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## GROWTH AND DEVELOPMENT OF NESTLINGS: SABOTA LARK *CALENDULAUDA SABOTA*


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Recommended citation format:
**Engelbrecht D, Mashao M 2016**. Growth and development of nestlings: Sabota Lark *Calendulauda sabota*. Biodiversity Observations, Vol 7.51:1-8

URL: http://bo.adu.org.za/content.php?id=244

Published online: 22 August 2016

**– ISSN 2219-0341 –**

## BREEDING BIOLOGY

# GROWTH AND DEVELOPMENT OF NESTLINGS: SABOTA LARK *CALENDULAUDA SABOTA*

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**Abstract**
Knowledge of the growth and development of nestlings has widespread application in fundamental and applied ornithology. Unfortunately detailed information on species-specific growth and plumage development patterns is lacking for most species. Here we present the results of a study on growth in selected mass and biometric parameters as well as plumage development based on data collected from 20 Sabota Lark *Calendulauda sabota* nestlings. The results revealed extremely rapid growth of the tarsus which is an adaptive strategy allowing nestlings to fledge at an early age and hence reduce the likelihood of a predator depredating the entire brood. There was also interesting variation in the presence or absence of down on the ventral surface and the position, size and number of tongue spots. This study provided a foundation for future comparative studies on avian life history strategies in larks.

**Introduction**
Knowledge of nestling growth and development has applications in fundamental and applied ornithology. It can provide information for comparative studies of development across avian orders or between closely related species with different nesting or parental care strategies as well as populations exposed to different environmental variables. Such information can also be used in management and conservation of populations and species (Jongsomjit *et al.* 2007). For example, detailed descriptions of development and aging of nestlings can be used to correctly age nests, a critical component in calculating accurate nest survival estimates. Finally, it can also be used to gauge the fitness of nestlings as environmental stressors, e.g. inadequate availability of food, may negatively impact upon growth and development. Despite its obvious widespread application, basic information on the growth and development of nestlings is still lacking for many species.

The Sabota Lark has a widespread distribution in southern Africa, but relatively little is known about the species breeding ecology. All that is known about the nestlings is that they are fully feathered and are capable of moving around when 10 days old (Mashao *et al.* 2015). Here we report on the growth and development of Sabota Lark nestlings in a savannah landscape in the Limpopo Province, South Africa.

**Methods**
As part of a study of the breeding ecology of the Sabota Lark in the Polokwane district, Limpopo Province, nest searching was conducted during the 2011/2012 and 2012/2013 breeding seasons. The onset of the breeding season was determined by weekly visits to the study area throughout the year and using parental behaviour cues such as carrying nesting material, food or faecal sacs. Once the first evidence of breeding activity was recorded, nest searches were carried out 2–3 times a week. When a nest was found during the incubation period, it was typically visited every 2–3 days but daily towards the approximate day of hatching in order to accurately record the duration of the incubation period and hatch day for aging purposes.

To record growth and development of Sabota Lark nestlings, the following parameters were recorded:
i) Mass to the nearest (0.1 g) using a portable digital scale
Mass is the most widely used parameter in nestling growth studies, but it is also arguably the most sensitive as it is affected by the time elapsed since the last feed, food

availability or environmental stress. Therefore it should be used with caution.

ii) ii) Length of the wing chord (wing ruler), tarsus and head (digital calipers) all recorded to the nearest 0.1 mm as described by de Beer *et al.* (2001)

These parameters are frequently used in nestling growth studies, are relatively robust to environmental stressors, and are good estimators of age.

iii) iii) The developmental timing of individual feather tracts using terminology and criteria adapted from Jongsomjit *et al.* (2007)

According to Ricklefs (1968), feather development may proceed independently of growth in body size or mass gain and as such is one of the most valuable indicators of the age of nestlings (Jongsomjit *et al.* 2007).

i) iv) Eyes, i.e. the age at which the eyes start opening or are fully open

Eyes tend to start opening at a predictable age but the time it takes for eyes to be fully open varies considerably between species (Jongsomjit *et al.* 2007).

Individual nestlings were distinguished by marking them with a non-toxic marker. All data related to the growth and development of nestlings was recorded within the first hour after sunrise and usually only until day 9 as nestlings sometimes exploded from the nest when handled. The day of hatching is considered day 0. The mean duration of the nestling period is 11.7 days (Engelbrecht, unpublished data). Nestling growth data was only included in the analyses if there were at least five data points available covering the entire nestling period.

