Namibian Journal of Environment

Environmental Information Service, Namibia for the Ministry of Environment, Forestry and Tourism, the Namibian Chamber of Environment and the Namibia University of Science and Technology.

The *Namibian Journal of Environment* (NJE) covers broad environmental areas of ecology, agriculture, forestry, agro-forestry, social science, economics, water and energy, climate change, planning, land use, pollution, strategic and environmental assessments and related fields. The journal addresses the sustainable development agenda of the country in its broadest context. It publishes four categories of articles: **Section A: Research articles**. High quality peer-reviewed papers in basic and applied research, conforming to accepted scientific paper format and standards, and based on primary research findings, including testing of hypotheses and taxonomical revisions. **Section B: Research reports**. High quality peer-reviewed papers, generally shorter or less formal than Section A, including short notes, field observations, syntheses and reviews, scientific documentation and checklists. **Section C: Open articles**. Contributions not based on formal research results but nevertheless pertinent to Namibian environmental science, including opinion pieces, discussion papers, meta-data publications, non-ephemeral announcements, book reviews, correspondence, corrigenda and similar. **Section D: Monographs and Memoirs**. Peer-reviewed monographic contributions and comprehensive subject treatments (> 100 pages), including collections of related shorter papers like conference proceedings.

NJE aims to create a platform for scientists, planners, developers, managers and everyone involved in promoting Namibia's sustainable development. An Editorial Committee ensures that a high standard is maintained.

ISSN: 2026-8327 (online).

SECTION D: MONOGRAPHS AND MEMOIRS

Recommended citation format:

Bryson U & Paijmans DM (2024) Lesser Grey Shrike *Lanius minor* Gmelin 1788 on its non-breeding grounds: comparative biometrics, moult data and criteria to determine age and sex. *Namibian Journal of Environment* 9 D: 1–20.

Lesser Grey Shrike *Lanius minor* Gmelin 1788 on its non-breeding grounds: comparative biometrics, moult data and criteria to determine age and sex

U Bryson[1], DM Paijmans[2]

URL: https://www.nje.org.na/index.php/nje/article/view/volume9-bryson
Published online: 12th March 2024

[1] Research Associate at the FitzPatrick Institute of African Ornithology, University of Cape Town, South Africa. ursula@thomas-bryson.de
[2] 22 Elizabeth Street, Hobart, Tasmania, 7000, Australia

Date received: 16th November 2023; Date accepted: 16th January 2024.

CONTENTS

ABSTRACT

In this study we present measurements, moult data and related observations for 356 Lesser Grey Shrikes *Lanius minor* ringed during their non-breeding season in Namibia. Our research focuses mainly on addressing critical gaps in knowledge about the species' plumage. We describe non-breeding plumage features that have been omitted in the southern African bird books, and thus provide essential information for accurate ageing. It is noteworthy that birds lacking a black forehead (frontal mask) and those with an incompletely black bill are not necessarily juveniles or immatures, as asserted in the literature and identification guides. These same plumage features are signs of moulting adults and can be observed particularly on the non-breeding, but at times already on the breeding-grounds. Additionally, we offer photographic evidence of the head moult, loss of black forehead and changes in bill colour during the non-breeding season. We discuss the timing and progress of primary moult in adults and first-year birds, along with plumage features for age determination. The study also examines the increase of mass, site fidelity, bird numbers responding to rainfall, and short and long-term fluctuations of population numbers. Our findings contribute insights into the ecology and behaviour of Lesser Grey Shrikes in the non-breeding grounds. Finally, we propose potential subjects for further research to enhance conservation and management efforts.

Keywords: Africa; age; bird ringing; errata in literature; *Lanius minor*, Lesser Grey Shrike, misidentification; moult; Namibia; non-breeding grounds; plumage; SAFRING; sex

1. INTRODUCTION

Species and subspecies of Namibian birds are underrepresented in research and literature of southern African birds, still showing huge gaps of knowledge. This lack of data refers also to the moult process of migrants on their non-breeding grounds. We have been ringing birds in southern Africa for more than twenty years and are evaluating our data to expand the knowledge about less researched species and subspecies in the region (Bryson & Paijmans 2021, 2022, 2023a, 2023b; Bryson *et al.* 2023; Paijmans & Bryson 2023).

In this paper, we present our observations, measurement data and moult data from 356 Lesser Grey Shrikes *Lanius minor* that we ringed in their austral migratory territories in Namibia. Our main focus was on the changes that Lesser Grey Shrikes undergo during their yearly complete moult, especially the moult of the head and the colour-change of the bill, and how this allows for more precise age determination. The lack of the frontal black mask or its mottled appearance, together with a bill not fully black, serves in the southern literature as a criterion for the young age of the Lesser Grey Shrike. As described in the northern literature (Cramp & Perrins 1993, p. 482; Shirihai & Svensson 2018, p. 192; see also Lefranc & Worfolk 2022, p.118), the black front of the mask is being moulted during the complete moult to a variable extent and the area can turn all grey. Then only the stripe of the lore and the ear coverts remain black (Figure 1).

Figure 1: *Adult Lesser Grey Shrike at the begin of the migration time. The black forehead is being replaced by grey feathers during the yearly complete moult. Suffolk, Great Britain, July 2006. Photo courtesy of Steve JM Gantlett.*

Many of the birds identified in the southern hemisphere as first-year are therefore adults. This leads to the need to re-evaluate the age of birds seen and captured and sheds new light on the numbers of young birds occurring in the area and the age ratio between them and adults.

The annual complete moult mainly takes place on the non-breeding grounds in southern Africa beginning to little explored degree with body, head and tertial moult already in the breeding grounds (see Section 10, Moult).

2. DISTRIBUTION AND SITES

The Lesser Grey Shrike is a migratory species. The whole world population, breeding from Spain to China, with an extent of about 6,000 km west to east and about 2,000 km north to south, spend the non-breeding season in the southern part of Africa in an area which encompasses little more than a tenth of the breeding range (Dowsett 1971, p. 263; Herremans 1998b, p. 588; see also insert in Figure 2).

We ringed Lesser Grey Shrikes in Namibia (Figure 2): in the western arid savanna at the edge of the Namib-Naukluft Park (Farm Sphinxblick 22°29'S, 15°27'E, Figures 3 and 4), south of the Waterberg (Farm Hamakari 20°36'S, 17°20'E), in the central eastern bushland near Witvlei (Farm Okatjerute 22°21'S, 18°31'E, Figure 5), near Otavi (19°37'S, 17°11'E), in the Erongo mountains (21°29'S, 15°52'E), in Omaruru (21°20'S, 16°04'E) and at Spitzkoppe (21°50'S, 15°09'E).

3. METHODS

3.1 Bird ringing

Our catching tools were mainly clap traps baited with mealworms and set up around perches (in the pre-Namib, Figure 3) or along fence-lines (on the

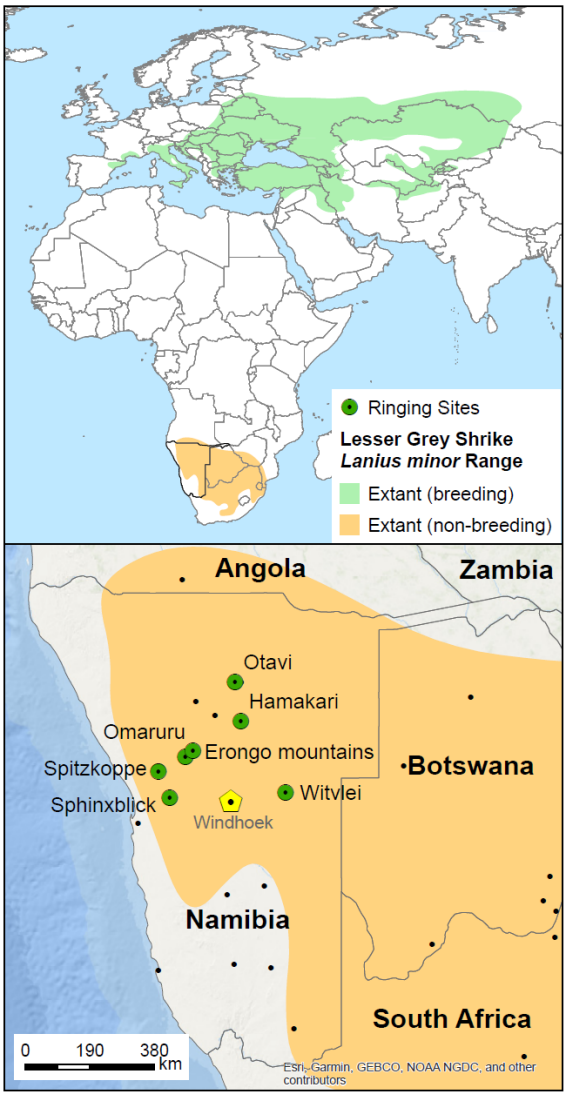

Figure 2: *Distribution map for the Lesser Grey Shrike, downloaded from www.iucnredlist.org on 3 August 2023. The upper map shows the boreal breeding grounds, the lower map the non-breeding grounds in Africa and its occurrence in Namibia. Green dots designate sites where the data were gathered in the current study.*

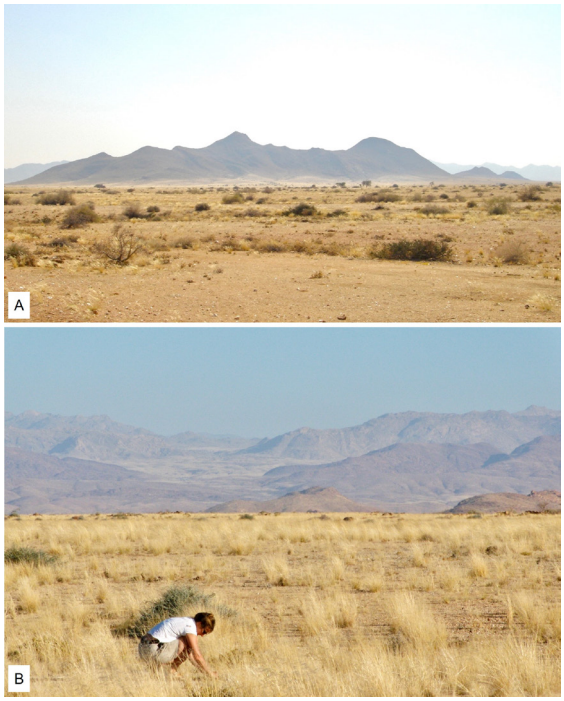

Figure 3: *(A) Typical study site in the pre-Namib desert of western Namibia with small trees and bushes. Farm Sphinxblick, 19 June 2005. (B) Setting up traps near the perches on low bushes. 23 November 2009.*

Figure 4: *About a week after the rain the land turns green, still showing bare patches. Farm Sphinxblick, 22 January 2004.*

Figure 5: *Our traps along a farm road in the savanna of eastern Namibia. Near Witvlei, January 2019.*

farmland in the savanna, Figure 5). In some cases, we found Lesser Grey Shrikes also in mist-nets set up for a general bush-bird survey. The birds were ringed and measured and moult scores were taken in accordance with the guidelines of the South African Bird Ringing Unit's (SAFRING) Bird Ringing Manual (de Beer *et al.* 2001, based on Svensson 1984). All photographs were taken by the authors if not stated otherwise.

