

rings of one type, you can split the data into several pages if you like). You can choose a separate page for recaptures, or else record recaptures on the relevant ring series page.

2. Set up the columns in your spreadsheet, and copy the columns to as many pages as you need for your different ring series. If you're using older versions (without pages) then use separate files per ring series. Name the pages (/files) by the ring prefix.
3. Add in the ring data from your field book after each ringing session.

Adding data

To add consecutive ring numbers in Excel: Type the first ring number (e.g. BC06001). Select the cell and click and hold on the bottom right corner (on the plus symbol) and move down with the mouse. The ring numbers are then automatically incremented as you keep on moving. Let go of the left mouse button to end.

Some fields need only be filled in if relevant, i.e. Marking, Condition, Colour rings. Mass, Wing, Moults are not compulsory but you are encouraged to fill these in.

All other fields must be filled in for each ring record. Do not use dittos or blanks for repeat data. Use the copy function to copy

dates, localities, etc. that are the same.

Beware of errors. With computers it is easy to make mistakes!

You may have many additional fields (e.g. other measurements) in additional columns for your own use.

Do not use 0 or – for data not obtained: leave the cell blank.

Submission of data

Send data to SAFRING regularly, and certainly by the end of every ringing year. A good idea is to send data whenever you've handled 100 to 500 birds (over one or several sessions). Then the file will not be too large to send (by email). Choose a new page (/file) in your spreadsheet; copy the lines of unsent records from the different series to this page, as well as unsent recapture records.

Copy the page to a separate single file.

If you have access to email, mail the data as an attachment to dieter@maths.uct.ac.za.

If you don't have email, copy the data to a stiffy disc, put your name on the disc, and post it.

When you receive confirmation from SAFRING, check the SAFRING report against your computer records, and mark the records as having been sent (if not done yet).

Reflections on the use of colour-rings in southern Africa

Steven E. Piper

2 Canal Drive, Westville, 3630; email: PiperS@nu.ac.za

INTRODUCTION

Among the many tools for studying the lives of individual birds one of the least expensive and cost-effective is the use of colour-rings. For the last 23 years, with a series of helpers, I have been investigating aspects of the lives of a small population of Longtailed Wagtails *Motacilla clara* near my home just outside the

port city of Durban (Piper & Schultz 1988; Piper 1989; Piper & Schultz 1989). In this note I reflect on the successes and failures of that study and make observations on how the use of colour-ringed birds could be extended to other species in the sub-continent. I also draw upon my experiences in working with my colleagues in the Vulture Study Group (VSG) (Mundy *et al.* 1992; Piper 1994).

The soon to be published *Ringer's manual* contains a short review of the use of rings in the study of birds and outlines the history of birdringing as well as the reasons for using different techniques. The reader is referred to that review for background material. Herein I will assume that the prospective user of colour-rings has investigated other techniques such as patagial tags, neck- and nasal-collars, transponders, radio- and satellite-tracking and has decided, as I have, that colour-rings provide an ideal solution to tracking individual birds through space and time and following their social relationships.

THE BIG QUESTION

It's fun to colour-ring birds and somehow feels even more professional and scientific than just plain ol' ordinary ringing. However, if you have not posed a serious question that can only be answered by having uniquely identifiable birds then you should not put colour-rings on 'just for fun'. A number of reasons for making birds uniquely identifiable from afar, without having to recapture them are provided in the text below. Note also that anyone wanting to start a colour-ringing project should contact SAFRING in the planning stage of the project, prior to ringing.

STUDY CRITERIA

Before commencing a study using colour-rings it is necessary to give consideration to four characteristics of the intended study species and the environment in which you wish to study it.

The first and most important of these criteria is safety. You should never fit colour-rings to a species when you suspect that this will have a significant chance of inducing injury or mortality. Two examples will suffice. Some storks exhibit urea hydrosis (i.e. they defecate on their legs) to cool themselves in hot weather and it is likely that colour-rings will trap faeces and this could lead to irritation and infection. Some species use their legs in such a way that the presence of

colour-rings could interfere with some aspect of their lives. *Gymnogenes Polyboroides typus* put their legs into holes in trees while foraging and colour-rings could possibly entrap them there (H. & Z. Bernitz pers. comm.). It has been suggested in laboratory studies that male Zebra Finches fitted with red rings are more attractive to potential mates (Ratcliffe & Boag 1987)!

