ALAN LEE

ANGELA PERRYMAN

a journey through the mysteries of moult

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As a bird researcher in South Africa's botanically diverse fynbos biome, I have come to regard bird ringing as part of my journey to understanding moult. SAFRING and my training mentors strongly recommended that, having put a ring on a Cape Sugarbird's leg, I should also record the state of the bird's flight feathers. Initially I had no interest in doing this. I wanted to know where the birds were moving to, so recording the status of the bird's feathers in terms of moult seemed to me a laborious duty.

Moult is typically recorded for each primary feather, but the demarcation between primary and secondary feathers is not always as distinct as one might hope. Most passerines begin the annual change of feathers at this intersection, but even with years of experience under my belt, I often find >

ABOVE A juvenile Barn Swallow's coming of age: the brilliant blue adult feathers can be seen progressing along and gradually replacing the duller juvenile primary feathers.

OPPOSITE African Penguins undergo what is known as a catastrophic moult, when they replace all their feathers at the same time. This takes 2–3 weeks, during which time they cannot go to sea to feed and so can lose up to half of their body weight.

myself counting the feathers 'backwards', trying to determine where they theoretically meet. Then there's the task of distinguishing old feathers from new. Trying to do so tests the skills of even the most seasoned ringers.

But what began as a 'duty' for me soon turned into fascination. The process of moult, which I initially approached as a mere data collection task, became a window into the lives of the birds I was studying. The annual cycle of feather renewal is deeply intertwined with the rhythms of nature and the birds' own life histories. Moulting is more than just feather replacement; it's a complex and energy-intensive process that's closely linked to a bird's ecological and physiological needs. Its timing often aligns with a species' breeding cycles and environmental changes. For example, adult Cape Sugarbirds undergo moult after breeding – and closely resemble the bedraggled status of my wife and me who, with a child in our lives, don't get enough sleep, shelve make-up accessories and neglect the ironing pile. While our recovery is an ongoing journey stretching into its second decade, birds are far more efficient at getting the youngsters out of the nest, in most cases wrapping up the entire process in just a few months.

However, getting dressed in fresh feathers is more complicated than our daily digging into the wardrobe. For me, changing clothes from day to day is optional (when my wife is not around), but for birds it's not that simple. For them, the process of moult takes months and is a crucial phase in their life, serving several key functions. Primarily, it allows birds to replace worn, damaged or old feathers with new ones, ensuring their efficiency in flight, insulation and waterproofing. This is vital for survival, as feathers play a critical role in temperature regulation, camouflage and mating displays. My displays have far lower chances of success if I haven't bothered with fresh apparel.

The moult cycle also presents significant challenges and vulnerability for birds. During this time, they can experience a reduction in flight capability and agility, making them more susceptible to predators. This is particularly true for species that undergo a simultaneous moult, losing multiple flight feathers at once. How would you feel running around naked?

Moreover, the energy demand of growing new feathers is substantial. This often means that birds need to increase their food intake during moult, sometimes changing their foraging behaviour or habitat use. The nutritional requirement is especially high for growing feathers.

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In fynbos, where ecological interactions are complex and food availability can be seasonal, the timing of moult is crucial. Birds must balance the need to moult with other energy-demanding activities in their annual cycle, such as breeding, migration or preparing for harsh weather conditions. The synchronisation of moult with these activities varies greatly among species and is influenced by a myriad of factors, including climate, habitat and individual health.

The moult process itself can reveal a lot about a bird's life history and strategy. For example, some fynbos species moult quickly to minimise their vulnerability, whereas others spread out the process over a longer period to maintain mobility. From the conservation perspective, it is important to identify which birds are most vulnerable in our changing world. For this we need to know when birds start to moult and how long the process lasts. This is surprisingly hard to measure in wild birds, as we can rarely capture the same birds every day to determine how moult has progressed. Instead, we must make inferences from the random captures of birds from any given population during ringing events.