3.2 Determination of sex

We determined the sex of Lesser Grey Shrikes as far as possible, by plumage, following the phenotypical characteristics described in the common and specialised European literature (i.e. Blasco-Zumeta & Heinze 2023; Bub 1981, p. 120; Cramp & Perrins 1993, pp. 482–483; Pearson 2000, p. 359; Shirihai & Svensson 2018, pp. 193–194; Yosef *et al.* 2020) and reconfirmed it, when possible, by shape of the two pubic bones and their distance from each other (Schwichtenberg 1973, p. 45). The paper by Krištín *et al.* (2007) on tail patterns as a further supportive criterion to determine the sexes came to our attention only after finishing this study. We revised all our photographs, were able to confirm most of our decisions and add further determinations of the sex.

3.3 Determination of age

The age groups from areas with well-defined breeding seasons can generally be well differentiated into first-year and older birds. We determined the age by a combination of plumage features such as colour, markings, quality, abrasion and contrast of old and fresh plumage, especially during the moult process, changing shape of primaries with ageing, and by the colouration of the bill and the occurrence of a gape flange. We followed mainly Bub (1981), Fry *et al.* (2000), Herremans (2005), del Hoyo *et al.* (2008), Shirihai & Svensson (2018) and Blasco-Zumeta & Heinze (2023).

3.4 Measurements

Table 1 presents the measurements of our sample of Lesser Grey Shrikes. The culmen was measured to the indentation on the front of the skull following the convention for the measuring of passerines (Demongin 2016, p. IX). For the general description of methods and measurements see Bryson & Paijmans (2021, 2022).

There are no significant differences between the sexes or the ages. Head, culmen and mass of the first-year birds correspond with those of the adults, although first-year birds of age group 5 are slightly lighter than those of the other age groups.

Young birds were caught far more often than adults (285:65, equivalent to 4.38:1). It is unclear to what extent this is due to the higher number of individuals in the new brood, and/or first-year birds occupying lower-grade areas than adults. Herremans (2003 in litt., pers. comm.) points out a possible interaction with body condition and proneness to become trapped as young birds in less optimal territories, with lower weight, may be more likely to be caught.

Table 1: *Measurement data from this study. Average measurements (including standard deviation, minimum and maximum measurements) of adult and first-year Lesser Grey Shrikes. We followed the convention of marking young individuals in the first calendar year with SAFRING Code 5 (until 31 December), and in the second calendar year until the first northern migration with SAFRING Code 6 (from 1 January), which enables us, with some uncertainty, to determine the age more precisely.*

Grouping	Parameter	Wing (mm)	Tail (mm)	Tarsus (mm)	Culmen (mm)	Head (mm)	Mass (g)
All Adults SAFRING Code Age 4	Mean ± SD	115.8 ± 3.2	91.8 ± 4.4	25.2 ± 0.9	23.1 ± 1.6	42.9 ± 1.2	45 ± 4.2
	Min–max	109–123	80–104	23–27.7	21.4–32	40.4–46	37.5–61.2
	n	65	59	61	61	61	65
Adult Unknown Sex	Mean ± SD	115.8 ± 2	90.4 ± 3.4	25.1 ± 1	23.4 ± 2.4	42.4 ± 1.3	44.3 ± 5
	Min–max	111–119	84–96	23.3–27.7	21.4–32	40.4–46	37.5–61.2
	n	21	17	19	19	19	23
Adult Females	Mean ± SD	115.7 ± 3.5	92 ± 3.6	25.3 ± 1	23.3 ± 1	42.7 ± 0.9	45 ± 4.1
	Min–max	110–122	83–98	23.6–27.3	22–26.2	41.2–44.7	39.2–58
	n	22	20	21	21	21	22
Adult Males	Mean ± SD	115.8 ± 3.9	92.6 ± 5.5	25.3 ± 0.9	22.7 ± 1.2	43.5 ± 1.1	45.7 ± 3.3
	Min–max	109–123	80–104	23–26.8	21.4–25.1	41.7–45.6	40.7–55.5
	n	22	22	21	21	21	20
All 0 to 6 months SAFRING Code Age 5	Mean ± SD	113.8 ± 3.9	89.1 ± 3.2	24.8 ± 0.8	22.8 ± 1.1	42.6 ± 1.5	42.2 ± 2.2
	Min–max	107–119	81–94	23.8–26.1	21.3–25.5	39.9–46.8	38.8–45.9
	n	15	14	14	14	15	15
All 0 to 6 months SAFRING Code Age 6	Mean ± SD	114 ± 4	89.8 ± 4.2	25.1 ± 0.8	22.7 ± 1	42.5 ± 1	44.5 ± 4.1
	Min–max	96–123	80–105	21.9–28.1	19.9–26.2	39.8–46.2	31.8–67.4
	n	270	251	255	254	254	270

Both sexes of adults were represented in equal numbers, although for one third of the adults sex could not be determined.

4. TAXONOMY

Some authors (Clancey 1980; Vaurie 1955 in Lefranc & Worfolk 2022) recognised two subspecies: *L. m. minor* Gmelin 1788 and *L. m. turanicus* Fediushin 1927. The variation has been discussed controversially and a subspecies-split was not always recognised (Cramp & Perrins 1993, Shirihai & Svensson 2018). Nowadays, the species is considered monotypic (Yosef *et al.* 2020; Lefranc & Worfolk 2022) since the "differences, if any, appear very slightly and are probably negligible" (ibid. p. 118).

5. CHALLENGES

5.1 Basic errata in the southern literature

Existing differences between breeding and non-breeding plumage and bare parts are well described in most of the relevant northern-hemisphere publications (Bub 1981; Pearson 2000 in Fry *et al.* "The Birds of Africa"; Cramp & Perrins 1993). Unfortunately, these facts have not found entry into the southern literature of field guides and bird books that depict only adult Lesser Grey Shrikes during the breeding season without considering a plumage change. This results in the perpetuated misidentification of adult moulting birds as first-year individuals, with consequences for the relation of numbers of first-year and adult birds and the determination of wintering grounds of the different age groups.

We had relied on this literature in the early years of data collection (Harris & Arnott 1988; Maclean 1993; Hockey *et al.* 2005; Chittenden *et al.* 2016) which show the adults always with black forehead and black bill and identify birds with grey forehead and paler bill as first-year birds.

While working on this paper it quickly became evident that the wing moult observed in adults and the head colouration described in the southern literature did not match. We finally found in the northern literature a bird with non-breeding head and bill colouration (Shirihai & Svensson 2018, p. 193; see Figure 17). As a next step, we reviewed our age determination of the individuals we had taken photos of after ringing. We could specify about two-thirds of all of our data, while for the other records unfortunately the age had to be revised due to lacking pictures to be "unknown".

5.2 Random use of terms for age description

Another challenge is the random use of terms when the age of a not fully developed adult bird is designated. In general, the terminology to describe the age of birds is far from consistent or clearly defined. Several core terms are used arbitrarily in both a general and a restricted sense. It is hence not standardised and differs within Africa and also widely between the continents (see Schulze-Hagen 2019). We tried to be consistent in the use of terms and as clear as possible, mainly following Harris & Franklin (2000, pp. 50–51), Shirihai & Svensson (2018, p. 17) and Jenni & Winkler (2020a, b).

We want to point out especially the use of the term "juvenile" that is used in a wider sense for any kind of young bird and creates much confusion when a precise and differentiated determination of age is demanded. We used the term "juvenile" in the restricted sense. It describes the first-year bird until the time of its post-juvenile moult, which sets in latest at three months and ends at about four to six months. With very few exceptions, all our first-year Lesser Grey Shrikes arrived on the non-breeding grounds in their post-juvenile plumage, at times with first signs of the complete moult on median coverts, one tertial or one or two primary feathers with corresponding greater coverts. For age terms see the Glossary for Ageing in Bryson & Paijmans (2021, pp. 21–22).

6. LESSER GREY SHRIKES ON THE BREEDING GROUNDS

6.1. Timing of breeding

Lesser Grey Shrikes breed in the northern hemisphere. Eggs are laid mainly from May to June (range of April to July). The young fledge about 32 days later i.e. mainly June to July (15–16 days for incubation and 16–18 for nestling period) (Cramp & Perrins 1993) and stay with their parents for at least another two weeks (Lefranc & Worfolk 2022, p. 124).

We have not found any published records of breeding Lesser Grey Shrikes in southern Africa. Other migratory species like White Storks *Ciconia ciconia* (Cape Town, pers. obs.) or European Bee-eater *Merops apiaster* (for example Török 1999; pers. obs. near Cape Town) are known to have turned into resident breeding species in southern Africa with inner-African migratory patterns. For one member of the *Laniidae*, the Red-backed Shrike *Lanius collurio*, there are repeated claims of breeding but these assertions have not been substantiated (see discussion in Bryson & Paijmans 2023a).

6.2. Juveniles on the breeding grounds

Three plumages have been described during the first half year of life: a first juvenile plumage, a second generation of juvenile plumage and the plumage after the post-juvenile moult (Bub 1981, p. 119;

Figure 6: *Juvenile with bars on upperparts and flanks. The chest is already becoming light-coloured. Spain, July 2018. Photos courtesy of Marc Gálvez.*

Figure 7: *Two first-year Lesser Grey Shrikes in transitional plumage in July. (A) The very first plumage is pale brownish-grey above, still finely barred on the head and on the back. The bird is in the process of its post-juvenile moult: the dark medium coverts have already been replaced. The brownish-black mask does not extend onto the forehead. The gape flange is still pink and prominent. Spain, 21 July 2015. (B) This individual has replaced the barred, drab body feathers with more uniform grey ones of a second generation of juvenile plumage that grows at the age of 3-4 weeks. Spain, 18 July 2018. Photos courtesy of Marc Gálvez.*

Cramp & Perrins 1993, p. 498). These plumages are not clearly recognisable from each other, as there is, as in all bird species, a continuing transition in addition to a considerable variability in time.

The plumage of juveniles is “brown-grey from crown to mantle (...) overlaid with fine ... brown-grey bars” (Cramp & Perrins 1993, p. 482) of varying extent. Wing and tail are duller than in adults and, as a useful tool for determining the age of the bird, the coverts and flight feathers show white tips (Figure 6).

Some of the features appear in first-year birds on the non-breeding grounds.

Fully grown juveniles replace in parts the barred feathers with more uniform grey ones of a second generation of juvenile plumage at the age of three to four weeks (Cramp and Perrins 1993, p. 498). (Figure 7A). Post-juvenile head and body moult (i.e. partial moult) begins soon after fledging (Figure 7B) and is completed in 10–11 weeks by August to September.

7. GENERAL CRITERIA OF SEX AND AGE ON THE BREEDING AND NON-BREEDING GROUNDS

Several features of the plumage are described as sex-related and give cues for the distinction between the sexes: the colouration of the upper-parts and of the breast, the colouration and width of the black forehead and the black markings on the tail. These characteristics are subject to variations and may undergo a change with age.

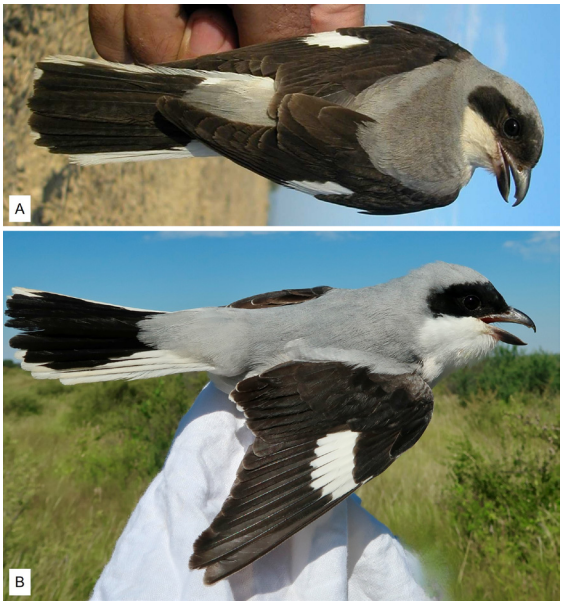

Figure 8: *Upper-parts of adults. (A) Female with dull grey upper-parts and brownish wing. Spain, 11 July. Photo courtesy of Javier Blasco-Zumeta. (B) Male with blue-grey upper-parts and black shafts on white T6 and T5. 2 April 2021.*

Individuals can be positively assigned to an age group on the non-breeding grounds based on characteristics of the plumage and presence of an existing gape flange. First-year birds, hatched in the boreal summer, arrive at about half a year of age, adults at about one and a half years of age or older.

