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An introduction to primary moult

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Feathers work brilliantly on birds because they are so lightweight. Their disadvantage is that they wear, and have limited lifespans. All bird species have developed strategies for replacing their feathers: the process is called moult. The different groups of feathers serve a variety of functions, from insulation to locomotion. Each type of feather needs to be replaced before it fails to perform the purpose for which it is designed. Abrasion and ultraviolet light are two of the factors which cause feathers to deteriorate. This paper focuses on the moult of the most important feathers involved in flight, the primaries (Fig. 1).

Birds are the only vertebrates that regularly replace the most important part of their locomotory apparatus. This gives rise to an avalanche of consequences in the life of a bird that are not faced by any other taxon of vertebrates (Winkler & Rymkovich 1998). The study of the process of moult is as challenging and interesting as other major components of the annual cycle of birds, such as migration or breeding.

Moulting places a variety of demands on a bird. Expressed in energetic terms, these are:

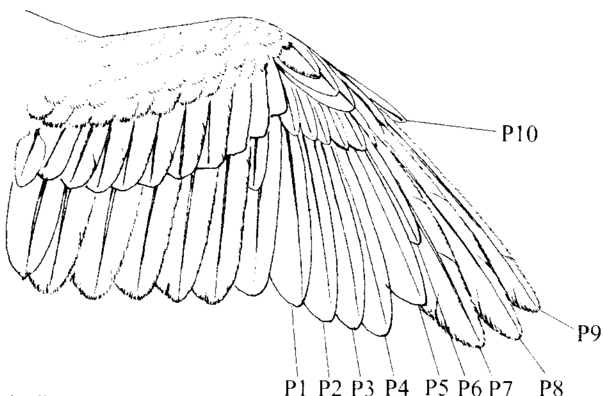

Fig. 1. The primaries are labelled P1–P10.

Safring News (2000) 29: 44–46

1. Energy is required to produce the organs that grow each feather.
2. Energy is needed to produce the feathers themselves.
3. Extra energy is needed to maintain body temperature while there are gaps in the plumage.
4. Extra energy is needed for flight while the flight feathers are replaced; gaps in the wing and tail as a result of dropped and/or growing flight feathers increase the drag and result in less efficient flight.

It is also likely that special chemicals are required for feather production; these either need to be synthesised, or to be part of the diet. In human terms, these chemicals are the equivalent of essential trace elements and vitamins.

The study of moult is most advanced in Europe; important reviews are those of Ginn & Melville (1983), Svensson (1992) and Jenni & Winkler (1994). Some of the moult strategies employed by European species are listed in Table 1.

Moult strategies in Africa are not well known. Craig (1983) stated: 'Basic data on moult are lacking for most southern African passerines'. This statement remains true nearly two decades later, and applies equally to non-passerines. Investigation of moult can most easily begin with the study of primary moult; for many species, most of the body feathers are replaced while the primaries are moulting. A knowledge of primary moult generally gives a good indication of the overall timing of moult. However, there is a huge amount of additional information derived from studying the moult of the smaller feathers; the book by Jenni & Winkler (1994) is a formidable demonstration of this.

Ringers are in the forefront of opportunities to study moult. The new SAFRING ringing guide provides the instructions for recording the progress of moult, and is not repeated here. However, learning how to record moult is a skill that is most easily learnt by demonstration. Provision is made for the submission of primary moult data in the SAFRING electronic ringing records; this makes it possible to combine the efforts of many ringers to obtain large enough sample sizes to make the analyses possible.

It is important that primary moult data should be submitted for all birds. Birds that are not in active primary moult should preferably be recorded as 'all primaries new' or 'all primaries old'; if it is impossible to decide whether the feathers are 'new' or 'old', then the moult should simply be recorded as 'no primary moult'. The statistical model that estimates the timing and duration of primary moult can use the information that is contained in the records of birds that are not actively moulting (Underhill & Zucchini 1988; Underhill *et al.* 1990). In fact, one of

Table 1. Moult strategies of European passerines, adapted from Jenni & Winkler (1994).

	Timing of moult	Example
1	Complete post-breeding moult in late summer, before migration	Thrush Nightingale *Luscinia luscinia*
2	Complete post-breeding moult in late summer, partial pre-breeding moult of body feathers in spring	Pied Flycatcher *Ficedula hypoleuca*
3	Complete moult in 'winter' in non-breeding area, after migration	Barn Swallow *Hirundo rustica*
4	Partial post-breeding moult in late summer, suspended before migration, and completed in non-breeding area	Tawny Pipit *Anthus campestris*
5	Partial post-breeding moult before migration, then a complete pre-breeding moult in the non-breeding area	River Warbler *Sylvia fluviatilis*
6	Complete post-breeding moult before migration, and a second complete pre-breeding moult in the non-breeding area	Willow Warbler *Phylloscopus trochilis*

the best estimates of the average duration of primary moult for the individual bird is the number of days between the date on which 50% have started moult and the date on which 50% of the birds have completed moult.

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Birds in the air: a quality perspective

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Many trainee ringers, upon receiving their A-permit, continue to ring for the sake of ringing because the newly qualified ringer does not have a specific bird-ringing project to pursue. During the course of the Bird Ringers' Workshop and Conference held at Witsand, a few speakers indicated projects in which these ringers could participate. With this in mind, I would like to add another project to the list.

I did my university training in the occurrence and concentration of metals in selected freshwater birds and I work as a pollution ecologist doing impact assessments. I would therefore like to combine bird ringing with a study of environmental quality. I am moving away from my interest in water pollution into a field of which I know very little, but in which the average bird ringer can easily participate, and that is air quality.

Birds do not only use feathers for flying; they also use them as a route for excreting undesirable pollutants, especially metals, much in the same way as the liver and the kidneys are used to eliminate pollutants via faeces and urine. Scientists in Europe and America have effectively used bird feathers as indicators of air quality. For example, researchers (Garcia *et al.* 1988) have linked atmospheric lead concentrations with levels of lead in the lungs of Feral Pigeons found in Madrid, Spain (see table).

These researchers also found a gradual increase in the lead concentrations in the bones of the Feral Pigeons from rural areas to urban areas with a high traffic density. Also, the lead levels in bones of female pigeons were usually higher than in those of male pigeons. This is due to the fact that female pigeons need to actively accumulate calcium for eggshell formation. The carrier protein is unable to recognise the difference between calcium and lead. Research was conducted in Poland (Sawicka-Kapusta *et al.* 1986) on three species of tit occurring in forests heavily polluted by metal smelters, forests polluted by industry and a forest with no pollution. The results indicated gradual increases of various