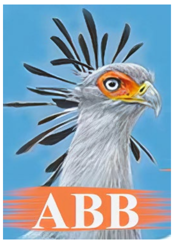

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Temminck´s Courser *Cursorius temminckii*, Swainson 1822: plumage, moult, biometrics, and determination of age

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Abstract

Data on biometrics and moult are scarce for many southern African species, and plumage features throughout the different age categories are not fully described. The moult of coursers is hardly explored, and many questions remain. In this study, we present biometric measurements and moult data of 12 Temminck´s Coursers *Cursorius temminckii aridus* from Namibia ringed during several years between December and March. With photographic evidence, we illustrate the progress from juvenile into adult plumage, compare features of young and adult plumage, and show undescribed features, like the white trailing edge of secondaries and the occurrence of apparently two age groups of coverts in young Temminck´s Coursers. We elucidate the previously undocumented strategy of the primary moult of Temminck´s Coursers by showing congruences with the well-examined moult of the closely related Cream-coloured Coursers *Cursorius cursor* from northern Africa. We hope that our observations serve as a basis for further research to clarify and validate the proposed moult strategies and, with them, a refined determination of age.

Keywords: bird ringing, Temminck´s Courser, *Cursorius temminckii,* Cream-coloured Courser, *Cursorius cursor*; age determination, juvenile plumage, plumage development, moult, biometrics

Introduction

Basic information for many African, southern African, and especially Namibian species and subspecies is scarce or unavailable. For Temminck´s Coursers *Cursorius temminckii* (Figure 1), data on biometric measurements and moult are poor, and plumage features are not fully described. Bird ringing offers a unique opportunity to closely inspect and observe phenotypical signs and features. In the Afrotropics, the breeding times of birds are not necessarily determined by seasons as in the Palaearctic. The age of a bird must thus be derived from its own plumage features like colouration, wear, or shape of the feathers, and, if applicable, from other signs like bare parts or eye colour.

What struck us most during our studies on Temminck´s Courser and Burchell´s Courser *Cursorius rufus* (Bryson and Paijmans 2024) was the absence of a complete moult into adulthood at a determined period in the annual cycle. Our observations suggest a process over several years to attain the plain, fully coloured adult plumage (Bryson and Paijmans 2024). This can be derived not only from residual coverts and several visible waves of primaries but also from the overall appearance and the colouration of the tail in Temminck´s Coursers and of the front part of the crown. We could correlate these features in the time of the post-breeding moult between December and March. This period is when both young and adults underwent phases of their primary moult, and a direct comparison between the progress and the expression of moult was possible.

It could not be determined whether these processes are periodic, continuous, or both and how the moult advances of each year reflect the progressive acquisition of the plumage. However, we present our biometric and moult data of 12 Temminck´s Coursers from Namibia and add further measurements from the literature.

Here, we discuss and illustrate with photographic evidence the plumage development in different ages to better determine the age of birds when being observed

Figure 1. Adult Temminck´s Courser (Omusati, Namibia, April 2021, Macaulay Library ML329673051, © Gabriel Jamie).

or being ringed. We document the unstudied strategy of primary moult of Temminck's Courser by comparing our photographs of wings to the description of the well-examined moult of another *Cursorius* species, the closely related Cream-coloured Courser *Cursorius cursor*, and show congruences in the primary moult of both species. Furthermore, we also investigated different age signs, focusing on the Namibian subspecies *C. t. aridus* and compared plumage expressions of first-year birds in different stages after their post-juvenile moult with those of definite adults.

It is our hope that our observations and hypotheses may serve as the basis for further research to clarify and validate the proposed moult strategies and, with them, a refined determination of age.

Methods

Timing, locations and photographic documentation

We caught and ringed Temminck's Coursers from December to March between 2011 and 2020 on the farms Hamakari (20°36'S 17°20'E) south of the Waterberg,

Figure 2. Ringing site for Temminck´s Coursers in Namibia: flat terrain with short grass in open (to semi-open) savanna. We found the coursers on this field in shallow depressions covered with slightly more vegetation than visible in the foreground. (Farm Hamakari, March 2019, ML616707861, © Ursula Bryson).

Windpoort (19°20'S 15°28'E) south of Etosha National Park, and Okatjerute (22°21'S 18°33'E) north of Witvlei. The habitat is grazed plains of cattle farms in sparsely vegetated savanna (Figure 2). The authors took the photographs in Namibia and show Temminck´s Coursers unless specified otherwise. For comparison with our own pictures, we gathered material from the internet, mainly from the Macaulay Library, which hosts almost 1400 photographs from all over the species' distribution range.

Taxonomy and subspecies

Plumage differences and the range of the different subspecies are extensively discussed in Clancey (1984). The subspecies are well-defined chromatically and show differing migratory or sedentary behaviour. Of the three subspecies occurring in southern Africa (Clancey 1984, Hockey 2005, Maclean et al. 2020), *C. t. aridus* (called *damarensis* in Clancey 1984) is reported to occur in central to northern Namibia and Botswana to western Zimbabwe (Hockey 2005), while Clancey (1989) claims that "all 3 subspecies occur in South West Africa", now Namibia. See Maclean and Herremans (1997) for more details.

