breed. Their success rate is, however, generally rather low. By contrast, helpers seem able to learn what to do, and when they establish themselves as breeders, they tend to do much better than others. It takes a lot of practice and skill to forage in the woodlands for oneself, let alone for a

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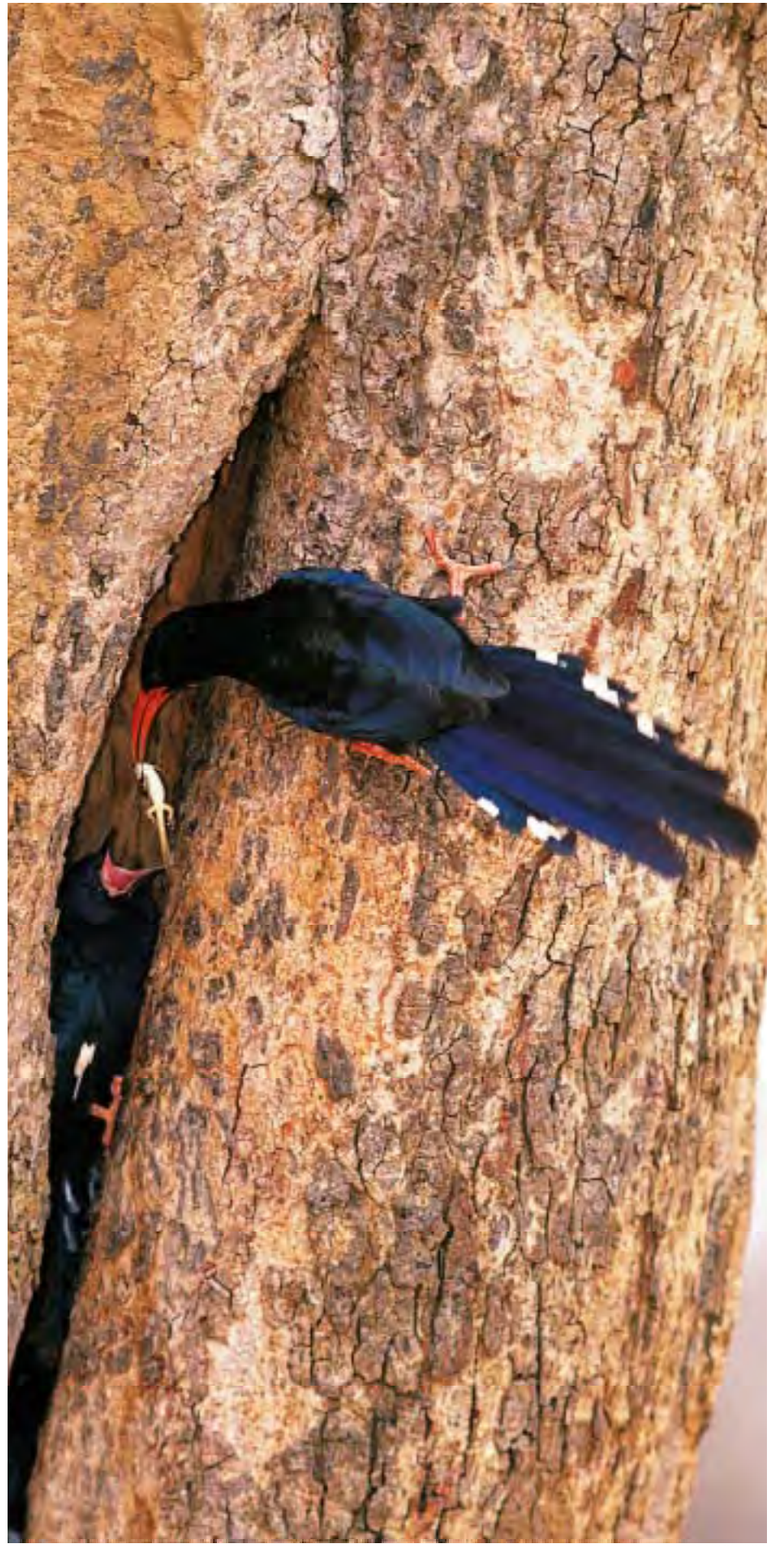
Left and right *Communal living has advantages for the woodhoopoes – increased numbers mean a better defence system and more helpers to feed the young.*



