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Results of year one of a new nesting box project near Windhoek

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Introduction

The nest box was developed by a British conservationist, Charles Waterton, in the early 19th century to encourage more birds on his Yorkshire estate. Since then nest boxes have become widely used, particularly in Europe and North America, for two main purposes: (a) to enhance the conservation of cavity-nesting species by providing additional nesting sites to increase bird populations, and (b) to facilitate research on a wide range of topics from simple observations on breeding biology, growth of nestlings, moult, food and behaviour through to carefully designed research manipulations to answer complex life-history questions such as productivity, predation, parasitism, population limiting factors and competition.

In Namibia the first large-scale use of nest boxes for research was in the Daan Viljoen Game Park in the summer of 1980/81 when 26 nest boxes were put up - 25 attached to trees and one to a small cliff (Riekert & Clinning 1985). Over the course of the next 30 years a number of detailed studies were conducted on cavity-nesting birds in nest boxes by local and visiting scientists, keen birders and ringers. The boxes were maintained, repaired, replaced and added to. By 2000 some 240 nest boxes were spread over an area of about 15 km^2 in the Park, making this the oldest and largest nest-box programme in Africa (Boix-Hinzen *et al.* 2000). At least 26 scientific and semi-popular articles have been published on the research findings from these studies (Table 1).

The Ministry of Environment & Tourism, which is the mandated agency to manage the Daan Viljoen Game Park, is currently not able to control illegal access to, and activities within, parts of the Park where the nest boxes are located. This has resulted in (a) nest boxes being opened and the contents removed, (b) boxes being broken down and used for firewood, and (c) the environment for research becoming unsafe. Local and visiting researchers are thus no longer encouraged to work on the nesting boxes in Daan Viljoen. This is most unfortunate as there has been a long and productive history of monitoring, research and publication built around the nest boxes in Daan Viljoen. The longer that studies are run the more in-depth they become and the more insightful and valuable they are to our understanding of species, communities and ecosystems. Most of the funding for the nest box monitoring and research at Daan Viljoen came not from the Ministry of Environment & Tourism or from the government of Namibia but from NGOs, foundations, universities and private sources. The loss of the nesting box programme in Daan Viljoen is a sad loss to science in Namibia.

Table 1: A list of known publications, in chronological order, resulting from research on cavity-nesting birds using nest boxes in the Daan Viljoen Game Park, central Namibia