Cursorius t. aridus is overall paler and greyer (see Figure 7) than the other two subspecies, *C. t. temminckii* and *C. t. ruvanensis*. This concerns, to varying degrees, mainly the crown, cheeks, breast, and throat. The cinnamon area of the mid-breast is both lighter and more restricted, and the black mid-ventral patch is smaller with a corresponding increase in the extent of the lateral white (Clancey 1989). Therefore, we considered all individuals from our sample from Namibia as *C. t. aridus*.

Capture, measurements, moult codes, and determination of age

Birds were caught in flap-traps baited with a mealworm. After capture, the bird was ringed with a SAFRING numbered ring and measurements, except for the skull (see below), and moult scores were taken as described by de Beer et al. (2001). The following parameters were recorded: the length of the flattened wing chord, the length of the tail, tarsus and culmen (all to the nearest mm), and the mass (g). The measurements of the culmen were taken to the skull, i.e., to the indentation on the front of the skull.

Some moult processes could be described with the commonly used moult codes. For serially descendent moult, further studies might benefit from applying more systematic recording and refining codes (see Rogers 1990) to capture the complexity of different growth waves.

We determined the age of the first-year and adult birds by plumage features, e.g., by the vermiculated, dotted, buffy, or pale-fringed feathers of non-adults that contrast with the dark, plain, uniform feathers of adults.

To study plumage features, we extensively researched all the photos of Temminck's Coursers in the Macaulay Library database.

Results and Discussion

Measurements

Table 1 presents the measurements of eight adult and four first-year *C. t. aridus* from our study. Wing measurements of the same subspecies from Hoesch and Niethammer (1940) and Clancey (1989), which were published in Hockey (2005), are also presented for comparison. The wings of first-year birds appear to be shorter, but sample sizes were small, and sexing could not always be done reliably.

Plumage of first-year Temminck´s Coursers

The age of Temminck´s Coursers can roughly be determined by different plumage expressions: those of downy young, juveniles, immatures, and adults.

Downy young

The first description of a newly hatched Temminck´s Courser in the literature is from Steyn (1965, and includes a photograph), who describes the upper parts as cryptically coloured, "mottled black, buff and red-brown". See also Maclean and Kemp (1973). The bird was from Ntabenende, KwaZulu-Natal, South Africa, thus of the subspecies *C. t. ruvanensis*. The downy young of coursers, in general, are "... in colour and structure closer to that Pteroclididae than ... of any other wader group" and of a "highly modified pebbly-pattern type" (Cramp 1983) (Figure 3).

Juvenile

The dark colour of the down changes to a lighter, more mottled appearance after about 14 days, but it is still effective as camouflage, as described in detail by Engelbrecht (2001).

While in juvenile plumage, the first-year birds reach the size of adults (see ML615670678). The plumage of juveniles is quite distinct from the adults. It is coarsely mottled on the upperside, while the black spot on the belly and the colouration on the underside develop gradually. On

Table 1. Measurement data from this study. Average measurements (including standard deviation and range) of Temminck's Coursers *C. t. aridus*.

Grouping	Wing (mm)	Tail (mm)	Tarsus (mm)	Culmen (mm)	Head (mm)	Mass (g)
Adult (n = 8)	124.9 ± 3.8 (120.0–131.0)	49.4 ± 2.1 (46.0–52.0)	42.1 ± 1.6 (38.9–43.8)	25.6 ± 1.8 (23.3–28.6)	47.3 ± 1.2 (45.5–49.3)	65.1 ± 3.6 (58.2–70.7)
First-year (n = 4)	122.3 ± 3.1 (118.0–125.0)	49.1 ± 6.1 (45.0–56.0)	41.8 ± 1.7 (39.5–43.7)	25.3 ± 2.0 (23.6–27.6)	46.8 ± 1.4 (44.8–48.1)	64.9 ± 4.2 (60.1–68.6)
Hoesch and Niethammer (1940)						
Adult male (n = 2)	120.0–125.0					
First-year male (n = 2)	116.0–127.5					
Clancey (1989); also in Hockey (2005)						
Adult female (n = 7)	120.0–128.0					
Adult male (n = 6)	126.0–132.0					

Figure 3. An adult Temminck´s Courser with two downy chicks in their cryptic plumage. No location or date. The colouration of the back of the adult excludes the ssp. *C. t. aridus* (Clancey 1984), while the dark cheeks point towards *C. t. temminckii* (https://commons.wikimedia.org/w/index.php?curid=9676191, © Chandres).

the bland chest, darker brown or black spots are visible (Figure 4). The buff or pale rufous supercilium will turn white, and the black stripe below will emerge during the first year.