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brood of highly demanding, growing chicks. A second reason is that more often than not, helpers are 'family'; either offspring from earlier breeding attempts or related (typically siblings) to one of the alpha pair. It makes biological sense to invest in one's family, even if the young being cared for aren't one's own. Because of this 'blood connection' or relatedness, helpers invest their efforts in ensuring that their shared genes are passed on to the next generation. This co-operative breeding strategy is employed by a diversity of animals, ranging from honey-bees and ants to naked mole-rats.

A third reason is that in some circumstances roosting cavities and territories are hard to come by, and even harder to defend. A larger group can usually defend a cavity or maintain a large territory, and when times are tough, for example in times of drought, territories are often expanded to improve foraging. Under these circumstances, small groups run the risk of being displaced completely. This can be an utter disaster for woodhoopoes, which have to find safe roosting cavities every night. It seems that the best option, unless another territory can be found immediately, is to join another group.

The disadvantage of joining another group is that newcomers always start at the bottom of the ladder. A very strong pecking order is present in most group-living birds and in woodhoopoes this takes on added significance. Should one of the alpha pair die, the male or female next in line in the pecking order will take over as breeders. For newcomers this can mean a very long wait for the chance to reproduce.

Threats from predators

No one is really too sure why woodhoopoes always roost in a cavity. Some evidence suggests that during winter, group huddling in cavities can result in a considerable saving of energy. This does not explain why, on warm nights, cavi-

ties are preferred over safe roosts in thorn bushes or high up in trees. What is known for sure, however, is that roosting in cavities can be downright dangerous. Cavity raiding by nocturnal, arboreal predators such as genets, tree civets, African wild cats and feral domestic cats, and possibly a number of snake species, is well known and in some areas is a significant cause of death. Wherever there are strong forces (for example, high levels of predation) acting on populations, there are equally strong forces of natural selection that act to alleviate those pressures. Group-living and cavity roosting seem to have set the stage for a strong selective pressure for woodhoopoes to evolve some mechanism that would counteract the high risk of predation.

Defence

Many organisms use chemicals in a variety of ways to defend themselves against predators. They do it by being malodorous, tasting really bad, or actually being poisonous. Skunks do it. Butterflies do it. Frogs do it. Fish do it. But birds? Surprisingly, chemical defence has been documented in more than 120 species of birds. Two well-known southern African gamebird species, the Common Quail *Coturnix coturnix*, and the Spur-winged Goose *Plectropterus gambensis* are so poisonous that they can kill. Luckily they are not toxic during the time they spend in southern Africa. The quail eats nasty European plants like hemlock shortly before its seasonal migration in Europe, and if eaten at this stage the bird can cause an illness known in medical parlance as 'coturnism'. (Despite this, hunting and eating quail remains a national pastime in much of southern Europe.) Another migrant, the Spur-winged Goose spends much of its time in The Gambia, where it eats a particularly poisonous beetle not found in southern Africa. Both these species, and indeed all other known examples of chemically defended birds, take the toxins they use from their diet.

The exact nature of chemical defence is known in relatively few bird species, with the most recent evidence coming from the genus *Pitohui*. Three species of *Pitohui*, endemic to New Guinea, have

been shown to have a toxic compound of a class found only in one other taxonomically and geographically distant group, the neotropical poison-dart frogs of the genus *Phyllobates*. The chemical compounds found in the skin and muscles of *Pitohui* species are believed to be strong enough to kill a medium-sized bird of prey.