	Title of publication / thesis / report	Author(s)	Year
1	The use of artificial nest boxes in the Daan Viljoen Game Park	Riekert B & Clinning C	1985
2	Some observations on the breeding biology of the African Scops Owl.	Riekert BR	1986
3	The breeding biology of the African Scops Owl	Brown CJ, Riekert BR & Morsbach RJ	1987
4	Some factors affecting productivity of three *Tockus* hornbills in central Namibia	Riekert B	1988
5	Yellowbilled Hornbill feeds Grey Hornbill nestlings	Mendelsohn J	1990
6	Namibian hornbills in nest boxes	Mendelsohn J	1997
7	Notes on misdirected feeding behaviour	Boix-Hinzen, C	1997
8	Nest boxes for birds in Namibia	Mendelsohn J	1998
9	Canned hornbills in Daan Viljoen Game Reserve!!	Boix-Hinzen, C	1998
10	Sperm storage and pair bondage: Reproductive conflict in hornbills	Stanback M, Boix C, Richardson D & Mendelsohn J	1998
11	Plugging the gap – monitoring Monteiro's Hornbills	Boix-Hinzen C, Stanback M & Mendelsohn J	2000
12	Determinants of the timing of female nest departure in Monteiro's Hornbill *Tockus monteiri*	Mills SL & Boix-Hinzen C	2000
13	Immunocompetence and the tasty chick hypothesis in the nestling Monteiro's Hornbill: some preliminary findings	Howse J & Boix-Hinzen C	2000
14	Female dependence and expensive male parental care results in genetic monogamy in Monteiro's Hornbill, *Tockus monteiri*	Boix-Hinzen C, Stanback M, Richardson D & Mendelsohn J	2000
15	Low reproductive rates in two *Parus* species in southern Africa	Wiggins, DA	2001
16	Millipedes in Hornbill plugs: towards an understanding of millipede secretions and their possible adaptive significance in Hornbill plugs	Law-Brown J & Boix-Hinzen C	2001
17	*The Birds of Africa*: vol. 6. Picathartes to Oxpeckers	Wiggins DA (Editor for southern African *Parus* species accounts)	2002
18	Aromatherapy for tits	Boix-Hinzen C & Witts L	2002
19	Interesting bird sightings from Daan Viljoen Game Reserve over the past four years	Boix-Hinzen C	2002
20	Co-operative breeding in Carp's Tits (*Parus carpi*).	Boix-Hinzen C, Ludwig T & Turbe A	2002
21	Genetic monogamy in Monteiro's hornbill, *Tockus monteiri*	Stanback M, Richardson DS, Boix-Hinzen C & Mendelsohn J	2002
22	Fathers with highly demanding partners and offspring in a semidesert environment: energetic aspects of the breeding system of Monteiro's Hornbills (*Tockus monteiri*) in Namibia	Klaassen M, Brenninkmeijer A, Boix-Hinzen C & Mendelsohn J	2003
23	Nest boxes for Namibia	Boix-Hinzen C	2004
24	Monteiro's Hornbill in *Roberts Birds of Southern Africa* VII	Boix-Hinzen C & Kemp AC	2005
25	Damara Hornbill in *Roberts Birds of Southern Africa* VII	Boix-Hinzen C	2005
26	Developmental and functional significance of dorsal air bags in nestlings of Monteiro's Hornbill *Tockus monteiri*	Downs CT, Boix-Hinzen C & Brown M	2009

Methods

As a result of the situation at Daan Viljoen, the nest box programme had to look for alternative sites to carry out research into cavity-nesting birds. Two sites were selected near Windhoek, part of Regenstein farm some 10 km SSW of Windhoek, and part of Aris farm about 20 km SSE of Windhoek. Both sites fall into the

Highland Shrubland vegetation type of the Acacia Tree and Shrub Savanna Biome at between 1,850 and 2,000 m above sea level and receive an annual median rainfall of about 300 mm (coefficient of variance about 40%). The Regenstein study site consists of an undulating raised plateau surrounded by cliffs and steep rocky slopes. The dominant tree species are *Acacia hereroensis*, *A. reficiens*, *A. karoo*, *Albizia anthelmintica*, *Combretum apiculatum* and *Ziziphus mucronata*. The Aris study site is mainly flat terrain drained by an ephemeral sandy river and dominated by *A. erioloba*, *A. karoo*, *A. hebeclada* and *Z. mucronata*.

The nesting boxes were made of 2 cm thick wood glued and screwed together (Figure 1). The large nest boxes are about 25 x 25 cm in width and depth by about 50 cm high. An entrance hole of about 60 mm in diameter is positioned about 30 cm from the base of the box, offset to one side and angled up towards the top nearer rear corner. A wooden block of about 15 x 15 cm and 2 cm thick is fitted to the area of the entrance before drilling the hole to increase the depth of the wood around the hole to about 4 cm. Off-setting the entrance, angling the hole upwards and increasing the thickness of wood at the entrance are all aimed at reducing the likelihood of baboons being able to reach the nest contents. The thicker entrance also provides a more substantial surface for hornbills to attach their entrance plug. A narrow strip of wood is attached to the box below the entrance hole as a perch. The lid of the box is not glued but attached by screws so that it can be removed to inspect, and gain access to, the box contents.