There is no information about a post-juvenile moult in Temminck´s Coursers. It is likely that Temminck´s and the Burchell´s Coursers, as well as other "shorebirds", retain their juvenile plumage "for a few weeks, exceptionally up to three months" (Cramp 1983). The post-juvenile moult may be even more protracted in both courser species (see Bryson and Paijmans 2024). As observed in two juvenile Temminck´s Coursers undergoing a partial moult on 7 and 8 January 1935 (Hoesch and Niethammer 1940), the juvenile flight feathers of waders are usually retained (Hayman et al. 1986). What remains unexplored is the age at which the tail moult takes place.

Immature

During the post-juvenile moult, the strongly patterned juvenile plumage is replaced by the plain plumage of the adult. This process extends over an undocumented time (Figures 5a and 5b). It regularly reaches into the second year of life, or even further, and this results in a patchy or streaked appearance with a variable number of residual, well-marked feathers remaining in the plain plumage of the adult.

Evidently, Temminck´s Coursers reach sexual maturity before the adult plumage, especially on the coverts, is fully attained. Also, heads marked with scallops are found in some breeding birds (see ***Crown and forehead and corresponding wing and upperparts***). Meade-Waldo collected two male breeding Cream-coloured Coursers with residuals of the juvenile, "partly spotted plumage" (Meade-Waldo 1889) and one "in a half-immature plumage" (Meade-Waldo 1893), which led him to the erroneous conclusion that coursers become sexually mature in the first year.

Since no observations or detailed descriptions of the moult progress have been published, we refer to the closely related (del Hoyo and Collar 2016), well-researched, mainly North African Cream-coloured Courser for comparison. Its post-juvenile moult follows the sequence of "head, neck, mantle and chest; scapulars and most wing-coverts; tertials, tail, tail-coverts, back, and rump" (Cramp 1983), a sequence likely to be

Figure 4.Juvenile Temminck´s Courser ssp. *ruvanensis* (a) with uniformly patterned crown, back and coverts and dark spots on the chest. ML614337367. (b) Dorsal view and showing the buffy supercilium and the developing stripe behind the eye. (c) Front view with dark spots on the chest and neck. ML614337366. (Western Zambia, November 2023, © Per Alström.).

Figure 5.Juvenile Temminck´s Coursers ssp. *ruvanensis* in progressing age and transitioning to adult plumage (a) Buff supercilium and emerging black band behind the eye (Western Zambia, 28 October 2023, ML615241247, © Per Alström. (b) As moult advances, the supercilium turns white, and the adult's head colour becomes more salient (Arusha, Tanzania, 27 December 2014, ML203676791, © Phil Stouffer).

encountered in all *Cursorius* species. The completion of the adult plumage of Temminck´s Coursers may be comparable to that of Cream-coloured Coursers, where "adult plumages (are) acquired at (the) age of several months to just over one year" (Cramp 1983).

Unexplored features of the post-juvenile plumage

In the first-year plumage, we found unaccounted differences in colour and markings of the post-juvenile plumage that cannot be explained by retained feathers (Figures 6a, 6b and 6c). All three immatures are from one flock in December in the Okavango region, Botswana. They show what looks like two generations of post-juvenile coverts (see also ML608925866), fading marked tips of secondary coverts, white fringes, and a dark subterminal band on the median coverts.

Birds of the subspecies *C. t. aridus*, "...unlike their northern counterparts, are characteristically greyish over the upperparts ..., (and) have ... the breast markedly paler" (Clancey 1984), which shows already in individuals during the post-juvenile moult (Figure 7).

Plumage and moult specifics in coursers

In the Afrotropics, the breeding period and the subsequent post-breeding moult are not strictly determined by seasons, as is common in the higher latitudes. Thus, the age of a fully grown bird must be derived from the plumage features of the individual. For this purpose, a lot of information is missing. For example, it is unknown if coursers replace some or all body feathers twice a year, as most waders do (Jenni and Winkler 2020). Also lacking are details of the frequency of primary moult waves.

Figure 6. Three Temminck´s Coursers of the ssp. *aridus* in transition to full adult plumage. Variations of residual coverts of two non-adult feather generations in Temminck´s Courser. (Okavango, Botswana, December 2019, © Luboš Mráz).

Figure 7.Temminck´s Courser, ssp. aridus, in transition to adult plumage. (Hakusembe, Okavango River, Namibia, November 2022, ML507772681, © Albert Voigts von Schütz).

It seems likely that just one primary moult wave is started per year. Stresemann and Stresemann (1966) state that all "Charadriidae renew the primaries and the outer secondaries only once between two breeding cycles." This means that each moult wave can be attributed to one year. Thus, three visible moult waves would belong to a bird in at least its fourth year.

During the post-juvenile moult, the North African Cream-coloured Coursers replace the inner-most primary and rectrix (Glutz von Blotzheim and Bauer 1986). This is likely also the case for southern African coursers. From the material available, we could not determine with certainty at what age Temminck´s Coursers start and complete their first primary moult.