In South Africa we often struggle to find things to be proud of, but there is one thing we can add to the short list: the Underhill–Zucchini moult models. Les Underhill, best known for his guiding role with SABAP2, is a statistician who provided mathematical formulae to quantify population-level start dates and estimated duration of moult based on the random captures collected by bird ringers. These models are now increasingly used around the world.

In the recent special issue on the theme of moult in *Ostrich: Journal of African Ornithology* (edited by Adrian Craig and Birgit Erni), a paper by Philipp Boersch-Supan emphasises how repeated recaptures during a season can enhance these models. Also in the issue Les, together with Tanya Scott, introduces the Relative Duration Index, another method for examining moult. This novel moult index quantifies how long it takes to replace feathers and is illustrated with the impressive dataset Les's father, George Underhill, built up from captures of Laughing Doves. It is particularly useful for species where feather growth does not correlate directly with feather mass.

If this all sounds complicated, you're right! For me, the methods introduced by Rebecca Irons and her supervisory team (including Robert Thomson and Birgit Erni) using generalised additive models are visually far easier to interpret across the annual cycle, even though they don't give precise start dates and durations. But you may be more interested in Taylyn Bate's article that used photography and citizen scientists to obtain moult parameter estimates for African Black Oystercatchers, or Dieter Oschadleus's review on moult in weavers. Dieter's study underscores not only the complexity of moult patterns across species even within one bird family, but also the need for continued research in this area, especially given the ecological significance of weavers. Together these studies, representing the collective efforts of researchers, citizen scientists and bird enthusiasts, contribute to a deeper understanding of the avian life cycle. This collaborative approach is essential in the face of global environmental changes that continually reshape the lives of birds.

In the end, my journey into the world of avian moult has been more than just a professional endeavour. It has been a journey of discovery, filled with moments of challenge, fascination and profound respect for the resilience and adaptability of birds, as well as for those collecting the data. A special thanks to Mike Ford and Mark Brown, as well as all the volunteers I have roped in along the way. As we continue to unravel the mysteries of moult, we gain not only scientific knowledge, but also a greater appreciation for the natural world and its remarkable inhabitants. ◆

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A new species of sunbird? Or just a Malachite Sunbird transitioning into eclipse (non-breeding) plumage? Sometimes moulting birds can show interesting colour variations that can make identification confusing for beginner birders.

Why moult?

Birds moult to replace worn, damaged or old feathers with new ones and thus ensure optimal performance for flight, insulation and waterproofing. Feathers are crucial for temperature regulation, camouflage, mating displays and overall survival.

How often do birds moult?

The frequency varies among species. Most birds moult at least once a year, but the timing and duration can vary greatly, depending on the bird's life cycle, habitat and ecological needs. Some species may have more than one moult per year, especially if they have distinct breeding and non-breeding plumages. On the other hand, albatrosses replace only a subset of their flight feathers each year.

Are birds vulnerable to predation when moulting?

Yes, birds can be more vulnerable during moult. As they replace feathers, especially flight feathers, their ability to fly efficiently can be temporarily reduced, making them more susceptible to predators. In addition, the energy demands of growing new feathers can divert resources from other survival activities.

How does moulting differ across species?

All birds moult, but the patterns and strategies differ significantly from one species to another. Some species undergo a complete moult all at once, whereas for others the replacing of their feathers is a more gradual process. The duration of moult, the sequence in which feathers are replaced and the degree of impact on a bird's activities vary.

What other creatures moult?

Reptiles, amphibians, crustaceans and insects moult, generally shedding the outer layer of skin or exoskeleton to allow for growth or to replace worn or damaged outer coverings.

Do humans moult?

Humans are constantly shedding and replacing skin cells, which we hardly notice. And although it is not as drastic or functionally significant as feather moulting in birds, we constantly lose and regrow hair, a process that is essential for maintaining healthy hair and scalp.