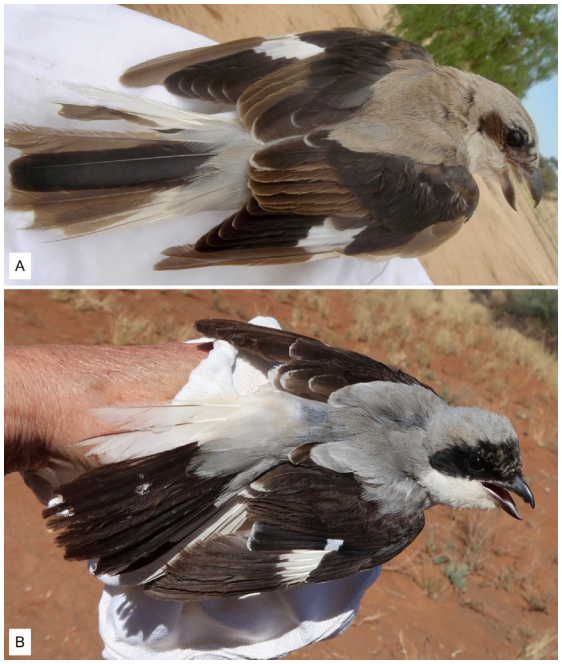

Figure 9: *(A) First-year female with post-juvenile brownish mantle and head and first new dull-grey feathers on the back and on the upper-tail coverts. The central tail feathers are brownish-black, the markings on T5 are longish. 11 February 2009. (B) Male with two white outer tail feathers. 10 December 2022.*

Figure 10: *Tail of (A) adult male with asymmetric, small black spots and dark shafts on T5. 11 March 2023. (B) Tail of a first-year male with still dark brown tail pattern and barred, blurred spots on T5. 17 March 2023.*

All pictures of the distinguishing features were taken in Namibia by the authors, if not stated otherwise.

7.1 Colouration of the upper-parts

Ages differ clearly in the (boreal) autumn, sexes usually in the (boreal) spring, sometimes all year round (Shirihai & Svensson 2018, p. 192). The upper-parts of the males are "ashy-blue-grey" (Figure 8B), less so in females (Cramp & Perrins 1993, p. 482) (Figures 8A and 15).

The overall grey colouration of the adult male plumage differs clearly from the first-year plumages of the male and more so of the female (Figure 9).

The dark parts of wings and tails are pitch black in males and browner and slightly lighter in females. It is undetermined if the black colouration of the wing becomes more expressed with age (Bub 1981, p. 123).

7.2 Black markings on the outer tail

As first described by Pajewski (in Iljitshew 1976, in Bub 1981, p. 120) the tail pattern shows a mostly reliable difference between females and males, best used together with other criteria for the determination of the sex (see also Krištín *et al.* 2007). Presumably from the first plumage on (Figure 9), the tail pattern in combination with the overall colouration of the upper-parts allows a clear classification of the sexes.

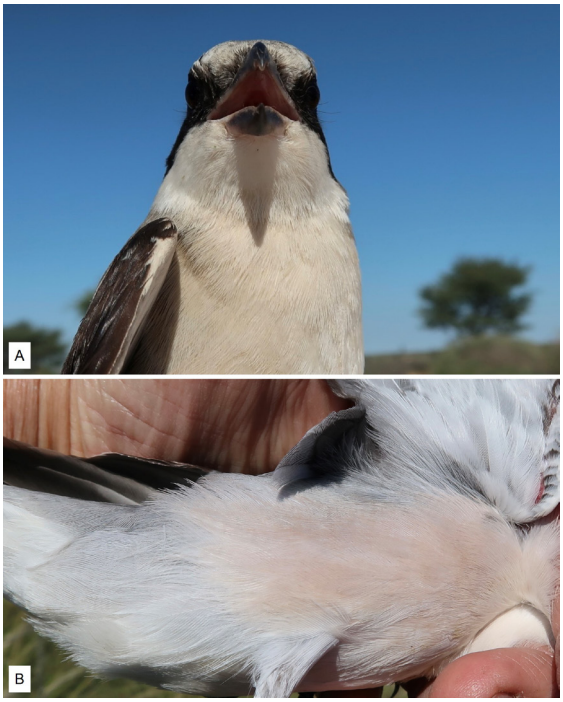

Figure 11: *Adult males. (A) After arrival on the non-breeding grounds with pale pink chest and grey forehead beginning the complete annual moult. 9 December 2022. (B) After his complete moult with typical light vinaceous underparts and whitish hind-flanks and vent. 2 April 2021.*

The outer rectrix T6 is always white in both sexes, while T5 shows a difference. A dark spot > 22mm long allows the determination of a female (Figure 9A). In males T5 is either all-white, with occasional black shafts (Figure 9B), or has spots of variable length and symmetry, which are smaller than those found on females (Lefranc 2022, p. 118; also Bub 1981, p. 122).

Figure 10 shows the varying size of the tail spot in males, (A) all-black in adults or (B) still brown and sometimes blurred in the first year of life.

7.3 Colouration of the breast

7.3.1 Adults

On average, the breast of females shows a lighter salmon pink than that of the male, especially in the breeding plumage. However, there is some overlap (Shirihai & Svensson 2018) (Figure 11). Furthermore, the worn feathers are replaced during the moult on the non-breeding grounds by brighter ones towards the time of departure. Due to extensive variation, the colouration alone cannot be used as reliable feature to determine the sex (Bub 1981, p. 120).

In our observation, males in particular show a wide variation of colouration (Figure 12), possibly due to individuals gathering from a diversity of provenances. The colour extends from the breast and chest to the flanks that can be well seen with the bird in the hand.

7.3.2 First-year Lesser Grey Shrikes

In first-year birds the chest and flanks in both sexes are more drab and tinged grey-brown (Figures 13A and B) and some still show light barring from the juvenile plumage (Figure13C). At this age, the sex can mostly be determined already by the tail pattern.

7.4 Forehead, ear-coverts and bill

The black forehead is a sign of breeding adults only, as is a dark black bill that is becoming paler at the base, of mainly the lower mandible, after breeding. Ear coverts in females are not as richly black as in males (Figure 14).

After the breeding season, adults moult the forehead which then turns grey to varying degrees and the bill becomes paler in both sexes (Figures 15C and D) on the non-breeding grounds. Grey feathers replace the black ones on the forehead in adults as described in detail by Shirihai & Svensson (2018, 193–194) and Cramp & Perrins (1993, pp. 482 and 498). In some early moulting individuals this occurs from June onwards. See Figures 1, 16 and 17 for images of adults photographed in the northern hemisphere. The mask is regained in the process of complete moult, in the early months of the year. (See also Fry *et al.* 2000; Glutz von Blotzheim & Bauer 1993.)

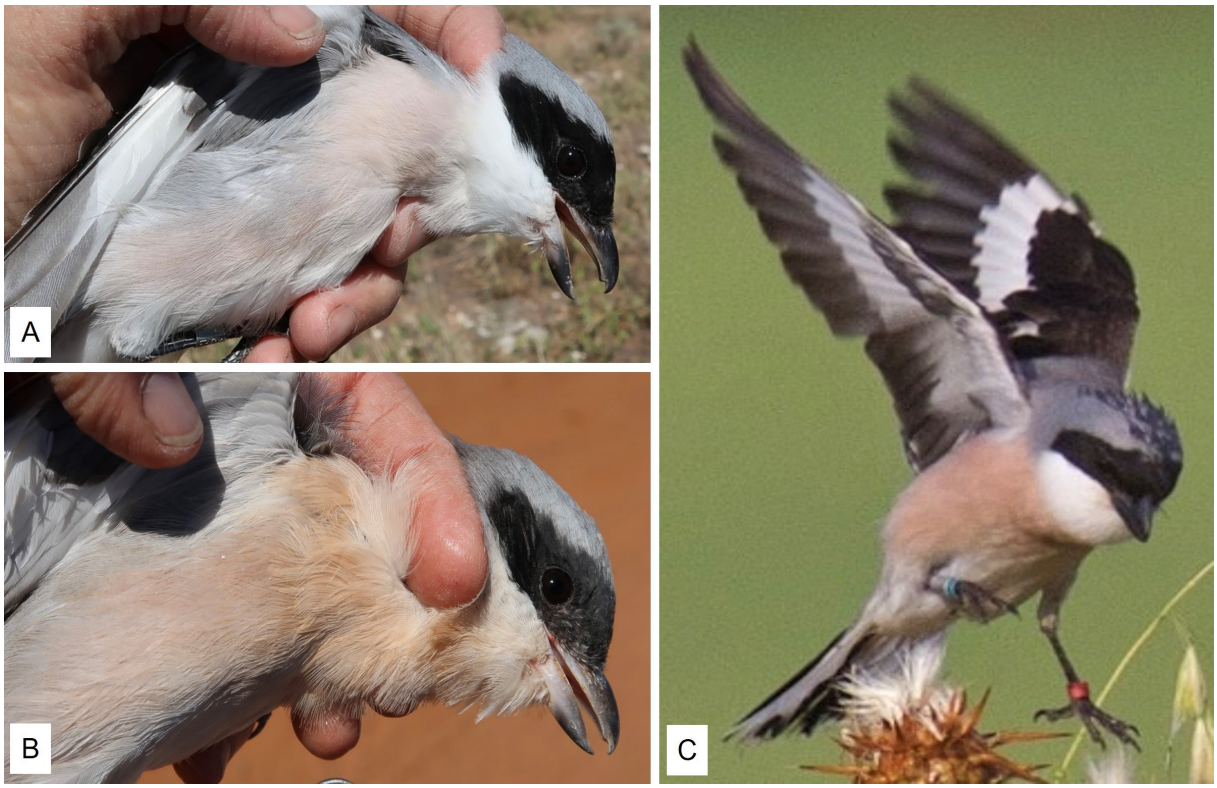

Figure 12: *Adult males, already in fresh, full plumage at the end of the complete annual moult, with - for our research area - (A) exceptionally grey and (B) exceptionally dark underparts. 17 March and 18 March 2023, respectively. (C) Contrasting dark underparts and white throat. Spain, May 2020. Photos courtesy of Marc Gálvez.*

First-year birds develop the black forehead mainly on the non-breeding grounds and the bill turns black only towards the time of the northerly migration.

Observations of Lesser Grey Shrikes kept in captivity for reintroduction in Spain showed that non-breeding adults or those with a failed brood start the complete moult already during the breeding season (Marc Galvéz 2020, pers. comm.; Figure 16; see also Bub 1981, p. 119). This early moult is documented also for Red-backed Shrikes. Heinroth & Heinroth (1924–1926, in Kramer 1950, p. 15) observed it in captive birds in a tame, freely breeding female. See also Bub for further observations (1981, pp. 105–106).