To add to the picture of complexity, Stresemann and Stresemann (1966) point out that the term "complete moult" is unsuitable when wing and body moult occur at different times of the life cycle. Nor can it be used in the case of continuous serial moult, the closest moult pattern applicable for coursers, since the wing will be moulted only partially. Furthermore, some tropical birds are engaged in a continuous diffuse body moult over most of the year without defined moult periods.

Plumage of adults and the determination of age

Adult Temminck´s Coursers, specified by the lack of residual juvenile feathers, still show noticeable plumage differences. Our study of Burchell´s Coursers (Bryson and Paijmans 2024) and the results of this study showed that adult plumage is only fully attained after more than one year. This can be derived not only from residual coverts but also from the overall appearance and the colouration of the tail and the front of the head. We could compare these features during the post-breeding moult when both young and adults undergo primary moult.

Plumage features to be considered when determining the age of an adult are:

- residual feathers, mainly coverts, tail and rump,
- number of moult waves of the primaries,
- the shape of the outer primaries,
- length of the outer secondary S1,
- length and colouration of the tertials,
- the colouration of the underparts,

- the colouration of the rectrices,
- markings of the front of the head, and
- the combination of these features.

Below, we illustrate and discuss different features throughout the ages that indicate certain age groups.

Belly patch

The chest is of a rufous colour, darkening into a black belly patch that extends between the legs in adults but not yet in juveniles (ML615670678). The remaining underbelly is white (Hockey 2005) (Figure 8a). The underparts are less colourful in first-year and young birds than in adults. The black feathers of the belly patch show light brown fringes (Figure 8b). The tertials are also plain and extend to the end of the tail (see ML536795121).

Tertials and the trailing edge of the secondaries

Adults display long, plain tertials that reach the tip of the tail (Figures 9 and 18, and ML536795121); young birds have tertials at the length of the secondaries, first marked and later plain (Figure 6). However, beware of moulting and growing feathers. At closer inspection, white wedges at the tip of the outer, blackish secondaries become visible. They form a thin white trailing edge that abrades with time (Maclean et al. 2020; Figures 9 and 10).

Figure 8. Comparison of the underparts of an adult and a young Temminck´s Courser at around one year of age. (A) Adult. (Namibia, April 2021, ML329672891, © Gabriel Jamie). (B) The paler young bird shows buff fringes on the black belly patch. (29 January 2011, SAFRING CC76344 [see also Figs. 11a and 12 for images of the same individual], ML616708083, © Ursula Bryson).

Figure 9. Adult with long, plain tertials, thin white trailing edge, and some residual lesser coverts. (5 February 2019, SAFRING number CV39422 [see also Figs. 11b and 13 for images of the same individual], ML616708712, © Ursula Bryson).

Figure 10. White trailing edge on the dark secondaries of an adult. P1 to P5 are new, P6 is growing, while P7 to P10 are the oldest. The sharply pointed tips disclose them as presumably juvenile feathers that have yet to be moulted. (Mpumalanga, South Africa, 25 November 2022, ML524163701, © Niall D. Perrins).