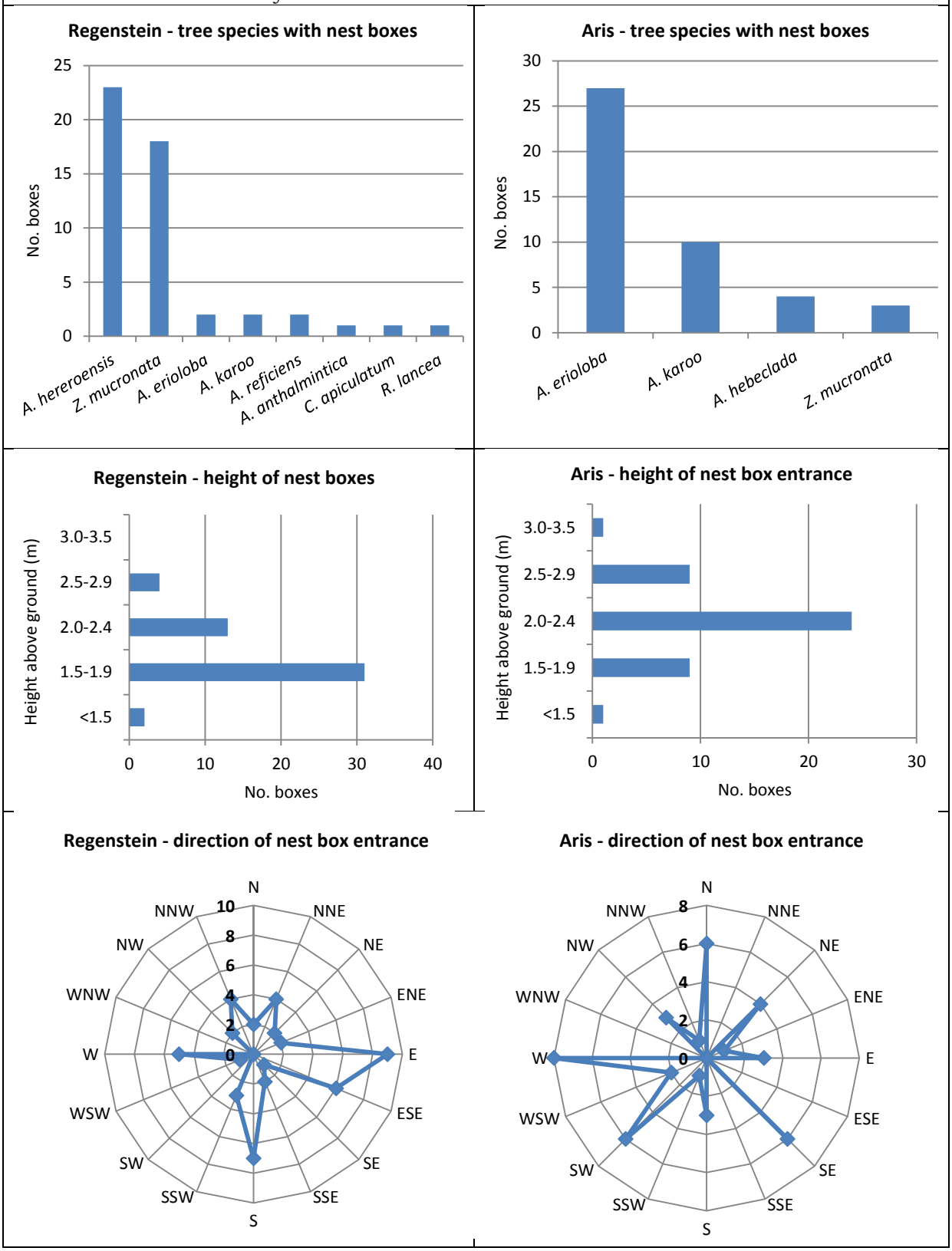
The small nest boxes are about 15 x 15 cm in width and depth by about 27 cm high. The entrance hole is about 35 mm in diameter and about 15 cm from the base of the box.

Two or three coats of linseed oil, thinned with about an equal volume of mineral turpentine, were applied to all outer surfaces of the boxes to protect the wood. Wood shavings were placed on the floor of each box to a depth of about 4 cm. The boxes were affixed to trees using binding wire of 3 or 4 mm diameter. The boxes were mounted as close to vertical as possible, but preferably with the top leaning forward than back to avoid rain water entering the box. Each box was marked with a unique number and its GPS coordinates recorded.