Adult Lesser Grey Shrikes without or with only a minimal frontal mask due to early moult have also been observed in the wild (Figures 1 and 17). (See also a mask-less, female adult bird photographed in Gauteng, South Africa at the end of November: https://macaulaylibrary.org/asset/393495551.) This fact might go undetected or the birds might be interpreted as first-year at a more superficial view.

7.5 Colouration of the head and width of frontal mask

During the non-breeding time the black on the forehead is being replaced to varying degrees by grey feathers. Adults start the post-breeding moult mostly while still on the breeding grounds and by the time they arrive in Namibia (or the non-breeding region at large), will have largely replaced the black forehead feathers with grey ones (Figure 18A). First-year Lesser Grey Shrikes arriving on the non-breeding grounds mostly show no black on the forehead (Figure 18B) which will develop into a compact mask before returning to the breeding grounds (Figure 19).

In breeding plumage, the width of the black forehead indicates the sex only in its most extreme measurements. It has been documented as 7–12 mm wide in females and 9–15 mm in males (Bub 1981, p. 119–120, see there also the photographic series of both sexes; Shirihai & Svensson 2018, p. 193, give 6.5–11.5 mm and 10.5–17 mm, respectively; Lefranc & Worfolk 2022, p. 218, 7–12 and 10–15 mm, respectively). Rarely, females show an expressive male-like black forehead, whereas some females have a primarily grey forehead.

The width of the black forehead alone is a "poor indicator of sex" (Shirihai & Svensson 2018, p. 192). We used it as a supporting criterion for sexing individuals towards the end of the head moult. The measurement was taken from the base of the exposed bill (at feathering) to the furthest black feather on top of the head.

Figure 13: *First-year birds at the beginning of the complete moult. (A) Male still with buff underparts lacking the warm tone of adults and greyish hind-flanks. 20 December 2021. (B) Male with even all-grey underparts without any pink tinge. 15 January 2011. (C) Mainly on arrival some individuals still show slight barring on the flanks. Thin body feathers with fewer barbs points out residual, still unmoulted, juvenile plumage, here of a female. 14 November 2017.*

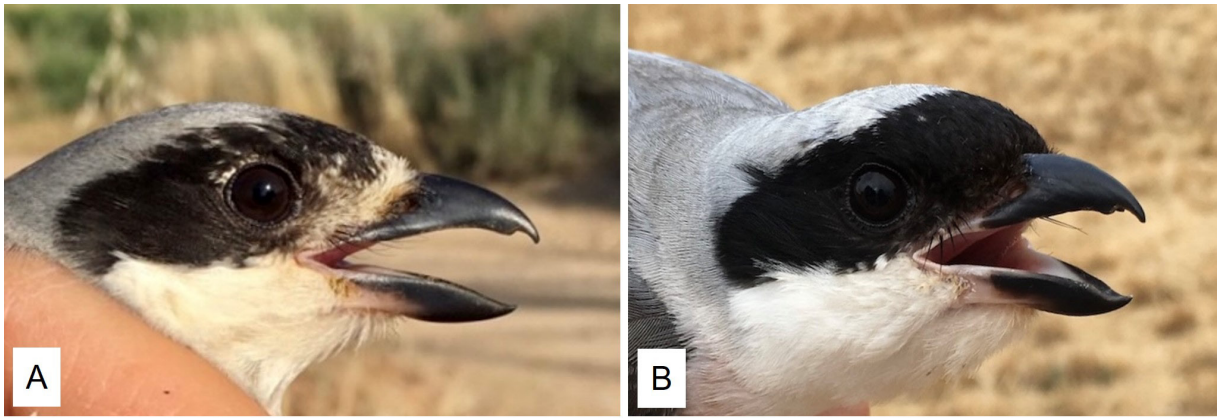

Figure 14: *Frontal mask and bill colouration of adults on the breeding grounds. (A) Female and (B) male. After breeding, the bill is becoming paler at the base, mainly of the lower mandible. Note also the darker grey-tone on the head of the female. 21 August 2017 and 22 July 2017, respectively. Photos courtesy of Marc Gálvez.*

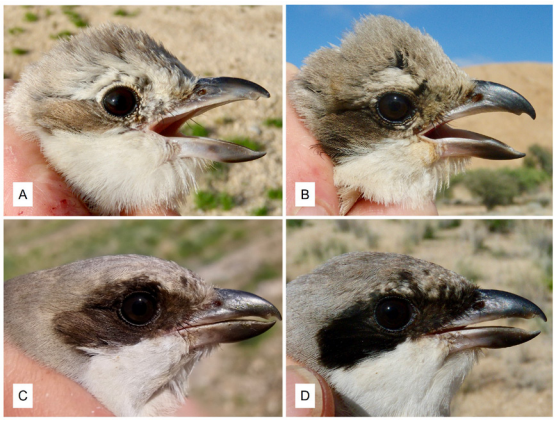

Figure 15: *Comparison of different age and sex in January. The pictures show the head of Lesser Grey Shrikes on the non-breeding grounds in Namibia: (A) Unsexed first-year bird; "babyface" with pale crown, pale brown ear coverts, pinkish gape, horn-coloured beak with growing "tooth", 9 January 2011. (B) First-year of life, presumably second calendar year, ringed at the same day as (A). Overall, this bird is further developed: very first black feathers above the eye; beak tip, "tooth" and colour more advanced. 9 January 2011. (C) Adult female in non-breeding plumage with only single black feathers on the forehead. The colour of the ear coverts are here exceptionally brown, possibly due to the age. In most females they are sub-black. 13 January 2011. (D) Adult male in non-breeding plumage with deep black mask reaching the beak, and few black feathers on the forehead. 15 January 2011.*

Figure 16: *Non-breeding, adult female in complete moult during the boreal summer. The forehead has turned grey. The age is well known since this bird is kept in captivity in a reintroduction program in Spain. 22 July 2015. Photo courtesy of Marc Gálvez.*

Figure 17: *Adult with grey forehead and still black bill; exceptionally early moult of forehead; presumably a female by brownish-grey rather than black ear coverts and primaries. Norfolk, June 2008. Published in Shirihai & Svensson (2018, p. 193). Photo courtesy of Steve JM Gantlett.*

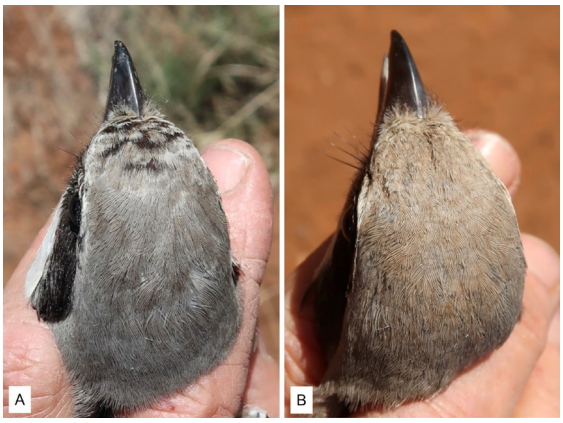

Figure 18: *(A) Grey head of adult with growing black feathers. 29 December 2021. (B) Brown head of first-year individual still without black forehead. Note the short, abraded feathers. 10 December 2022.*

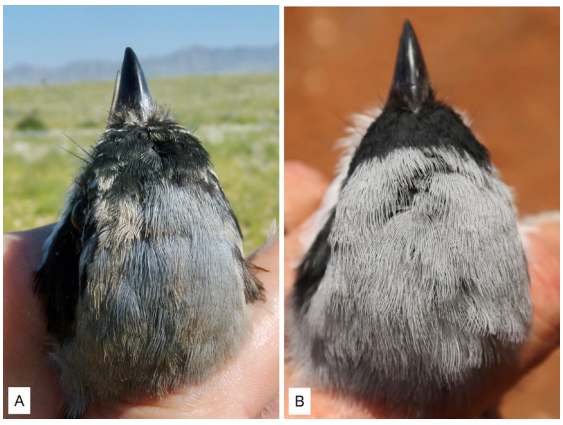

Figure 19: *First-year individuals in transition. (A) Head partially moulted with short brown abraded feathers and fresh long blue-grey feathers. 18 February 2011. (B) Before migration to the boreal breeding grounds the moult comes to completion. 11 March 2023.*

8. ARRIVAL TIME AND YEARLY COMPLETE MOULT IN NAMIBIA

Both adult and young Lesser Grey Shrikes appear in our study area in western Namibia in the area of 22°29'S, 15°27'E from January onwards when the beginning of the rainy season is expected. In the east, though, at 22°21'S, 18°31'E, arrival occurred earlier, with a low number mid and end of November and rising in December (see Tables 2 and 3).

This matches the observations in Namibia of the first arrivals further north from 3 November 1957 along the Omuramba Omatako southwards (Sauer & Sauer 1960, p. 71). In Botswana to the east, the median of first arrivals in 1992 was 2 November (n = 6), 18 November in 1993 (n = 18), the overall median 10 November (n = 44), of which 75% arrived in 26 days, from 31 October to 27 November (Herremans 1994, p. 60).

8.1 Moult

The annual complete moult mainly takes place on the non-breeding grounds in southern Africa, while body moult already starts in the breeding-grounds, involving one or more tertials and is probably suspended during migration. (See Lesser Grey Shrikes with one freshly moulted tertial from August in Greece: https://macaulaylibrary.org/asset/363846201 or from September in Finland: https://macaulaylibrary.org/asset/482872001.)

Table 2: *Extent of primary feather moult (P1 to P10) of adult Lesser Grey Shrike. Values are average moult scores of each primary for the n birds per month sampled. The colour gradient is shown on the side. The tail (t), head (h) and body (b) moult are expressed as a percentage of birds assessed showing signs of moult. No data were collected for the months marked in grey.*

Month	n	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	t	h	b	Moult Score
Jul	0														0
Aug	0														
Sep	0														1
Oct	0														
Nov	3	0	0	0	0	0	0	0	0	0	0	0%	0%	0%	2
Dec	11	4	4	3	2	0	0	0	0	0	0	0%	18%	27%	
Jan	24	5	5	4	4	3	2	1	0	0	0	65%	10%	50%	3
Feb	3	4	3	3	3	3	3	3	1	1	1	100%	100%	100%	
Mar	23	5	5	5	5	5	5	5	5	4	3	20%	29%	0%	4
Apr	3	5	5	5	5	5	5	5	5	5	5	0%	0%	0%	
May	0														5
Jun	0														

Table 3: *Extent of primary feather moult (P1 to P10) of first-year Lesser Grey Shrike (age group 5 and 6 in Safring code, corresponding to first-year birds: code 5 until 31 December, code 6 from 1 January on). Values are average moult scores of each primary for the n birds per month sampled. The colour gradient is shown on the side. The tail (t), head (h) and body (b) moult are expressed as a percentage of birds assessed showing signs of moult. No data were collected for the cells marked in grey.*

Month	n	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	t	h	b	Moult Score
Jul	0														0
Aug	0														
Sep	0														1
Oct	0														
Nov	7	1	1	0	0	0	0	0	0	0	0	0%	0%	0%	2
Dec	10	4	4	2	1	0	0	0	0	0	0	11%	0%	22%	
Jan	140	4	4	4	3	2	1	0	0	0	0	63%	28%	44%	3
Feb	82	5	5	5	4	4	4	3	1	0	0	89%	65%	62%	
Mar	50	5	5	5	5	5	5	4	4	4	3	39%	50%	59%	4
Apr	0														
May	0														5
Jun	0														

At times, an early body and head moult (Figure 1) has been described in the northern hemisphere, especially in non-breeding adults or after failed brood. New observations point towards moult on stop-over sites in northern Africa where two tracked individuals spent nearly two months before continuing their migration south (Adamik *et al.* 2023).