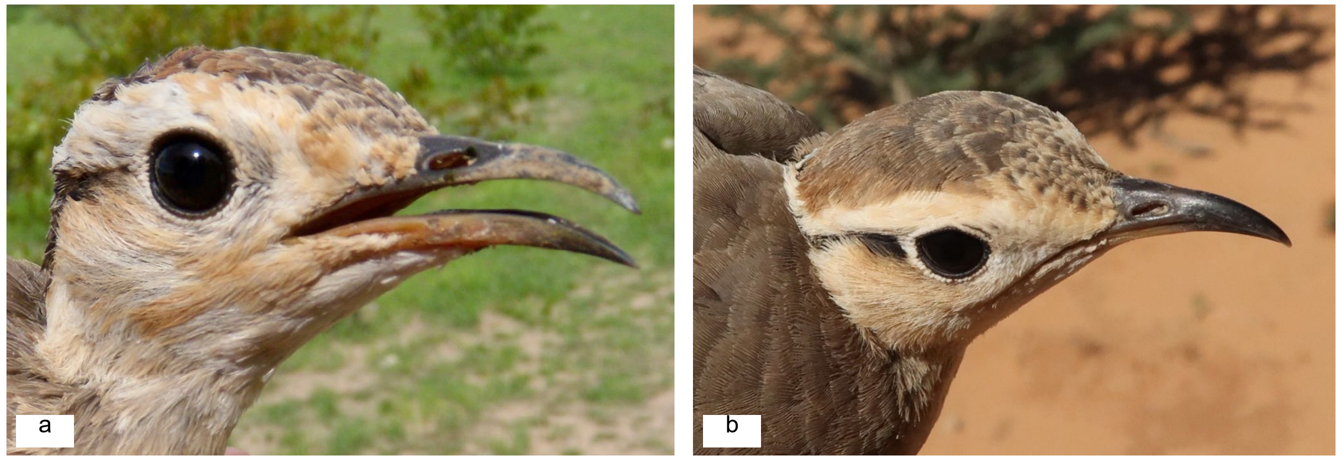

Figure 11. Head markings of younger Temminck´s Coursers. The crown is scaled, and the black and white stripes on the face are still developing. (a) First-year bird with first buffy rufous-tinged feathers on the face. (Windpoort Farm, Namibia, 29 January 2011, SAFRING CC76344 [see also Figs. 8b and 12 for images of the same individual], ML616708245, © Ursula Bryson). (b) Presumably second-year Temminck´s Courser at the end of its post-juvenile moult: the scaling reaches from the forehead to the drab hind crown. (Farm Hamakari, Namibia, 5 February 2019, SAFRING CV39422 [see also Figs. 9 and 13a and b for images of the same individual], ML616708729, © Ursula Bryson).

In adults, the trailing edges also show variation in width, presumably as individual traits depending on age and the degree of feather wear (Figure 10 and ML537543021, documenting a broad white band).

Crown and forehead and corresponding wing and upperparts

The number of juvenile feathers in the plumage indicates the progress of the post-juvenile moult and gives clues for the determination of age compared to other individuals. The head markings on the forehead, as noted by Peacock (2016) only, are a typical feature in juvenile plumage, although they are still encountered in adults. In our understanding, it takes several years for the head to turn plain rufous.

Figure 12. The corresponding wing to Figure 11a. All primaries and secondaries are of the same colour and in the same state of abrasion. This means that they were grown together in the first set of plumage. The coverts from the residual juvenile plumage involve the greater and median coverts and the scapulars. Primary moult is at the beginning (moult score 5200000000). (Windpoort Farm, Namibia, 29 January 2011, SAFRING CC76344 [see also Fig. 8b for an image of the same individual], ML616708327, © Ursula Bryson).

Figure 13. The corresponding body and wings to Figure 11b. Most of the feathers on the upperparts are moulted, but some residual feathers are still visible on the lesser coverts and the rump. The primary moult has advanced halfway (moult score 5555400000). (Farm Hamakari, Namibia, 5 February 2019, SAFRING CV39422 [see also Figure 9 for an image of the same individual], ML616708748, © Ursula Bryson).

In birds that still possess residual juvenile feathers, the markings on the forehead are expressed in diffuse scaling. The hind crown is still brownish. With age, the face loses the drab colouration and gains an even buffy, rufous-tinged colour (Figures 11a and 11b). The age of the individual in Figure 11a was determined by the start of a single wave of primary moult (Figure 12), which took place at the same time as the post-breeding moult in adults.

Figures 12, 13a, and 13b show the corresponding wings to the individuals from Figures 11a and 11b. The primaries of first-year birds generally look uniform since they have grown simultaneously. This happens only in the very first set. Their replacement starts during the first complete moult. In the Cream-coloured Courser, advanced first-year birds look "like adults, but all primaries [are] equally new, rather than showing suspended moult as in many adults; occasionally, a few juvenile wing-coverts or scapulars are retained" (Cramp 1983), as in Figure 12.

In our opinion, the individual in Figures 11a and 12 is at the beginning of its second year. The primaries and secondaries are of the same colour and quality, and numerous greater, median, and lesser coverts are still from the juvenile plumage. The primary moult is starting and is already engaged with P2 (moult score 5200000000). It is possible that P1 was already moulted during the post-juvenile moult.

We noticed the outer secondary S1 was shorter than the remaining secondaries on all four young Temminck's Coursers we processed. This points towards its replacement during the (early) post-juvenile moult. In adults, the outer S1 was the same length as the other secondaries (S1 of young birds in Figures 12 and 17a vs. of adults in Figure 13).

The individual in Figures 11b and 13 has already undergone one "complete" moult cycle at about the same days of the year. The primaries are halfway moulted, and the outer primaries are brown and abraded. Only a few lesser coverts and feathers on the rump are retained, and most rectrices have been replaced (outer R5 and R6 are still old and brown). Based on these features, we consider this individual as one year older than the individual in Figure 11a since basic moult processes are repeated only once a year. It is undocumented if coursers constitute an exception in this periodicity.

Figure 14 shows three different adults. Their receding head markings and the increasing intensity of rufous point towards the advancing age. None of them had residual juvenile feathers. We discuss the plumage of 14a in **Primary moult** (see also Figure 18).

We found photographs of breeding adults with strong markings on the forehead (as in ML218306631). We discarded the hypothesis that these markings could be a sign of sex after examining museum specimens of both sexes (Figure 15a female, 15b male). We did not find a colour difference between the sexes. All the skins were free of residual marked feathers and, thus, were of full adults. The plain rufous colouration (on the left female and the left male) appears to be from older, fully developed adults, while the markings (both right skins) are from younger adults, as other plumage features like the intensity of underpart colouration and the brightness of the white stripe from above the eye to the neck indicate.