The second criterion is visibility. Species with longer legs who walk rather than hop about are more likely to be seen. Birds that stand upright on perches (e.g. Pale Chanting Goshawk *Melierax metabates*) rather than those who perch with their legs withdrawn up to their bodies (e.g. the cuckoos) show their rings off to advantage. Species that forage in an open environment (e.g. Hadedda Ibis *Bostrychia hagedash*), rather than those that forage or walk about in dense vegetation, or forage or swim in water (e.g. ducks), have more visible legs.

Thirdly, good candidates are those species that are of a confiding nature and allow the observer to approach to within a reasonable range (e.g. Sacred Ibis *Threskiornis aethiopicus*). They are better candidates for a colour-ringing study than those which avoid human contact or turn their back on the observer when first detected (e.g. Narina Trogon *Apaloderma narina*).

Lastly, resident species are better suited to a colour-ringing study than migratory or nomadic species. There can be few things as frustrating as going to the effort of marking 20 to 30 individuals only to find that they soon disappear and never return! However, there have been studies in southern Africa where colour-rings have been used in pilot-studies to elucidate movement patterns and the best examples of these are of seabirds that breed in colonies and then disperse around the southern Africa coast. African Black Oystercatchers *Haematopus moquini* have been fitted with colour-rings in the southwestern Cape and have been resighted along the Namibian coast (Mark Boorman pers. comm.).

Lastly, an unexpected bonus when using colour-rings is that a dead bird bearing col-

our-rings is more likely to be noticed and reported! It was found that colour-ringed Cape Griffons were more likely to be reported dead than those with just a metal ring (Piper 1995).

DESIGN CRITERIA

It is a serious mistake to just begin a study using colour-rings without giving consideration to four design criteria. (At this point I smite my breast and begin the *mea culpa* litany!)

Firstly you need to give consideration as to what rings to use. You need to choose a colour-ring that is of the appropriate size and shape and is made from a suitable material and which is within your price range. You must fit a ring big enough to be seen from your regular operating distance yet small enough to fit on the bird's legs. You need to ascertain that the material you wish to use will remain colour fast for the duration of your study, noting that some colours in some materials fade rapidly. In my wagtail study I stopped using yellow after I found that it regularly faded to become indistinguishable from white. The colours that I have found to be most useful are red (coded as R), blue (= B), green (= G), white (= W) and swart (= S). I use light blue and light green to prevent confusion with swart. ('Swart' rather than black so that I can code 'S' for swart and 'B' for blue.)

Some people use all manner of outlandish colours: pink, purple, brown etc. but I strongly advise against this as it becomes more and more difficult to resight these consistently. Some materials become brittle with age and are then prone to cracking and falling off, e.g. Darvic colour-rings on vultures (Mundy *et al.* 1992).

Secondly, you need to provide a rough estimate of how many permutations you will need for the *entire duration* of your study. It is easy to fall into the trap of thinking that if you only have 20 birds in your study flock then about 50 permutations will be enough. As a rough guide for a study of passerines assume that you will lose 50% of your adults each year and that you will have to ring their

replacements as they recruit to the population. Naturally all the replacements will come from outside your study area and none of them will be ringed! When you go out to colour-ring a new bird that has joined your study population you will catch individuals that are in the process of dispersing; they may be caught and ringed once only in your study site and then they will disappear! On the one hand ringing these lone birds is a waste of a colour permutation but on the other hand they actually contribute to your knowledge of dispersal distances if you search the surrounding terrain and resight them. In my wagtail study I welcome these birds, which I call 'birds of passage' but which are better known as 'floaters' because a small but significant proportion of them return later to become territory holders. You should allow as many extra permutations for these birds of passage as you do for replacements. Lastly you should allow about two extra permutations each year per pair for new recruits to the population, i.e. the fledglings produced by each pair. You need to decide when you will ring new recruits each year. You may decide only to fit a metal ring to each nestling rather than waste a whole colour-permutation on a young bird that may have a greater than 50% chance of dying before it is old enough to recruit to the breeding population.