Our findings on moult (Tables 2 and 3) generally match the data of Dowsett (1971, pp. 264–265) collected from 36 museum specimens from Botswana, Zambia and Zimbabwe. The Lesser Grey Shrikes he assessed did not start moulting until the second half of December (ibid., p. 265); our data from this month were captured at the end of December.

The replacement of the flight feathers proceeds quickly from January to early February and slows afterwards, while the body moult continues until late March or early April (ibid., p. 265). The moult advance (expressed in the moult score) in our sample from Namibia was 13 for the whole of December (no sample in Dowsett). For the whole of January our moult score reached 23, while Dowsett (1971) recorded 24 in the first half and 31 in the second half of the month.

In February our sample was too small (moult score for the two halves 38 and 40 respectively in Dowsett), but overall in March our adults had the primary score of 47, with Dowsett recording 41 for the first half only. In April, we recorded only two birds in the first days and one on 18 April.

Although one of our first-year birds (CV38330) already had a moult score of 9 in mid-November, most were in moult process only at the end of the month - none of the adults though.

In December the average score for first-year birds (11) fell behind that for adults (13). One female had an exceptionally advanced score of 22 on 29 December (CV39526).

The moult score in January for immatures (first year of life) was 18, and 24 for adults. In February it rose to 31 for immatures, compared to 25 for our minute sample of three adults. In March the primary moult of young and adults came close to completion with a moult score of 45 and 47, respectively.

Most birds, young and adult, complete their moult before departing for their breeding grounds again.

8.2 Adults

Adults can clearly be distinguished from young until the end of the first year of life by the overall colouration and more advanced moult of the primaries and tail (Figure 20).

Figure 20: *Grey, black and white plumage are features of adults. The moult of this adult is much further advanced than that of a first-year individual (Figure 21) with more brownish plumage. Primary moult score 28 (5555530000). 18 January 2009.*

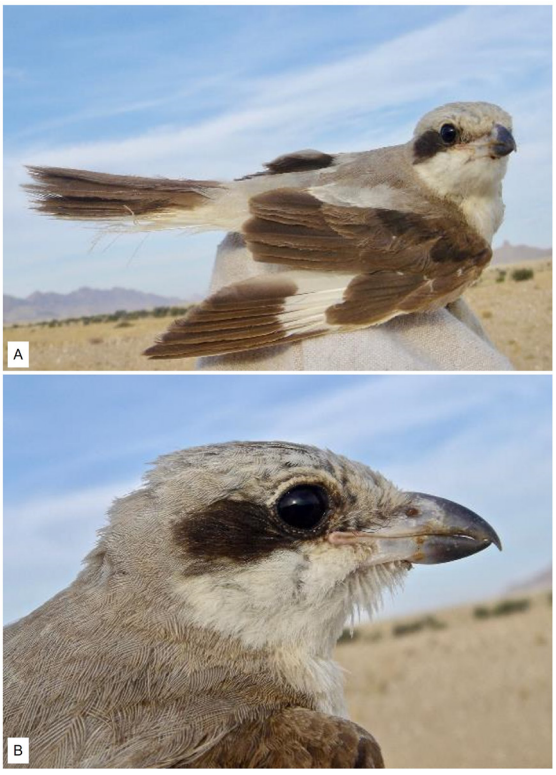

Figure 21: *First-year Lesser Grey Shrike, about half a year old. (A) In the typical arid savanna habitat of the pre-Namib, it is starting its first moult at the beginning of January, with pale and worn tail, primaries and coverts. The gap on the wing indicates three sprouting inner primaries. The only new, dark feathers are some median coverts; moult score 4 (2110000000). (B) Close-up of the head with a fast grown, not yet well matured bill with a small "tooth", a pale basis and a pink fleshy gape flange, yet quite dark ear coverts. Note the loose barbs of feathers on the mantle, as sign of a fast grown plumage. 5 January 2007.*

It is unexplored how the plumage changes throughout the first years: "Ringing must clarify whether the black colouration of the wings becomes more pronounced with increasing age, so that one-, two- and three-year-old birds (and older) can be distinguished" (Bub 1981, p. 123). Unfortunately, no further explanation or context is given.

8.3 First-year Lesser Grey Shrikes

The term "first-year" could mean a bird in the first calendar year (until 31 December of the year in which the birds was hatched), but in other publications it covers the first year of life, i.e. before adulthood. This includes the time in the second calendar year (from 1 January onwards of the year after hatching until approximately the breeding time of the adults). We specify the age for clarification when needed.

The extent of the moult progress in arriving birds is highly variable. Some first-year birds arrive in brownish, moderately abraded plumage with worn tail, brown remiges, fleshy gape and without black forehead. First fresh feathers sprout on the coverts, the first primaries are being shed. The mantle, rump and head as well as the less visible body feathers on the underside are being moulted in much varying degrees (Figure 21).

We observed another, well-stocked group of more worn individuals in the first months after arrival. They show several new primary feathers, coverts and tertials in mid-January (Figure 22) together with dramatically worn tails, but no frontal mask or only a few black feathers. It is unknown if these massive differences are due to different hatching dates and/or different provenances.

Figure 22: *First-year bird with light brownish head and mantle, pale, brown ear coverts, primaries and alula, this with white edges. The primary moult of this individual from mid-January was well advanced compared to the one of Figure 21, ringed in the begin of January. Primary moult score 23 (5555300000). 18 January 2009.*

9. EXCEPTIONAL PLUMAGES OF LESSER GREY SHRIKES

Unlike Red-backed Shrikes that are subject to a wide variety of plumage colouration (Bryson & Paijmans 2023a), Lesser Grey Shrikes in our research area were quite homogenous in their phenotype. During our studies, we encountered only a few Lesser Grey Shrikes with unusual features.

9.1 Juvenile plumage in southern Africa

Juveniles have normally completed their post-juvenile head and body moult by September. Due to this timing, individuals in juvenile plumage have not been recorded in southern Africa (Herremans 2005, p. 727), although "often some juvenile feathers [are] retained on arrival in [the] Afrotropics" (Stresemann 1920, p. 99, translated in Cramp & Perrins 1993, p. 499) and "some birds probably even [arrive] still largely in juvenile plumage" (Cramp & Perrins 1993, p. 499). We observed one individual arriving early in mid-November, still in the process of post-juvenile body moult. It showed brown, white-tipped remiges and coverts and barring on the rump, upper-tail coverts and flanks (Figure 23).

9.2 Residual feathers in March

We ringed a single individual in mid-March with numerous residual brownish feathers on the mantle while the head was still moulting and the underparts, wings and coverts were in fresh plumage (Figure 24).

For Lesser Grey Shrikes it has been described in the northern literature that "very occasionally [boreal] spring birds have one or two bleached and worn unmoulted" secondaries which "may be second-year birds, judging from the often brown colour and heavy abrasion of these retained feathers" (Svensson 1984, p. 212). Also Bub (1981, p. 124) mentions individuals returning to the breeding grounds with one to three bleached and worn, and thus unmoulted, coverts and one bird with the innermost tertial from the second-last plumage.

9.3 Unusual colouration

One individual (CV38329, Figure 25) showed an unusual colouration, which is unique for our studies. It was ringed in November and was very pale and sand-coloured for an adult. It had no signs of a juvenile though, like residual barring on the rump, fleshy gape flange or white tips on the remiges and coverts. The primaries are worn like in other adults, and the bill is horn-coloured and lighter at the base. While the second generation of the juvenile plumage as described in Cramp & Perrins (1993, p. 498) does not match this description, a picture in Cramp & Perrins (1993, Figure 4 on Plate 23, opposite p. 353) shows a similar Lesser Grey Shrike from central Asia in a (fresh) first adult non-breeding plumage (in

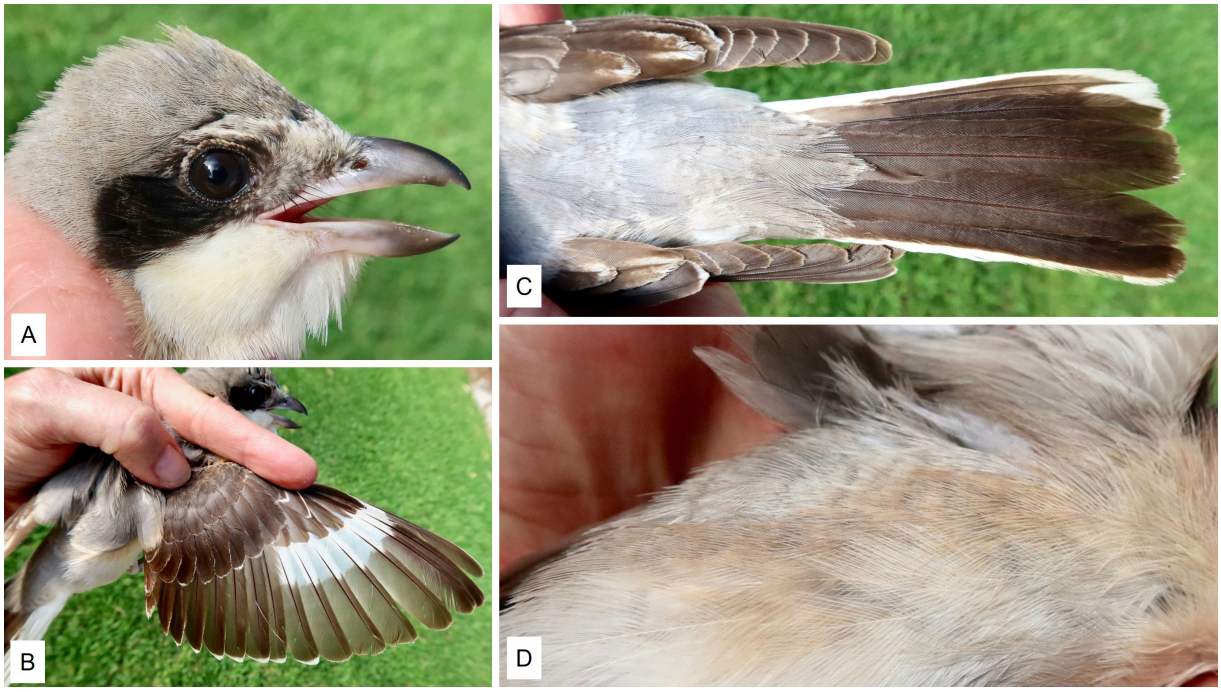

Figure 23: *Lesser Grey Shrike still exhibiting juvenile features. (A) A pink gape flange, horn-coloured beak with broad pinkish base, buffish fringes on the ear coverts and mixed old pale-brown and fresh grey feathers on the head (no black forehead, no dark colouration between eye and beak). (B) White fringes and tips on the wing: on alula and coverts, wide on pointed secondaries, finer on primaries. (C) Barred rump, tips of tertials with buff subterminal marbling (see Cramp & Perrins 1993, p. 498). (D) Barring on flanks with buff-rufous tinge. 14 November 2017.*