## Results

Although 57 nests were found during the study, only eight nests and 20 individuals met the criteria for inclusion in the analyses as described above. A description of the main developmental events of nestlings follows:

**Day 0** Eyes closed. The skin is a dark, purplish-black colour with tufts of straw-coloured down on capital, humeral, spinal and crural tracts (Fig. 1). The ventral skin is a paler fleshy-pinkish colour. Rarely some individuals have tufts of down on the ventral surface in some individuals (Fig. 2). Primary, secondary and caudal neosoptiles are present. The culmen and nostrils are a blackish-horn colour but the tip of the bill is a paler grey colour. The gape flanges are pale whitish-yellow and the inside of the mouth is a deep, bright yellow with two laterally situated tongue spots at the posterior end of the tongue and one at the distal tip of the tongue. In some individuals, the distal tongue spot is absent (Fig. 3). The upper and lower mandibles also have black tips. The viscera are clearly visible below the skin (Fig. 2). The egg tooth is clearly visible and is white in appearance. The nestlings generally lay with their heads down and there is very little coordination with regard to movement of the head. They lift their heads and open their beaks in a begging response when disturbed by touch or soft sounds. There is no audible begging call.

**Fig. 1.** A Sabota Lark nestling on the day of hatching (day 0).


**Fig. 2.** Most Sabota Lark nestlings lack down ventrally (below), but a few have varying amounts of tufts of down on the ventral side (above). These two individuals were from the same clutch.

**Day 1** No feather tracts have erupted yet but they are visible under the skin as darkened areas. These darkened areas are the developing feathers.

**Day 2** Eyes slits visible. First primaries begin to erupt, the overall skin tone is getting darker, approaching a blackish colour.

**Day 3** Eyes partially to fully open. Primaries and most secondaries in pin. First feathers on ventral and spinal track erupt.

**Day 4** Eyes fully open but kept closed or partially closed most of the time. Most feathers in pin on all tracts.

**Fig. 3.** Sabota Lark nestlings showing variation in the number of tongue spots. The individual on the left lacks a distal tongue spot compared to the usual pattern of three tongue spots of the individual on the right.

**Day 5** First ventral feathers in brush, the rest of the pin feathers continue to grow. Nestlings now tend to crouch and partially close their eyes when disturbed. They also make audible 'peep' noises when parents approach; otherwise they remain silent and mostly motionless.

**Day 6** All feather tracts have at least some feathers in brush except primaries, primary coverts and the tail which are all still in pin. First feathers on capital tracts only start to erupt.

**Day 7** All feathers on all tracts erupted. Some primaries and most secondaries in brush (Fig. 4-5). Most secondary coverts in brush. The first primary coverts are now in brush (Fig. 6). Egg tooth barely visible.

**Fig. 4.** Two 7-day old nestlings in the nest.

**Fig. 5.** Dorsal view of a 7-day old nestling.

**Day 8** All tracts have feathers in brush. Most primaries and secondaries between 15 and 25% of their length in brush. First primary and most secondary coverts in brush.

**Day 9** Primaries ± 30–40% of their length in brush.

**Day 10** Nestlings fully feathered but with tufts of down still present on the head (Fig. 7). Primaries approximately 50% of their length in brush.

**Fig. 6.** Right wing of a 7-day old Sabota Lark nestling showing the first primaries in brush.

**Fig. 7.** 10-day old Sabota Lark nestlings in the nest.

The growth patterns of the four biometric parameters are presented in Fig. 8 and Figs. 9–12 show scatter plots and trend lines for the different parameters.

## Discussion

The growth and development of Sabota Lark nestlings are broadly similar to other *Calendulauda* larks (Boyer 1988; Engelbrecht & Lonzer 2009). The presence of tufts of down on the ventral parts of some nestlings is seemingly unusual as we could not find any reference to this phenomenon in the literature. As with all larks, growth is rapid and follows a typical S-shaped curve for increase in mass and growth of the head and tarsus. Growth of the tarsus is particularly rapid in larks with most growth completed prior to fledging. Growth of the wing is initially slow but there is a sharp increase in its growth rate from day 3 onwards. Upon fledging, Sabota Lark nestlings are not able to fly yet but, given their well-developed tarsi, they are able to jump and flutter-fly short distances up to about 30 cm.