For example:	
Initial population	20
Annual increment	
Replace lost breeding adults (50%)	10
Birds of passage	10
Fledglings	20
Total increment each year:	40
Number needed for a five-year study	220

So for a five-year study you will need at least 220 permutations and to be on the safe side you should allow for about 350 permutations.

In designing your colour scheme you should bear a number of principles in mind:

1. Never repeat colours. You can have red over green over red but never red over red over green because you will have diffi-

culty in deciding if you are looking at one rather than two red rings and you will not be able to readily detect ring loss.

2. Give careful consideration before using a colour similar to that of the bird's leg. A swart ring top or bottom on a black leg may be almost impossible to see but in the middle of two other rings may indeed be readable, e.g. red over swart over green.

To help you compute the number of rings to fit to each leg the following examples suffice.

Example 1

If you use five colours (B, G, R, W and S) and fit two rings to the left leg you will have $5 \times 4 = 20$ permutations on the left leg. If you put a single colour above the metal ring on the right leg you will have five permutations there giving you $20 \times 5 = 100$ in total. If you are willing to put the metal ring on the left leg then you double the number of permutations to 200 and if you are prepared to put the metal ring above, rather than below the colour ring, then you have 400 permutations.

Example 2

Put three colour rings on the left leg ($= 5 \times 4 \times 5 = 100$ permutations) and two colour rings above the metal ring on the right leg ($= 5 \times 4 = 20$ permutations) to give a total of 2000 permutations.

The third matter to consider is data recording. You need to have a paperwork scheme that allows you to capture your ringing data in the field as you process your birds and simultaneously keeps track of the permutations used so that you do not fit duplicates. It's Murphy's Law: fit a duplicate and the birds will associate with each other and bug the life out of you! In my Longtailed Wagtail study there is a paper-based summary form for each set of 20 permutations and this is filled in as soon as the birds are colour-ringed; see the example in Figure 1. This ensures (vain hope!) that the same colour-permutation is never used twice.

Lastly, a colour-ringing study is no better

than the quality of the resightings collected. To my mind the only effective scheme for noting the colour-rings of a bird resighted in the field is to draw a little diagram showing the two legs labelled left and right and the ring positions top, middle and bottom; see the example in Figure 2. It is my sad experience that almost no members of the general public are able to correctly read and record colour-permutations. If you wish to colour-ring then you need to ensure that you have set aside enough time to make the requisite number of resightings and if you want other people to assist you then you need to train them.

The late 1990s have seen a wonderful advance in plastic engraving techniques and it is now possible, for birds that take at least a 7 mm ring, to purchase an elongated ring with any permutation of alphabetic characters and numerals on it. Provided the engraved letters and digits are big enough to be read in the field these work much better than colour-permutations and are less prone to mistakes. These new rings have been used very successfully on gulls in the UK (Rock 1999) and in southern Africa (L.G. Underhill pers. comm.).

OPERATIONAL PHASE

Most first-time users of colour-ringing think only of the initial cohort to be ringed and seldom think beyond that. In operating a colour-ring scheme there are four issues to be considered.

You first need to consider how many birds you wish to colour-ring and keep colour-ringed in order that you achieve the objectives of your study. It is outside the scope of this note to give general guidelines on this topic. However, this can sometimes be an easily answered question. If you want to monitor all the birds in a small population or follow the fate of two or three flocks of a social species then all you have to do is catch and mark them all and all the replacements and all their progeny!