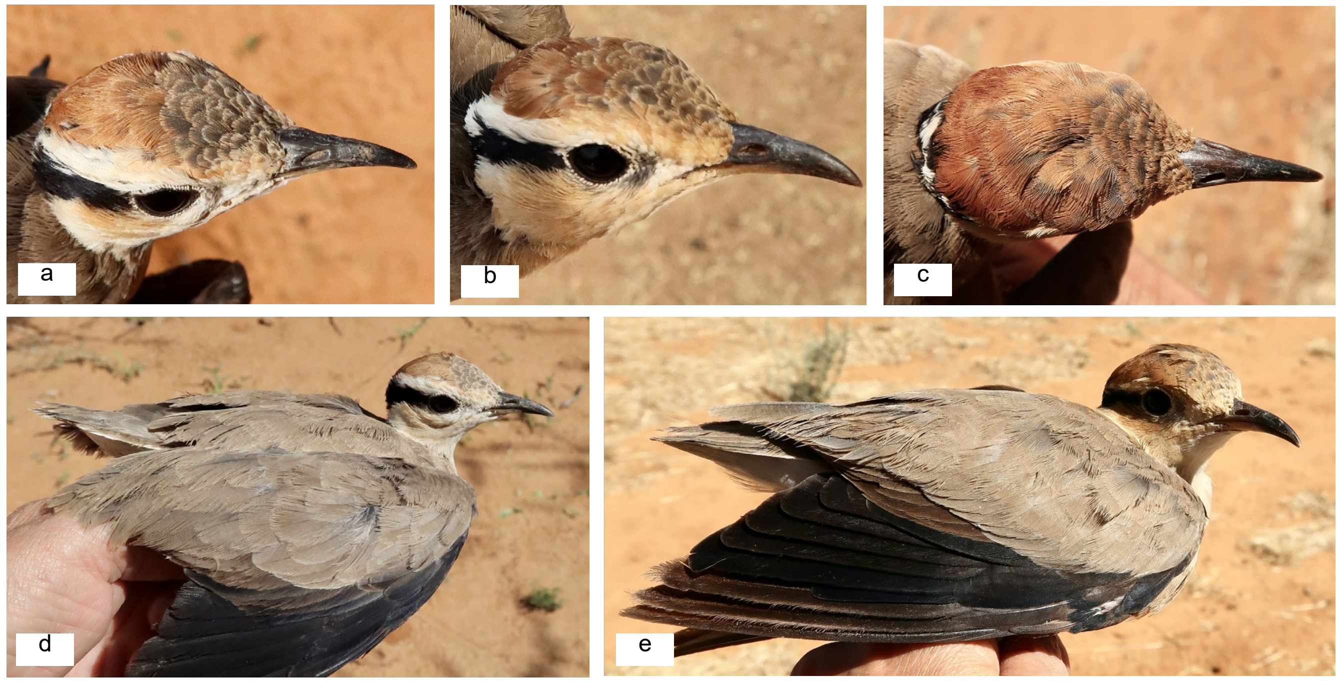

Figure 14. Head markings of adults with different degrees of grey scaling on the forehead and increasing intensity of rufous on the crown. The black and white stripes on the face are now distinct. (a) 5 February 2019, SAFRING CV39421, ML616708811. (b) 16 March 2019, SAFRING 4H35667, ML616708848. (c) 9 December 2020, SAFRING CV38477 [see also Fig. 19a for an image of the same individual], ML616708618. (d) ML616708814, and (e) ML616708629 show the corresponding upperparts, head and wing of (a) and (c). All photos from Farm Hamakari, Namibia, © Ursula Bryson.

Figure 15. Crown of adults. (a) Females and (b) males with plain rufous presumably of older adults (both left) and grey-brown markings (right) of younger adults. SNSB – Zoologische Staatssammlung München.

Primary moult

The primary moult in the genus *Cursorius* is largely unexplored and not fully understood. It is highly complex and has numerous variations with advancing age (Cramp 1983). For a detailed moult description in the comparable Burchell´s Courser, see Bryson and Paijmans (2024).

Overlap of breeding and primary moult

In the annual cycle of small and medium-sized birds, a complete moult is usually performed after breeding (Jenni and Winkler 2020). This moult comprises not only the smaller body feathers (partial moult) but also the larger wing and tail feathers and is generally a reliable point of orientation for determining age.

In the brief window from January to March, we found signs of primary moult in all birds of our sample, adults and first-year birds alike. While all four first-year individuals showed consistent descendent moult, the primary moult in adults was more diverse since coursers follow a pattern close to serially descendent moult.