Figure 1: The large and small nesting boxes used during the first year of this study. The 30 cm metal ruler provides scale.

Fifty large nest boxes were affixed to trees at Regenstein in 2013 (20 on 25 July, 20 on 26 July and 10 on 23 December), 38 on the Regenstein raised plateau and 12 below the plateau. Forty large boxes and four small boxes were affixed to trees at Aris in 2013 (30 large boxes on 3 August, 10 large boxes on 11 August

Figure 2: The tree species used to affix nesting boxes at Regenstein (50 large boxes) and Aris (40 large boxes & 4 small boxes), the heights of the entrance holes above ground (m) and the directions faced by the entrance holes.



and four small boxes in September). The tree species used, height of nest box entrance and direction faced by the entrance are shown in Figure 2.

The Regenstein and Aris study sites are part of a larger long-term experiment to determine whether food supply or cavity nest sites are limiting to the population sizes of different cavity-nesting bird species and to study succession and dominance in these species over time. The nest boxes are set up in clusters: four boxes each about 50 m apart, then, about 500 m away, three boxes about 50 m apart, then 500 m away two nest boxes and, a further 500 m, one box. This pattern is repeated - five times at Regenstein and four times at Aris.

Results & Discussion

In addition to birds, a number of other animals have been recorded using nesting boxes, including mammals, e.g. tree rat and dormouse; reptiles, e.g. snakes and lizards; insects such as honeybees, wasps and ants; and other invertebrates such as spiders. Some animals tend to dominate, notably bees, birds and mammals. The dominant species using nest boxes at Regenstein and Aris during the first year of the study are shown in Table 2. At Regenstein 63% of the boxes on top of the plateau were colonized by the Honeybee *Apis mellifera* while none of the boxes below the plateau were colonized. At Aris 16% of boxes were colonized by Honeybees and one by a dormouse. Honeybees are clearly serious competitors for nest boxes and thus natural tree cavities in some areas. Brown *et al.* (in press) concluded that natural sites for Honeybee hives on the Regenstein plateau are a limiting factor to the Honeybee population.

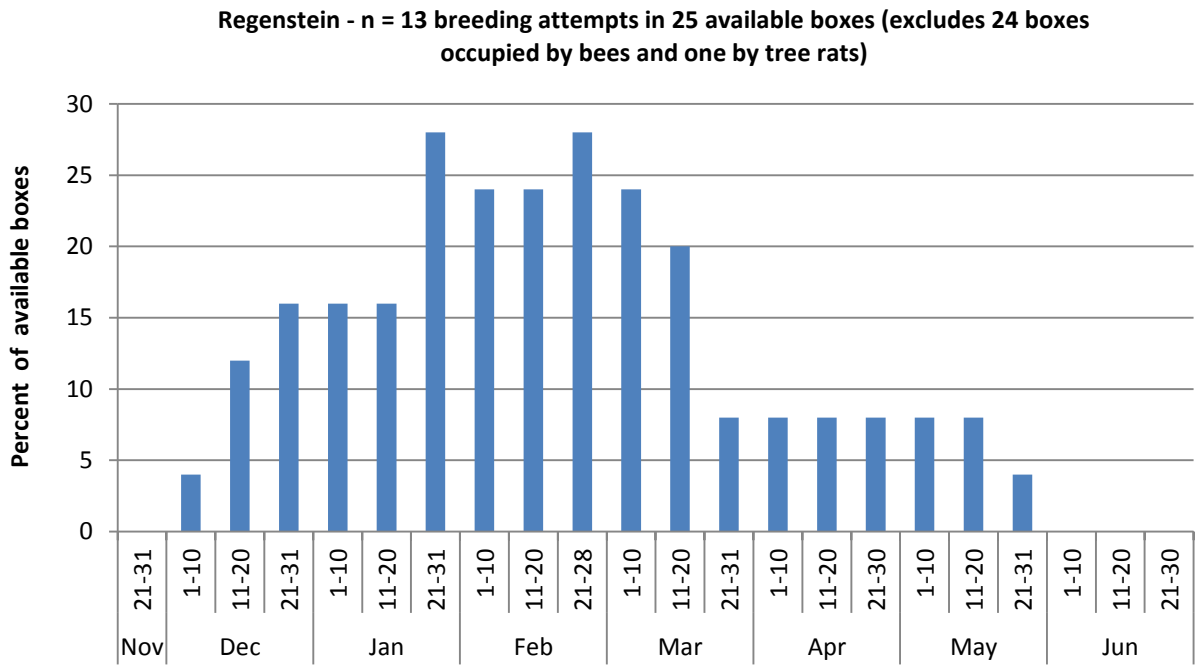
Table 2: The dominant species that used nest boxes during year 1 of the study and the number of boxes occupied (bees and tree rats) and breeding attempts (birds).