The second factor you need to consider is how often to ring to keep your population marked. In my wagtail study I assume that

Left Leg	Red ----- Metal ----- White	Red ----- Metal ----- Swart	Red ----- Metal ----- Blue	Red ----- Metal ----- Red
- ----- Swart ----- White	- R BC-22139 S A 300 30/9/1996 W W F78 61 mm TAIL (A)✓	- R 300 S A 650 21/10/96 W S BC-22143 69 mm TAIL (A)	- R 300 (A) S A 428 2/11/1996 W B 100 mm TAIL BB-29936	- R 300 S A 59 mm 30/11/1996 W R 146 UNIV. TERR BB-29949 NO ARRIVAL (A)
- ----- Swart ----- Blue	- R 300 S A 26/10/96 A30 B W 83 mm TAIL BC-22146 (A)	- R BC-22140 S A F64 J40 B S 30/9/1996 60 mm TAIL (A)✓	- R 300 S A 654 21/10/96 B B BC-22144 62 mm TAIL (S) (C) (A)	- R 300 71 TAIL S A E74 B R DONACUT 99 1520 6-11-99 BB-40198 NO ARRIVAL
- ----- Swart ----- Red	- R 300 S A 55 mm TAIL 20/11/1996 R W BB-29950 146 UNIV. TERRITORY	- R 300 S A 2/11/1996 K52 R S 100 mm TAIL BB 29935 (A)	- R 300 S A 15/10/1996 1455 300 62 mm TAIL (S)✓	- R BB 40192 S A 7/11/99 A20 R R FAIRLY CLIFF NO ARRIVAL 83 mm TAIL 300

Fig. 1. An example of a colour-permutation (= combination) sheet in which 12 sets of colour-rings are depicted. As each permutation is used, the basic data (e.g. ring number, date, etc.) are entered onto this form. This form acts as a quick reference to the colour-permutations used and is also a cross-reference to the ring numbers associated with each colour-permutation. Using a form such as this and adhering to it should prevent duplicates.

Colour-ringed Longtailed Wagtails

Date: Sheet:
Day Month Year NOBS:

Locality: Shonalanga
e.g. Mhlambanyathi

Reference Co-ordinates:

Latitude: South Longitude: East

Place:
e.g. C04.00 Spuit photo rapids

Colour-rings Left Right
 Top
 Middle
 Bottom
 Comments on Rings: _____

Time Observation
 1-1:30 Bird followed up river
 from just above F92 to
 F76 Bird sat on large
 wet on rocks.

© JOBS/BSH/CDP/Ver 4.01

Fig. 2. A simple form on which to record the resighting of a colour-ringed bird. Note the little picture-block in which the colours of the rings are filled in with the left leg on the left and the order shown as top, middle and bottom.

50% of the territory holders will either die or lose a ring or have a colour-ring fade during the year. Hence I need to process 12 of my approximately 24 territorial birds each year, i.e. I need to 'maintenance ring' about once a month. If they breed well during the year then the 12 pairs will produce up to 20 free-flying fledglings, and this entails approximately 12 additional ringing days during the breeding season from about September through to December, about three times a month. You need to be sure that you can manage this amount of effort.

When you plan a study involving indi-

vidually marked birds you need to give careful thought to how often you will need to locate each individual. For a study of survival you may want to be sure that each bird is alive at the start of each month, or at least at the start of each quarter. If you are wanting to monitor breeding in a species in which there are helpers at the nest, then you may need to monitor each flock once a week during the breeding season to detect the onset of nest building. Thereafter you may need to monitor each nest once every two or three days. So the third aspect of the operational phase is determining the monitoring programme. In

my experience, the ratio of 'resighting' time to 'ringing' time is somewhere between 2 and 10! I tend to ring Longtailed Wagtails in the Palmiet River about once a month and go on census walks on about two to six days a month.

The fourth and last aspect of a colour-ringing study is data recording and analysis. For many years I'd come home from work at lunchtime and then go for a four-hour walk in which I'd census about half the territories. As a consequence of coming home at supertime I'd eat, wash the dishes, have a bath and then be too tired to write up or capture my field observations. As a consequence I now have over 40 notebooks urgently needing to be analysed! A few years ago I switched to starting my walks before dawn so that I got to the first territory just after sunrise and so returned home in the early afternoon. That way I have time for lunch, a bath and a delightful late afternoon snooze! In the evenings I'm more relaxed and able to code up the data, and even more importantly, interpret what is happening as it happens. When I code up my earlier data I see that the significance of some important events passed me by at the time.