Figure 16 reflects the extent and the complexity of primary moult from our sample of 12 Temminck´s Coursers. We considered the ten functional primaries and did not include the vestigial eleventh primary. Code 5 stands for a new, fully grown feather, and code 0 for an old, worn primary, while numbers 1 to 4 correspond with the growing size of each feather.

	adult											*first-year*												
Month	n	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	n	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Nests	Moult Score
Jul	0											0											0	
Aug	0											0											1	0
Sep	0											0											0	
Oct	0											0											0	1
Nov	0											0											0	
Dec	2	2	2	2	2	2	3	1	0	0	0	0											2	2
Jan	2	5	2	5	4	2	0	0	2	2	2	3	4	3	1	1	0	0	0	0	0	0	1	
Feb	1	4	1	0	0	0	0	5	0	0	5	1	5	5	5	5	4	0	0	0	0	0	0	3
Mar	3	5	5	5	3	3	3	2	0	1	1	0											3	
Apr	0											0											0	4
May	0											0											0	
Jun	0											0											0	5

Figure 16. The complex pattern and the extent of primary feather moult (P1 to P10) of adult (left) and first-year (right) Temminck's Coursers *C. t. aridus.* Values are average moult scores of each primary for the number (n) of birds per month sampled. The colour gradient is shown on the side. On the right are also records of egg-laying months of Temminck´s Coursers in Namibia from Brown et al. (2015). No data were collected for the cells marked in grey.

Figure 17. Comparison of the wing and rump. (A) First, descendent, primary moult in the sequence of 4300000000. The rump and the greater and lesser secondary coverts are still from the juvenile plumage, and the secondaries look uniform in colour. (SAFRING CC76346, ML616708191). (B) Brown secondaries with white tips of a presumably second-year Temminck´s Courser with fringed, fresh body plumage, coverts, rump and tail. (29 January 2011, SAFRING CC76345, ML620412644). Both Windpoort Farm, Namibia, 29 January 2011, © Ursula Bryson.

Figure 18. The primary moult sequence of this bird is 5055400555. At first view, the moult looks like a serially descendent moult with three foci, but actually, only P5 is moulting. The moult sequence of the secondaries still must be described. (29 January 2011, SAFRING CC76347, ML616708138, © Ursula Bryson).

Figure 16 also includes seven records of egg-laying of Namibian birds (gathered by Brown et al. 2015), stretched out over all seasons.

Primary moult in the first years

The first wing moult is characterised by one single wave of descendent moult (Figure 17). Any time later, two or even three moult waves of a (seemingly) serially descendent moult (Cramp 1983; Figure 19) will always be a feature of the then adult wing.

Comparison between the primary moult of Cream-coloured and Temminck´s Coursers

Although Jackson (1917) gave a limited description of the moult process for the Cream-coloured Courser of different ages, the primary moult itself was still undocumented. Due to the absence of moult data of Temminck´s Coursers, we refer in this section closely to the text of Cramp (1983) on post-breeding primary moult of the Cream-coloured Courser to explore its moult strategy. We will show congruences to the description by means of photographs and our moult observations of Temminck´s Courser. Our paper on Burchell´s Coursers (Bryson and Paijmans 2024) expounds extensively on the same questions of plumage and moult. The strategies of the three species seem to be comparable. For better readability, we put the text taken from Cramp (1983) in bold italic.

The ***primaries*** moult in ***descendent*** sequence, the general moult pattern resembles the serially descendent moult. The primary moult of adults is ***usually suspended*** [in the northern species, ***in winter***, i.e., around six months after breeding] and seemingly (but actually not) serially descendant. A ... new series may start with innermost, but this does not always happen: apparently, two moult series are never active at the same time, and the innermost primary perhaps does not start before the outer ones are finished, or the outer series temporarily stops when the innermost starts (Figure 18).Moult ***starts with*** the ***inner primaries*** ... ***shortly after*** the ***eggs hatch*** ... ***but*** the ***primary moult*** is ***suspended [from late September to late October onwards...]*** (Figure 19a). A ***few*** individuals ***moult some more primaries*** after that [in ***December to January***], ***occasionally reaching***