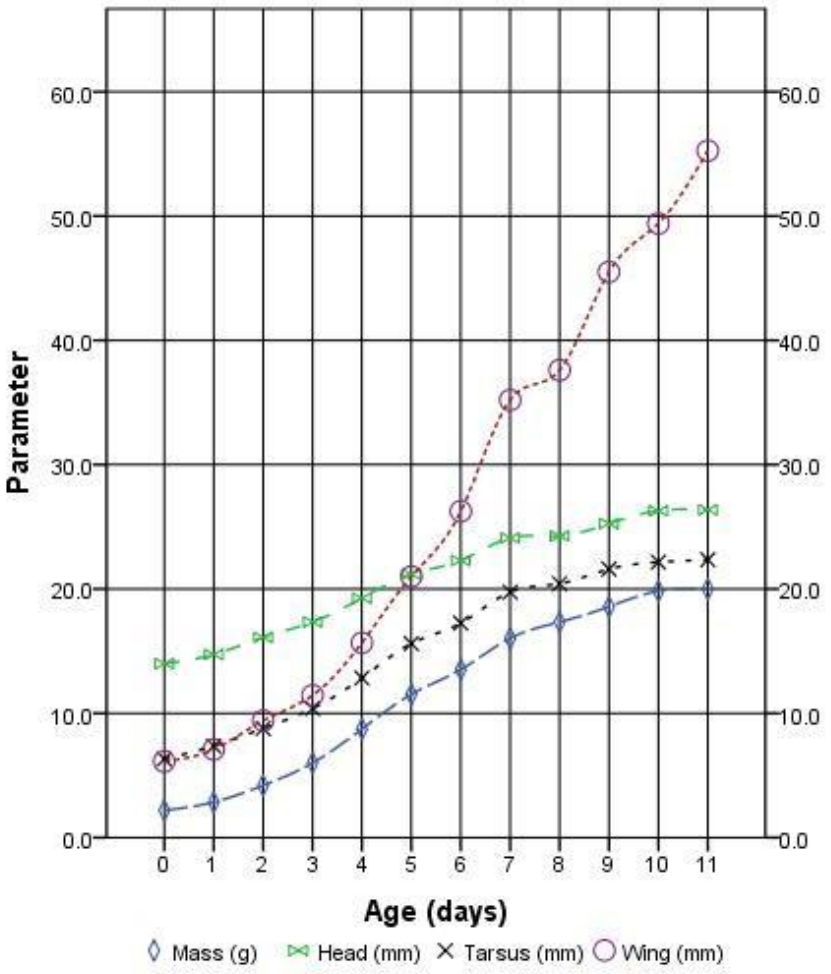


**Fig. 8.** Growth patterns of Sabota Lark nestlings for increase in mass (g) and growth of the tarsus, head and wing (mm).

The presence of tongue spots is a common feature of lark nestlings, but there is considerable individual variation in the number, shape and position of these tongue spots (Maclean 1969; Boyer 1988).

Interestingly, Engelbrecht (2005) found very little variation in tongue spots in the Short-clawed Lark *Certhilauda chuana*.

The behaviour of lark nestlings seems to vary between two extremes. On the one extreme are nestlings of species such as Chestnut-backed Sparrow-lark *Eremopterix leucotis* and Monotonous Lark *Mirafra passerina* that beg audibly and constantly move within the nest and sometimes even leaving the nest for brief periods from day 6 onwards (Engelbrecht and Engelbrecht 2010; Engelbrecht and Dikgale 2014). At the other extreme are nestlings that seldom beg audibly and remain motionless for long periods, only moving and making begging calls when the parents arrive at the nest (Engelbrecht 2005; Engelbrecht and Lonzer 2009; Engelbrecht and Mathonsi 2012). Sabota Lark nestlings subscribe to the latter strategy. When threatened, the nestlings tuck their heads in and lie flat in the nest. This effectively forms a shield within the nest cup which makes it rather difficult to get a hold of the nestlings (also see Engelbrecht and Mashao 2012). They will remain in this position until 'dislodged' at which time they will make a harsh, screech-type call.

In conclusion, the results presented here confirm the pattern of growth reported for larks in other studies. Field biologists studying lark nestlings should carefully check nestlings to establish how common or widespread the presence of down on the ventral surface is. The description of nestling development and the growth patterns presented here can be used in future to age nestlings and assess their fitness.