OPPORTUNITIES FOR COLOUR-RING STUDIES IN SOUTHERN AFRICA

Since I began my studies of the Longtailed Wagtail in 1976 and became associated with Dr Peter Mundy and his field studies of Cape Griffons the following year, I have noticed a number of species around southern Africa that are ideally suited to colour-ringing. A round dozen of these are listed below in hope that a kind reader will be inspired to choose a local bird for herself (or himself!).

1. The Ibis family

There are four ibis species in southern Africa and three of them are definitely worthy of a major colour-ringing study. The one I exclude, the Glossy Ibis *Pelagadis falcinellus*, is excluded only because I don't know anything about it and don't have a feel for its GISS in the field. If it was colour-ringed, would you

be able to see its rings?

The Bald Ibis *Geronticus calvus* is being studied at a few colonies and this programme should be increased.

The Sacred Ibis was almost unknown in the City of Durban in the late 1960s yet is now a prolific breeder at at least five major colonies in the inner city in 1999. There may be over 500 pairs! It is now fairly unwise to go to the 'Concert in the Park' in the Durban Botanical Gardens after dark during the breeding season because of the nearly constant rain of urea that comes down from their nests! Together with some friends I ringed about 55 Sacred Ibis in Durban and these were transported far away to Eshowe (to try and get rid of them – they were a nuisance) but they all flew home again and they are still around the city. They are readily caught in a walk-in trap baited with day-old chicks and once colour-ringed they are very easily recognised in the field from their colour-rings.

One of the most amazing avian expansions to have taken place in southern Africa is that of the Hadedas Ibis. What is so unusual is how little comment it has evoked. How can such a large, obvious and irritatingly noisy bird, especially pre-dawn, not engender more public comment? I have what I think is a small family party on my front lawn and I would dearly love to know who is married to whom and who their offspring are! But I don't know how to catch Hadedas, do you? I'd be pleased to hear from anyone who could. I am sure that there is a very interesting story to be found around the success of these two urban birds.

2. The Thrush Family

An obvious species to work on is the Olive Thrush *Turdus olivaceus*. It's everywhere; there's hardly an urban garden in southern Africa without at least a small highly mobile population of thrushes rushing hither and yonder! Dr Richard Liversidge marked about 80 birds in Kimberley; they came to his garden to eat his mulberries in the spring and were then seen around the suburb. They are so bold, allow an easy approach and because they run about gardens it is very easy to see

their colour-rings.

Some work has been undertaken on the much much rarer Spotted Thrush *Zoothera gutta* but it is so difficult to find and monitor that the rewards are likely to be much smaller. However, the similar-looking but rather different Groundscraper Thrush *Turdus litsit-sirupa* is much more numerous and comes into city gardens and farmyards and may be much more rewarding to study. However, I've not been able to catch them!

3. The Robin, Chat and Robin-Chat families

If there is any bird that I lust after, in an ornithological sense, it is the Anteating Chat *Myrmecocichla formicivora*! It's such a neat bird; it sits on fence-posts and watches you drive by just calling out for colour-rings! They are always in the same place whenever you drive by but actually there is a massive turnover of birds (Earlé & Herholdt 1988). They have a complex breeding system involving fledglings from earlier nests in the season becoming helpers later in the season (*ibid.*).