The way of the woodhoopoes

All birds have a small preen gland situated above the tail, at the base of the spine. In most birds the gland secretes a variety of fatty acids, oils and other organic compounds, which the birds spread on their feathers during preening. Such preening has two widely recognised functions: in much the same way as regularly used wood or leather needs oiling, the oils of the gland are considered essential to the maintenance of good feather condition; the second function may be for fungicidal, bactericidal or other hygienic purposes.

Woodhoopoes seem to have found a third and unique use for this gland. Their preen gland is capable of producing a scent so strong that experienced researchers can tell how recently a roost cavity was used, based only on the lingering odour. Further, the secretion remains detectable for several hours on the hands of those who have handled birds (and is extremely unpleasant to taste). In short, woodhoopoes smell bad!

Yet more compelling, albeit circumstantial, evidence for chemical defence comes from woodhoopoe behaviour. When disturbed at their roost cavities, woodhoopoes do something rather unusual. Normally, birds will try to defend themselves with their bills, and woodhoopoes certainly have bills long enough for us to suppose they might do the same. Curiously, they face away from a threat. Not only do they turn tail, but they also expose their preen gland. Typically, the emission of a drop of their extremely pungent secretion accompanies this behaviour. This response to threat seems to be designed to maximise the effect of a deterrent odour. Viewed in this light, their strange reaction to predators (and biologists) looks remarkably astute instead of mystifyingly silly.

This has led researchers to speculate that the unpleasant secretion is used in chemical defence. Speculation, conjecture and circumstantial evidence are all very well, but how does one prove that a bird uses chemicals to defend itself against predators?

The proof of the pudding…

The first step was to identify what compounds were responsible for the smell. Professor Ben Burger of the University of Stellenbosch, together with a student, analysed the chemical composition of woodhoopoe preen-gland secretions. They identified a suite of volatile compounds responsible for the powerful scent associated with woodhoopoes. In fact there were so many compounds that the odours could quite likely be used for other purposes, such as territorial or roost-cavity defence, communication or the maintenance of social structure, and keeping ectoparasites such as feather mites and lice at bay.

Once the smell-producing compounds had been identified, they could be synthesised in relatively large quantities. This meant I could set about testing whether the woodhoopoe secretion was in fact a deterrent to predators. Simple food-choice tests were performed on domestic cats, using canned cat food laced with the synthetic scent. The assumptions behind this were that cats are representative of the kind of predators likely to investigate tree cavities. I had to make sure the cats were hungry, so that if they left any food uneaten it was because they really didn't like it. I gave the hungry cats a choice of two bowls of canned cat food, one normal and the other laced with the chemicals found in woodhoopoe preen glands.

… is in the smell

The results of the tests were totally unequivocal, but not what I had expected. Predictably, all the cats gobbled the unscented food. Some took one sniff at the bowl of smelly food, turned up their noses and went to lick the untainted bowl clean. Most, however, attempted to eat the food despite its smell. All gave up after realising the food not only smelled bad, but tasted disgusting too. What this simple experiment showed is that woodhoopoe scent is a powerful deterrent to predators. However, because most of the cats at least attempted to eat the food, even though it smelled very bad, I could not conclude that bad smell alone is enough to deter hungry predators. Woodhoopoes, just like income-tax returns, are rather complicated.

Some of the cats were prepared to try and eat the food, even though it clearly smelled bad and tasted even worse. This suggests that under natural conditions at least some predators are likely to attempt to capture roosting woodhoopoes. What probably happens in nature is that the predator would kill and possibly eat a woodhoopoe. But it would do so without relish, and would learn to avoid in future any cavities that had the tell-tale smell of woodhoopoes which would serve as a warning that these birds are not a tasty meal.

Woodhoopoes are the first birds to have proven chemical defence against predators. Further research may reveal more surprises. To date, all other chemicals used by birds in their defence are thought to have been sequestered from plants or insects in the diet. The preen gland naturally produces a wide range of organic chemicals and there is every reason to believe that woodhoopoes are the first birds known to science that synthesise their own defensive compounds. □

Preening not only enhances feather condition in the Red-billed Woodhoopoe, but it may well be part of the species' defence armoury by making it smell and taste foul to predators.

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