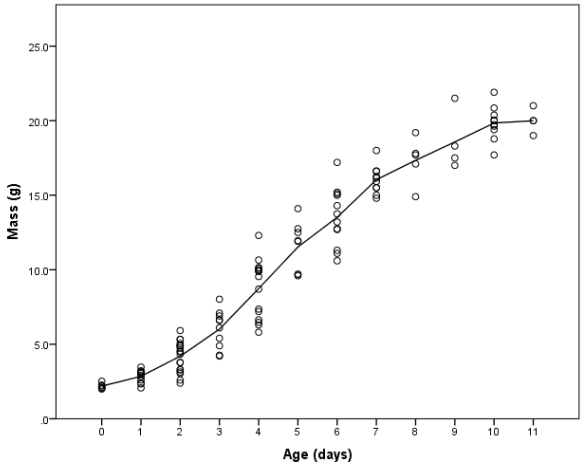


**Fig. 9.** A scatterplot of increase in mass of Sabota Lark nestlings from hatching (day 0) to fledging (~day 11).

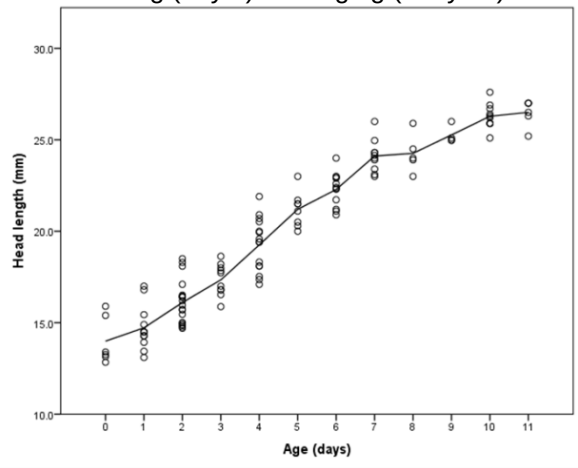


**Fig. 10.** A scatterplot of increase in the head length of Sabota Lark nestlings from hatching (day 0) to fledging (~day 11).

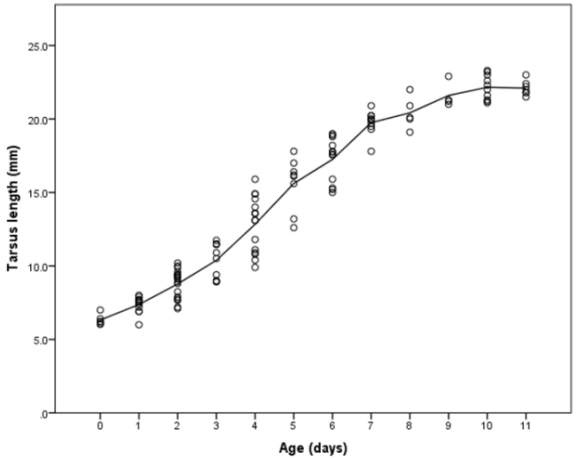


**Fig. 11.** A scatterplot of increase in the length of the tarsus of Sabota Lark nestlings from hatching (day 0) to fledging (~day 11).

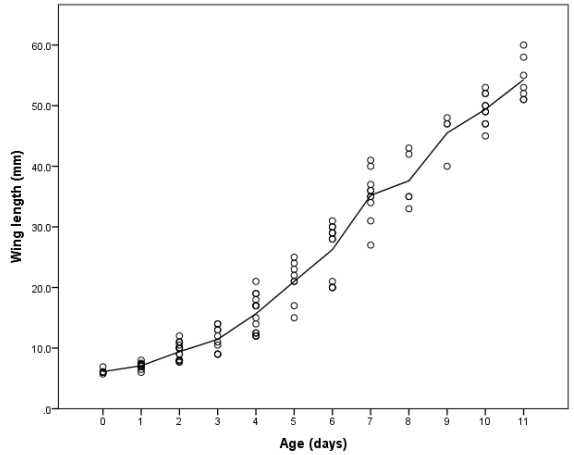


**Fig. 12.** A scatterplot of increase in wing length of Sabota Lark nestlings from hatching (day 0) to fledging (~day 11).

**Acknowledgements**

We wish to express our gratitude to the management of the Polokwane Nature Reserve for granting us permission to conduct the research in the reserve.

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