Two years ago I colour-ringed three Mocking Chats *Thamnolaea cinnamomeiventris* at a camp site on the farm Mambaso alongside the Thukela River. They are still in and around the campsite coming in to the cooking shed and toilets much to the delight of the visitors. They come so close that it is possible to read their colour-rings with the naked eye. I don't know how one would catch them in their natural, bolder-strewn or cliff-face environment, but once marked they would be easy to observe. I would think that all the *Cercomela* Chats (Familiar *C. familiaris*, Trac-trac *C. trac-trac* and Sicklewinged *C. sinuata*) would be easy birds to study, and very rewarding. If you have not yet bought a copy of Dr Terry Oatley's book *The robins of Africa* (Oatley 1998) you should do so right away. It's a beautifully written book about delicately hued birds authored by one of our last field-naturalists. Every time I dip into it I am beguiled by the charm and sensitivity of the writing and wish that I could express myself

with at least one millionth of his skill. In his book he has outlined a whole slew of problems around the issue of local movement, especially altitudinal migration, that can only be solved by ringing. Along the eastern parts of southern Africa from East London in the south through the former Transkei, KwaZulu-Natal, Mpumalanga and the Eastern Highlands of Zimbabwe in the north, there are more than a hundred major forest patches. Many of these contain populations of one or more of the following four species (Chorister *Cossypha dichroa*, Natal *C. natalensis*, Cape *C. caffra*, Starred *Pogonocichla stellata* and possibly Whitebrowed *Erythropgyia leucophrys*) and these species show total or partial migration, mostly altitudinal.

Well I could go on and on and on! There are so many beautiful and interesting species to study in southern Africa: many, many more than there are birdringers available to study them. And the best part is that there is a species on your very doorstep just waiting to be looked at. Within a few years you could become the world expert on the Hadedas Ibis!

REFERENCES

- Earlé, R.A. & Herholdt, J.J. 1988. Breeding and moult of the Anteating Chat *Myrmecocichla formicivora*. *Ostrich* 59: 155–161.
- Mundy, P.J., Butchart, D., Ledger, J. & Piper, S. 1992. The vultures of Africa. Randburg & Halfway House: Acorn Books & Russel Friedman Books.
- Oatley, T.B. 1998. The robins of Africa. Johannesburg: Russel Friedman Books.
- Piper, S.E. 1989. Breeding biology of the Longtailed Wagtail *Motacilla clara*. *Ostrich Supplement* 14: 7–15.
- Piper, S.E. 1994. Mathematical demography of the Cape Vulture. Vols 1 & 2. Faculty of Science. Cape Town, University of Cape Town.
- Piper, S.E. 1995. A model of the ring-recovery reporting process for the Cape Griffon *Gyps coprotheres*. *Journal of Applied*

Statistics 22(5 & 6): 641–659.

Piper, S.E. & Schultz, D.M. 1988. Monitoring territory, survival and breeding in the Longtailed Wagtail. *Safring News* 17(2): 65–76.

Piper, S.E. & Schultz, D.M. 1989. Type, dimensionality and size of Longtailed Wagtail territories. *Ostrich Suppl.* 14: 123–131.

Ratcliffe, L.M. & Boag, P.T. 1987. Effects

of colour bands on male competition and sexual attractiveness in Zebra Finches (*Poephila guttata*). *Canadian Journal of Zoology* 65: 333–338.

Rock, P. 1999. The efficacy of the colour-ringing system used for Herring Gulls *Larus argentatus* and Lesser Black-backed Gulls *Larus fuscus* in Bristol 1980–1997. *Ringling & Migration* 19(4): 306–310.

An introduction to primary moult

Les G. Underhill

Avian Demography Unit, UCT, Rondebosch, 7701; email: lgu@maths.uct.ac.za

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:

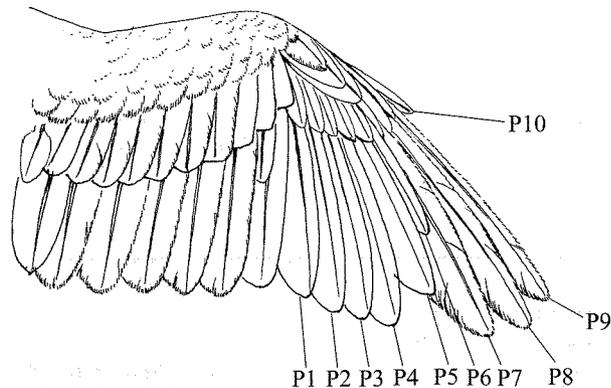


Fig. 1. The primaries are labelled P1–P10.

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