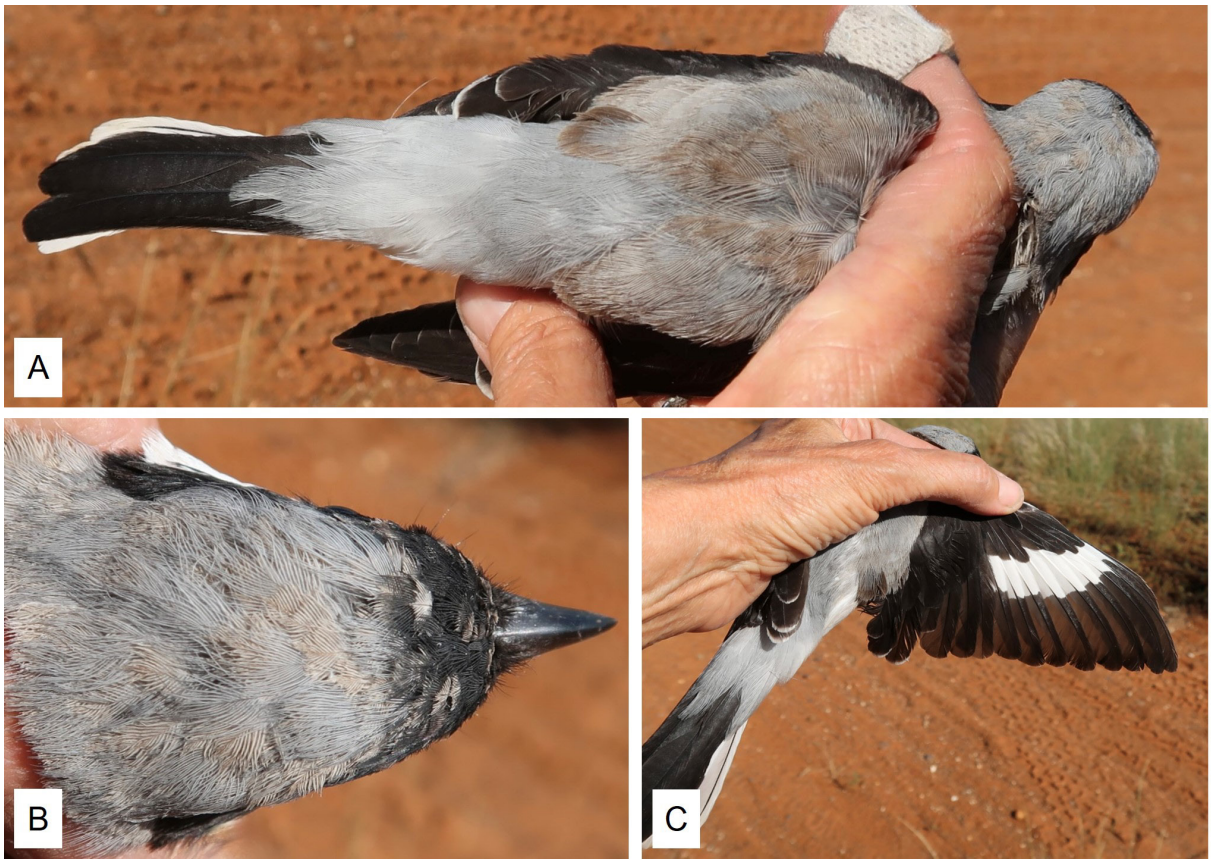

Figure 24: *An uncommon late moult of the mantle that might not be completed until migration (A) while on the head (B) and the wing (C) moult is almost finished. 11 March 2023.*

the boreal autumn) of the formerly *L. m. turanicus,* subspecies characterised by a larger wing. The measurements, though, were in the middle range of our sample, and the question remains inconclusive (see also the discussion in Clancey 1980, p. 161).

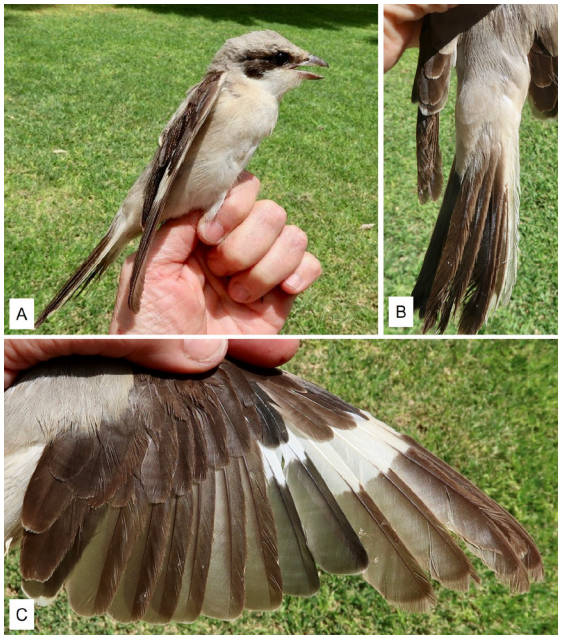

Figure 25: *Sandy coloured female with (A) pale underparts and (B) light buffy rump. (C) By the moult state the age was determined as adult. 16 November 2016.*

10. NOTES

10.1 Retraps and site fidelity

Despite continuous ringing efforts in the same months over many years, we could not find any site fidelity on the non-breeding grounds. However, we had four short-term retraps out of 356 birds: after one day (CV35746), after four (CV38330) and after eight days (CV38328 and CV39683) at the very same location of first capture. Within our sample, we could not confirm the site fidelity expectations reported for Red-backed Shrikes, as expressed in Herremans (1998a, p. 491).

10.2 Mass gain from arrival to departure

Lesser Grey Shrikes in our study area experienced a considerable mass change per month. In adults we measured an increase in body mass in the months leading up to the impending migration cycle (Figure 26). The mean body mass showed a steady and significant increase from 41.6 (± 2.2) g in November to 55.7 (± 6.9) g in April, with a corresponding median rise from 41.4 g to 5 g. These trends are indicative of migratory birds' documented pre-migration fattening strategy, which requires increased foraging activity and metabolism changes to accumulate energy reserves (Baierlein 2003). Please note that the sample sizes of observed adults were relatively small for each month, with counts ranging from 3 to 24.

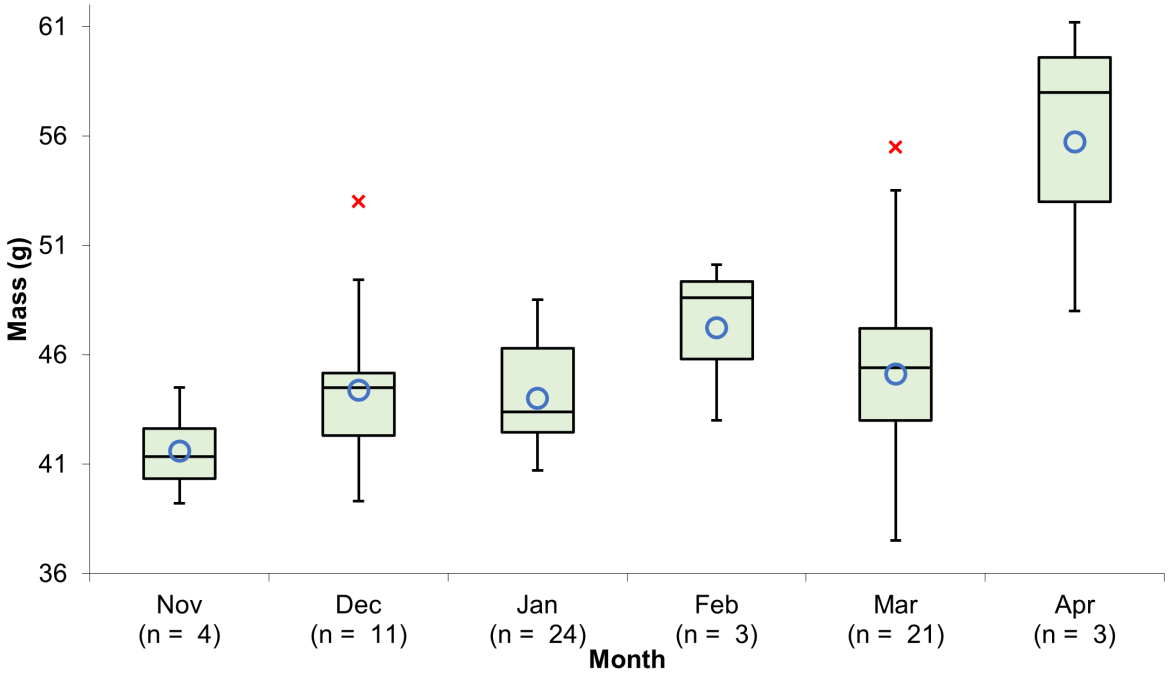

Figure 26: *The average mass (g) of adult (age code 4) Lesser Grey Shrikes in Namibia by month between the migrations. Each box represents the interquartile range (IQR) between the first (Q1) and third (Q3) quartiles, with a central horizontal line indicating the median. Whiskers extend to the maximum and minimum values within 1.5 times the IQR from the box. Outliers are depicted as individual data points beyond the whiskers (red X). The blue circle indicates the mean mass of the birds sampled each month.*

Sampled juvenile Lesser Grey Shrikes had a notable and consistent increase in body mass over the months leading up to the migration period (Figure 27). Specifically, the mean body mass showed a steady and significant increase from 41.5 (± 2.9) g in November to 45.8 (± 5.9) g in April, with a corresponding median rise from 41.9 g to 44.7 g.

10.3 Interaction with the Southern Fiscal *L. collaris*, Red-backed Shrike and Fork-tailed Drongo *Dicrurus asimilis*

We cannot confirm competition between Lesser Grey Shrike and Southern Fiscal (*L. collaris*) and the domination of the latter, as described by Ferret (in Dowsett 1971, p. 264) for our study area in western Namibia. In more than 20 years of observation, we never saw a similar event, despite the observation of hundreds of individuals of both species.

Loske (1985, p. 31), though, twice observed a Lesser Grey Shrike displacing a Red-backed Shrike from a perch, and "several times" being displaced by a Fork-tailed Drongo *Dicrurus asimilis* from an exposed look-out on a telephone pole or a tree top.

10.4 Precipitation and fluctuation of bird numbers

Unlike the more stable numbers of sedentary Southern Fiscals, the numbers of migratory Lesser Grey Shrike and Red-backed Shrike fluctuated over the years in response to substantial rainfall arriving from the north and (especially) the east in 2009, 2011 and 2014 (Figure 28, as published in Bryson & Paijmans 2021, p. 15).

10.4.1 Rain patterns in the pre-Namib

Namibia as a semi-arid country is said to have had a seven-year cycle of good and little rain (farmers GK, WR, 2003, pers. comm.) with an outstanding annual variation in rainfall (Moreau 1972, p. 134). In our western research area at the border of the Namib-Naukluft Park, total annual rainfall between 2002 and 2014 varied from 15 mm to 650 mm. Figure 29 shows some changes of the vegetation and landscape during the time of our research.

10.4.2 Relation between numbers of shrikes and rainfall

We started our consistent studies in the western research area in the pre-Namib in 2002 and concluded during a year-long drought in 2014 near Witvlei in the east. Until 2009, we had caught only one or two Lesser Grey Shrikes per year.