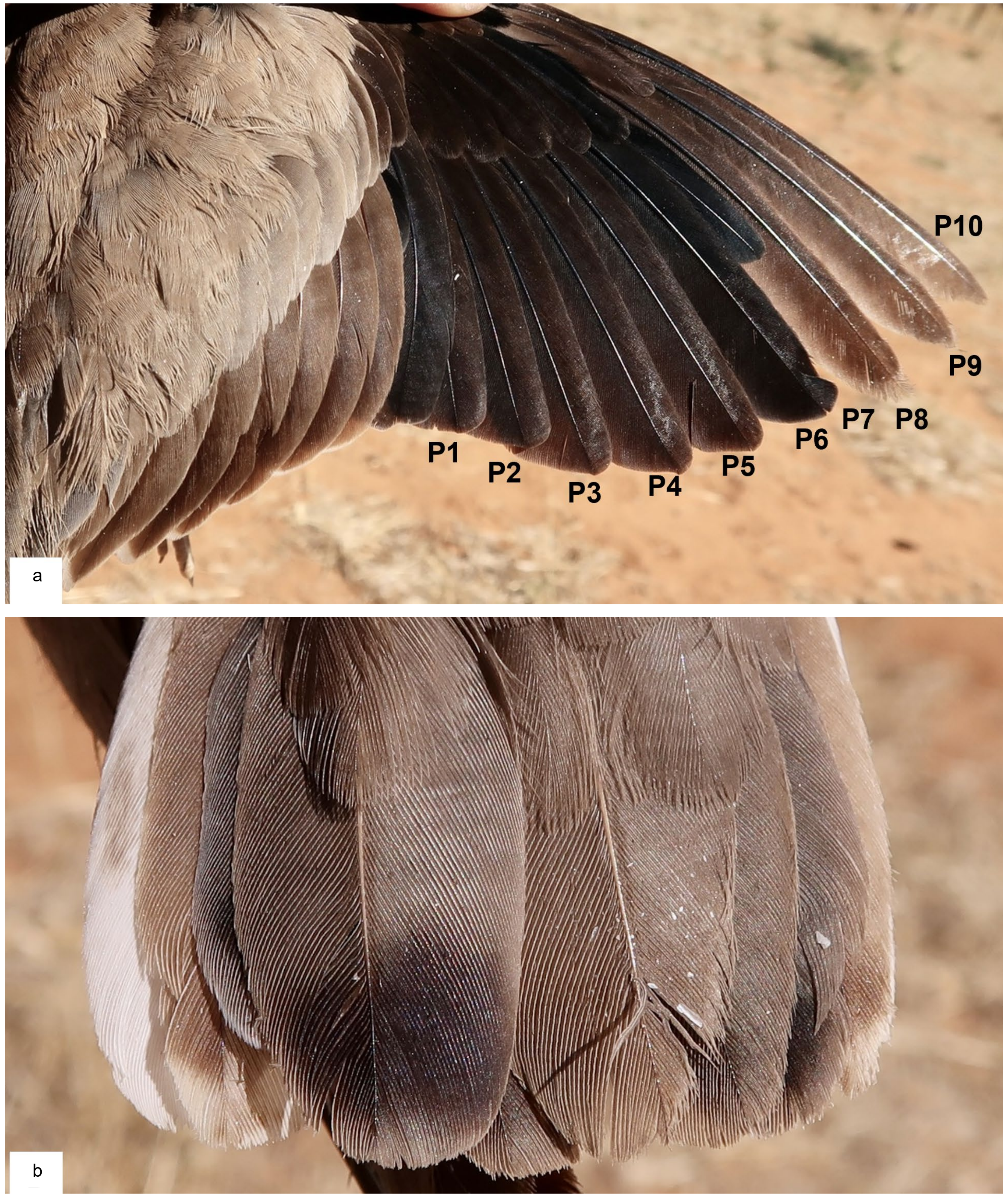

Figure 19. Adult. (a) The outer primaries P8 to P10 are older than the inner ones P1 to P5. The primaries P6 and P7 are in the process of growing. Moult sequence of 5555543000. (SAFRING CV38477 [see also Fig. 14c for an image of the same individual], ML616708613). (b) Rectrix R4 growing in a first-year tail. (9 December 2020, ML616708613). Both images © Ursula Bryson.

completion, but the ***outer primaries usually*** are ***retained until the next year*** and ***some primaries*** are ***probably replaced only every two years***.

Figure 19a shows a wing with apparently three generations of primaries, which allows a determination of the bird's minimum age. We specified the age as follows: P8 to P10 are the oldest (1st generation), P1 to P5 are from a

new, interrupted wave (2nd generation), and P6 and P7 have started on the place of interruption in the actual year (3rd generation). If P8 to P10 are still from the juvenile plumage, the bird would be in its third year. This hypothesis is supported by pale secondaries, the mainly brownish tail feathers with buffy tips (R5) and an off-white colour (R6), and a grey, freshly growing R4 (Figure 19b) compared to the grey, black, and white tail of a full adult (Figure 18).

Parasites and diseases

No obvious ectoparasites (ticks, mites, feather lice) or diseases (avian pocks) were found in the coursers investigated.

Retraps

There are 121 Temminck´s Courser records in the SAFRING database. There is only one retrapped bird: an individual was resighted at the same locality 18 days later.

Further research

Overall, the basic knowledge and understanding of detailed plumage features, age development and the physical moult process of Temminck´s Coursers is restricted (or non-existent). Sample sizes for biometric data and moult are low, as are data about their breeding biology.

Detailed descriptions, based on a comprehensive sample, are needed of:

- the plumage, including possible plumage differences at times of breeding and non-breeding, and
- the plumage in the second year of life.

Particular attention should be directed to the following: the moult process, including:

- the primary moult, and
- the sequence of the overall moult progress on body and wing, including the progress of secondary moult,
- the duration and moult strategy during the post-juvenile and adult moult, and

Also, more data about the nesting and breeding of *C. t. aridus* and other subspecies are needed.

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