From our farmers (pers. comm.) we know about a long drought in the time before 1999 which made sheep farmers give up their farms for lack of vegetation. Maybe the low numbers of Lesser Grey Shrike and other species in the first years after the millennium resulted from this poor rainfall condition and had turned habitual, with birds not visiting or exploring the area after it had been unsuitable for a long time. From 2009 onwards, with

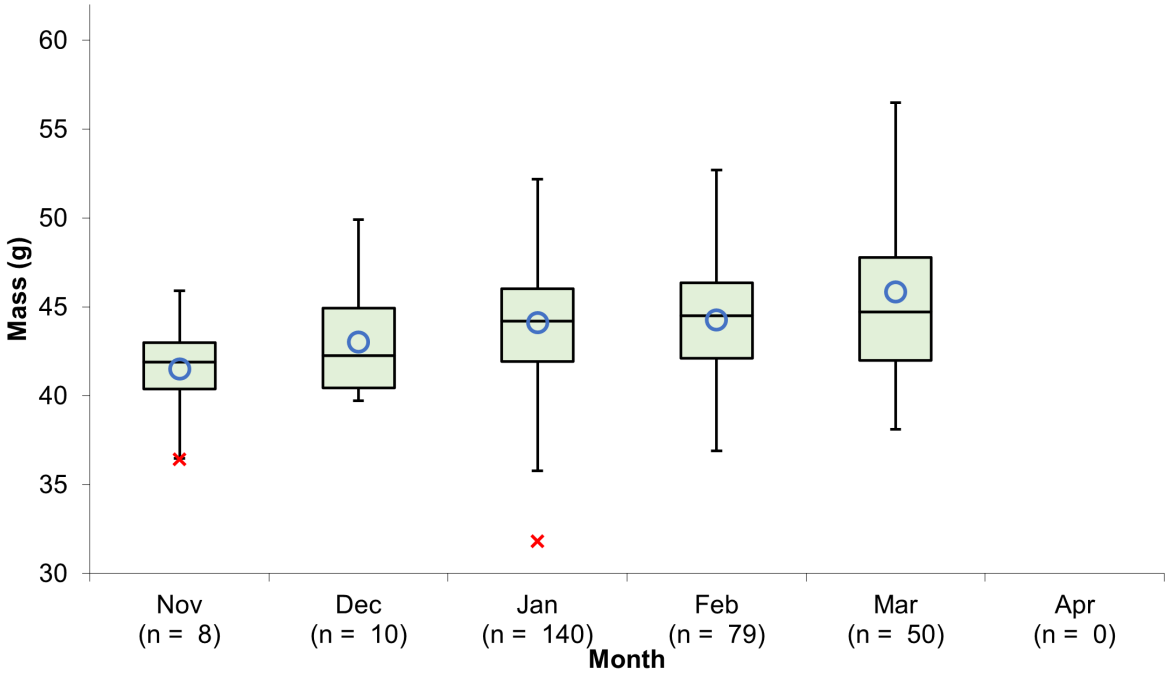

Figure 27: *The average mass (g) of first-year (age code 5 and 6) Lesser Grey Shrikes by month. Each box represents the interquartile range (IQR) between the first (Q1) and third (Q3) quartiles, with a central horizontal line indicating the median. Whiskers extend to the maximum and minimum values within 1.5 times the IQR from the box. Outliers are depicted as individual data points beyond the whiskers (red X). The blue circle indicates the mean mass of the birds sampled each month.*

the second peak of good rain after a wet 2006 when we ringed one single bird, Lesser Grey Shrikes were at least present (see Bryson & Paijmans 2021, p. 15, Figure 19). The excellent rain of 2011 reflected in an enormous increase of birds, numbers and species, arriving at the now suitable habitat. During this peak, we could observe literally one Lesser Grey Shrike on each bush, and through our binoculars we could see in the field of view about 20 birds at once. After having ringed almost 100 Lesser Grey Shrikes, we decided to focus on other species, although we could have caught many more. During this influx in 2011, Red-backed Shrikes also took advantage of higher food availability and increased in numbers, an event that occurred again in 2014.

We have discussed different variables: more favourable conditions further east or north, from where the rain and the birds come to the arid savanna, which might have satisfied the needs of the species; slow or definite withdrawal from a formerly visited non-breeding area due to drought and thus

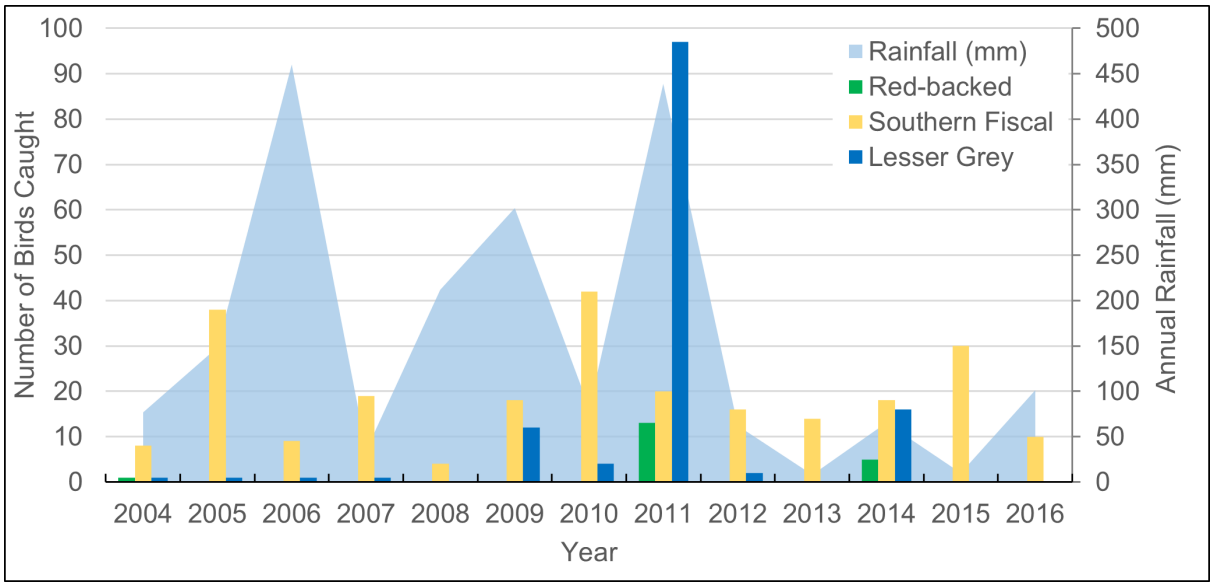

Figure 28: *The numbers of Lesser Grey Shrike, Red-backed Shrike and Southern Fiscal ringed per year in the pre-Namib savanna (22°25'S, 15°25'E) in relation to annual rainfall fluctuations as published in Bryson and Paijmans (2021). Rain data extracted by Tony Robertson from: http://earlywarning.usgs.gov/fews/product/48#download.*

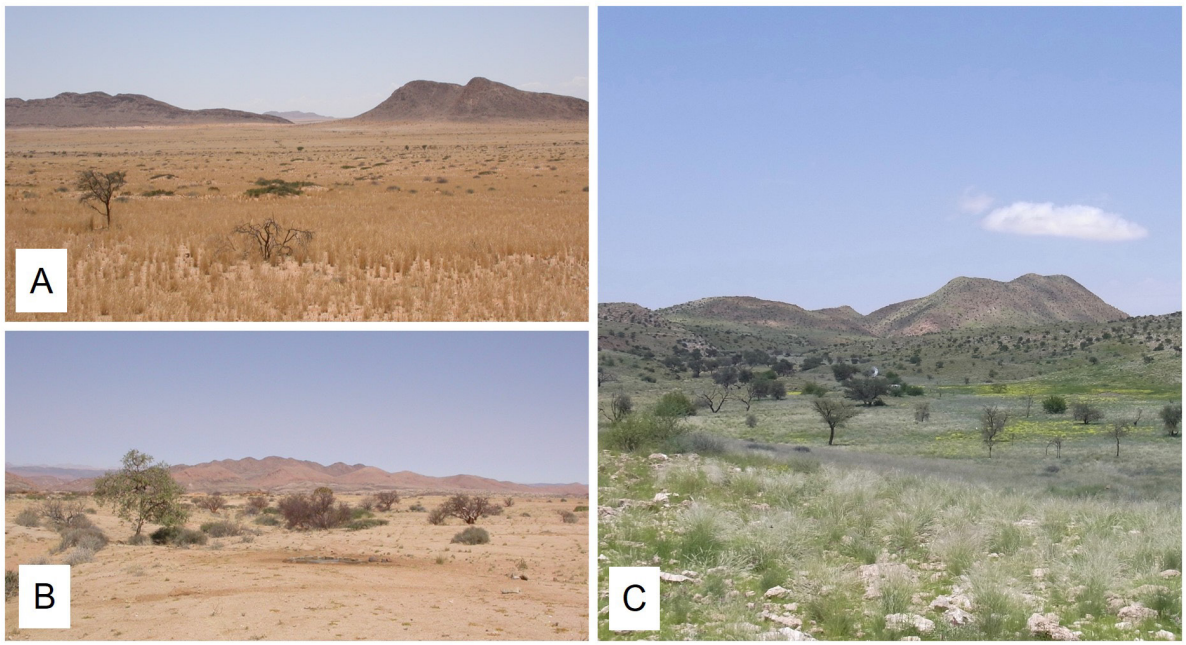

Figure 29: *Changing vegetation in the arid savanna at Farm Sphinxblick at the edge of the pre-Namib. (A) During the dry season, 26 November 2002, (B) during drought years, 3 September 2003, and (C) after exceptionally good rains. 3 February 2011.*

unfavourable conditions; and/or low overall numbers of migratory individuals due to possible factors in breeding grounds or on the migration route. See also the discussion on site fidelity, punctuality of arrival in relation to rainfall and drought and the range extension of migrants in the Kalahari basin (Herremans 1998b).

10.5 Numbers in the literature

For Namibia, several road counts of Lesser Grey Shrikes have been published. The variation of numbers indicates a relation to precipitation.

Considerable fluctuations in Lesser Grey Shrikes numbers have been observed using road counts across years, and intervals of days, weeks and months. On two occasions, more than two birds per kilometre were counted.

On 27 March 1970, Tree (A. J. Tree, pers. comm., in litt. 2020; Tree 1998) counted 11 Lesser Grey Shrikes along the stretch of 30 km of the main road between Karibib and Usakos and almost thirty years later, on 21 January 1998, around 2.5 times more (27 individuals). On the same days the numbers observed between Okahandja and Karibib (a distance of 115 km) were 148 (27 March 1970) and 218 (21 January 1998) individuals respectively, thus an average of one shrike every 527 metres.

Later in 1970, surveys along the road between Windhoek and Rehoboth (93 km) recorded 9 individuals on 8 February, 8 on 16 February, 17 on 18 February, 31 on 4 March and 72 on 1 April 1970 (ibid.).

On 23 March 1984, Loske (1985) counted 145 birds along 75 km of the road from Otjiwarongo to Okahandja which results in 1.9 birds per km, or one bird every 526 m. Becker (1975) registered a similar value: On 18 March 1975 he found one bird every 500 m between Usakos and Karibib (Loske 1985, p. 31), while along the coast, in the Namib and the pre-Namib the species was almost completely absent linking the occurrence of the species to rainfall in the assessed areas (ibid.).

In his “Monitoring of the world population of the Lesser Grey Shrike on the non-breeding grounds in southern Africa” Herremans (1998a) collected ample comparative material in Botswana, Namibia and South Africa. The survey covered an area of 43,125 ha and produced an average of 1.12 to 1.5 birds per km, corresponding to a distance of 666 m to 893 m between individuals.

10.6 Parasites

Contrary to our expectations and the usual occurrence in the field we observed only three individuals hosting mites. No ticks were found.

11. FURTHER RESEARCH

We recommend further research regarding the non-breeding grounds on:

- the site fidelity of the Lesser Grey Shrike,
- the function of rainfall as recommended by Herremans et al. (1995, p. 66) and
- the overall ratio of age groups and possible reasons thereof.

In terms of plumage, research is required to:

- explore the change of the colouration throughout the ageing of adult Lesser Grey Shrikes, and
- monitor the progress of moult processes throughout the months in different regions on the non-breeding grounds.

ACKNOWLEDGEMENTS

We want to thank Javier Blasco-Zumeta, Spain, and Rob Bijlsma, Netherlands, for their invaluable personal and professional support. Our gratitude goes to Tony Tree and Marc Gálvez for open-handedly sharing their experience of shrikes on the non-breeding and breeding grounds, and helping with comments, discussion and photos. We thank Pascal Eckhoff from the Humboldt Museum for Natural History, Berlin, for discussions on moult, Steve Gantlett for kindly letting us use his photos and Janine Dunlop from the Niven Library in the FitzPatrick Institute of African Ornithology at the UCT for her reliable and courteous service as librarian. We are also grateful to Norbert Lefranc for his gentle support, to Ken Stratford for revision and encouraging feedback and to Marc Herremans for discussion on moult, rich information and the generous scientific upgrade of this text. Much appreciated! Our thanks also go to the editorial team of the NJE, especially to Alice Jarvis, for their patience and support. We also want to express our gratitude to the Namibian Ministry of Environment, Forestry and Tourism for granting the ringing permit and to the Namibian farmers who kindly hosted us during our studies, allowing us to move and catch freely on their properties, especially D. and G. Kleemann from the Farm Sphinxblick, N. and K. von Kühne from the Farm Okatjerute, B. and W. Ritzdorf from the Farm Dabib, S. and W. Diekmann from the Farm Hamakari. And my gratitude goes to my ringing assistants Corné van der Merwe and Petrus Karwapa for easing the days in the field. The research was conducted under the South African Bird Ringing Unit (SAFRING) permit number 1240 and all birds were captured and handled under a ringing license issued by the Namibian Ministry of Environment, Forestry and Tourism (Enquiries: Holger Kolberg holgerk@afol.com.na).

REFERENCES

Adamík P, Wong JB, Hahn S, Krištín A (2023) Non-breeding sites, loop migration and flight activity patterns over the annual cycle in the Lesser Grey Shrike *Lanius minor* from a north-western edge of its range. *Journal of Ornithology*. Online: https://doi.org/10.1007/s10336-023-02102-7.

Baierlein F (2003) Nutritional strategies in migratory birds. In: Berthold P, Gwinner E, Sonnenschein E (eds) *Avian migration*.: 321–332. Springer, Berlin, Heidelberg, New York.

Blasco-Zumeta J, Heinze G-M 2019. Lesser Grey Shrike *Lanius minor*. Identification Atlas of Aragon's Birds. Online: http://blascozumeta.com/specie_files/15190_Lanius_minor_E.pdf.

Bryson U, Paijmans DM (2021) Common Fiscal (*Lanius collaris*) Linnaeus, 1766: comparative biometrics, moult data and criteria for the determination of age and sex. *Namibian Journal of Environment* 5 D: 1–23. Online: https://nje.org.na/index.php/nje/article/view/volume5-bryson/volume5-bryson.

Bryson U, Paijmans DM (2022) White-crowned Shrike (*Eurocephalus anguitimens*) A. Smith, 1836: comparative biometrics, moult data and criteria for the determination of age. *Namibian Journal of Environment* 6 D: 1–22. Online: https://nje.org.na/index.php/nje/article/view/volume6-bryson.

Bryson U, Paijmans DM (2023a) Red-backed Shrike (*Lanius collurio*) Linnaeus, 1758: comparative biometrics, moult data and criteria for the determination of age and sex in the non-breeding grounds. *Namibian Journal of Environment* 7 D: 1–19. Online: https://nje.org.na/index.php/nje/article/view/volume7-bryson.

Bryson U, Paijmans DM (2023b) Mountain Wheatear *Myrmecocichla monticola*: comparative biometrics, moult and breeding data, and criteria for the determination of age and sex. *Namibian Journal of Environment* 7 D: 20–40. Online: https://nje.org.na./index.php/nje/article/view/volume7-bryson2.

Bryson U, Paijmans DM, Boorman M (2023) Tractrac Chat *Emarginata tractrac*: comparative biometrics, moult data and criteria for the determination of age and sex. *Namibian Journal of Environment* 7 D: 41–56. Online: https://nje.org.na/index.php/nje/article/view/volume7-bryson3.

Bub H (1981) Kennzeichen und Mauser europäischer Singvögel. Stelzen, Pieper und Würger (Motacillidae und Laniidae). Ziemsen, Wittenberg.

Chittenden H, Davies G, Weiersbye I (2016) *Roberts bird guide*, 2nd ed. John Voelcker Bird Book Fund, Cape Town.

Clancey P (1980) On the Lesser Grey Shrike *Lanius minor* in southern Africa. *Durban Museum Novitates* 12: 161–165.

Cramp S, Perrins C (1993) Handbook of the birds of Europe, the Middle East and North Africa. The birds of the western Palearctic. Flycatchers to shrikes. Royal Society for the Protection of Birds. Oxford University Press, Oxford.

de Beer S, Lockwood G, Raijmakers J, Raijmakers J, Scott W, Oschadleus H, Underhill L (2001) The bird in the hand. *SAFRING bird ringing manual*.: 44–66. Online: http://SAFRING.adu.org.za/downloads/ring-manual-06.pdf.

del Hoyo J, Elliott A, Christie D (eds) (2008) *Handbook of the birds of the world. Penduline-tits to shrikes*. Lynx Edicions, Barcelona.

Demongin L (2016) Identification guide to birds in the hand. The 301 species most frequently caught in western Europe. Identification, measurements, geographical variation, moult, sex and age. Beauregard-Vendon.

Dowsett RJ (1971) The Lesser Grey Shrike *Lanius minor* in Africa. *Ostrich* 42(4): 259–270. Online: https://doi.org/10.1080/00306525.1971.9634416.

Fry C, Keith S, Urban EK (eds) (2000) *The birds of Africa. Picathartes to oxpeckers*. Academic Press, London.

Glutz von Blotzheim U, Bauer K (1993) *Handbuch der Vögel Mitteleuropas. Passeriformes*. Aula Verlag, Wiesbaden.

Harris T, Arnott G (1988) *Shrikes of southern Africa*. Struik, Cape Town.

Harris T, Franklin K (2000) Shrikes and Bush-shrikes. Including wood-shrikes, helmet-shrikes, flycatcher-shrikes, philentomas, batises and wattle-eyes. Christopher Helm, London.

Heinroth O, Heinroth M (1924) *Die Vögel Mitteleuropas*. Berlin-Lichterfelde.

Herremans M (1994) Fifteen years of migrant phenology records in Botswana: a summary and prospects. *Babbler* 28: 47–68.

Herremans M (1997) Habitat segregation of male and female Red-Backed Shrikes *Lanius collurio* and Lesser Grey Shrikes *Lanius minor* in the Kalahari Basin, Botswana. *Journal of Avian Biology* 28(3): 240. Online: https://doi.org/10.2307/3676975.

Herremans M (1998a) Monitoring the world population of the Lesser Grey Shrike *Lanius minor* on the non-breeding grounds in southern Africa. *Journal für Ornithologie* 139(4): 485–493. Online: https://doi.org/10.1007/BF01653472.

Herremans M (1998b) Strategies, punctuality of arrival and ranges of migrants in the Kalahari basin, Botswana. *Ibis* 140: 585–590.

Herremans M (2005) Lesser Grey Shrike *Lanius minor*. In: Hockey P, Dean W, Ryan P (eds) *Roberts Birds of Southern Africa*, 7th ed.: 727. Trustees of the John Voelcker Bird Book Fund, Cape Town.

Herremans M, Herremans-Tonnoeyr D, Borello WD (1995) Non-breeding site-fidelity of Redbacked Shrikes *Lanius collurio* in Botswana. *Ostrich* 66(4): 145–147.

Hockey P, Dean W, Ryan P (2005) (eds) *Roberts Birds of Southern Africa*, 7th ed.: 727. Trustees of the John Voelcker Bird Book Fund, Cape Town.

Iljitshew V (1976). Key to sexing and ageing of Passerines in Soviet Union. Moscow. (In Russian.)

Jenni L, Winkler R (2020a) *Moult and ageing of European passerines*, 2nd edition. Christopher Helm, London.

Jenni L, Winkler R (2020b) *The biology of moult in birds*. Helm, Bloomsbury, London.

Kasparek M (1981) Die Mauser der Singvögel Europas. Ein Feldführer (The moult of the passerines of Europe. A fieldguide). Dachverband Deutscher Avifaunisten.

Kramer G (1950) Über die Mauser, insbesondere die sommerliche Kleingefiedermauser beim Neuntöter (*Lanius collurio* L.). *Ornithologische Berichte* 3: 15–22.

Krištín A, Valera F, Hoi C, Hoi H (2007) Do melanin-based tail patterns predict individual quality and sex in Lesser Grey Shrikes *Lanius minor*? *Journal of Ornithology* 148(1): 1–8. Online: https://doi.org/10.1007/s10336-006-0091-3.

Lefranc N, Worfolk T (2022) *Shrikes of the world*. Helm, Bloomsbury, London.

Loske K-H (1985) Beobachtungen paläarktischer Zugvögel in Namibia/SWA - mit Bemerkungen zum derzeitigen Kenntnisstand. *Journal of the SWA Scientific Society* 39: 7–36.

Maclean GL (ed) (1993) *Roberts´ birds of southern Africa*, 6th edition. New Holland Publishers, London.

Moreau R (1972) *The Palaearctic-African bird migration systems*. Academic Press, London, New York.

Paijmans DM, Bryson U (2023) A comparison of measurements of passerine species and subspecies in Namibia. *Afrotropical Bird Biology: Journal of the*

Natural History of African Birds 3: 1–69. Online: https://doi.org/10.15641/abb.v3i.1272.

Pearson D (2000) *Lanius minor* Gmelin. Lesser Grey Shrike. Pie-grièche à poitrine rose. In: Fry C, Keith S (eds) *The birds of Africa. Picathartes to oxpeckers*. VI: 358–360. Academic Press, London.

Sauer F, Sauer E (1960) Zugvögel in Südwestafrika. *Bonner zoologische Beiträge* 11(1): 41–86.

Schulze-Hagen K (2019) Oskar Heinroth, Erwin Stresemann und die Geschichte der Mauserforschung (Oskar Heinroth, Erwin Stresemann and the history of research on moult). *Vogelwarte* 57: 1–12.

Schwichtenberg H (1973) *Die Unzertrennlichen. Agaporniden*. A. Ziemsen Verlag, Wittenberg Lutherstadt.

Shirihai H, Svensson L (2018) Handbook of western Palearctic birds. Passerines: flycatcher to buntings. Helm, London.

Stresemann E (1920) Avifauna Macedonica. Die ornithologischen Ergebnisse der Forschungsreisen, unternommen nach Mazedonien durch Prof. Dr. Doflein und Prof. L. Müller-Mainz in den Jahren 1917 und 1918. Dultz & Co., München.

Svensson L (1984) Identification guide to European passerines. Stockholm.

Török IH (1999) European Bee-eaters and the occupants of their burrows - friends or enemies? *Bird Numbers* 8(1): 16–17.

Tree T (1998) Highlights of a seven-week visit to Namibia in early 1998. *Lanioturdus* 31(3): 21–25.

Yosef R, International Shrike Working Group (2020) Lesser Gray Shrike (*Lanius minor*), version 1.0. *Birds of the World*. Online: https://doi.org/10.2173/bow.legshr2.01.