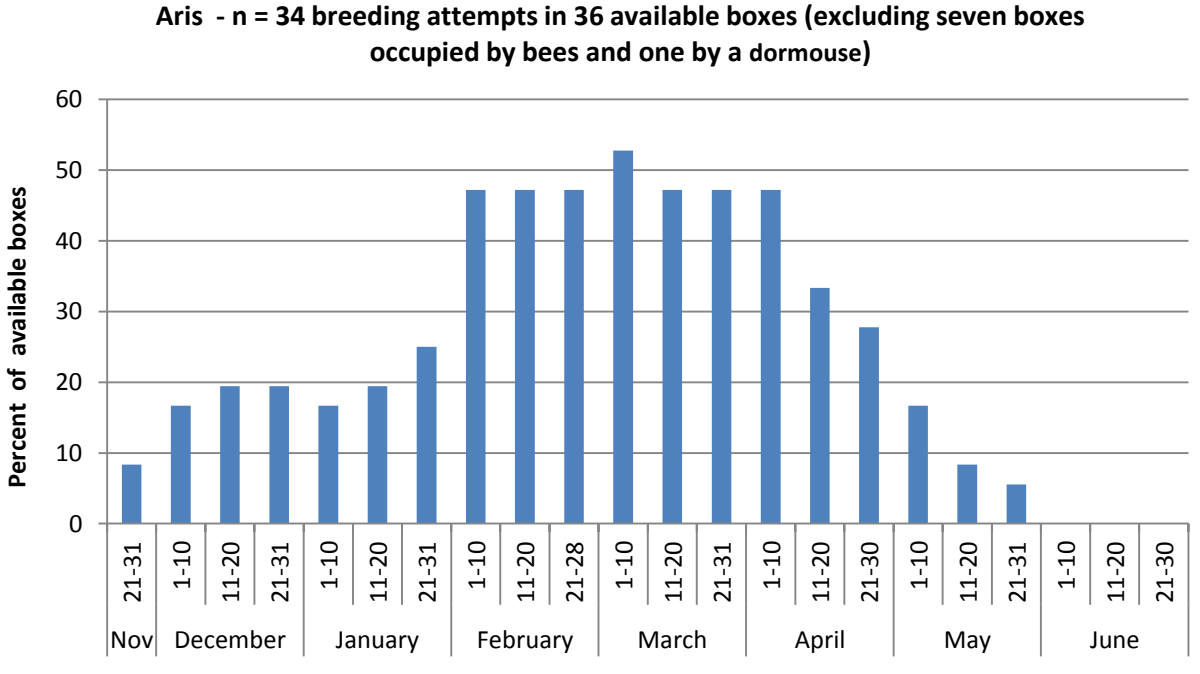
Species	**Regenstein (50 boxes)**			**Aris (44 boxes)**
	On plateau (38 boxes)	Below plateau (12 boxes)	Total	
Honeybee	24	0	24	7
Tree Rat	1	0	1	0
Dormouse	0	0	0	1
Available boxes	13	12	25	36
African Grey Hornbill	2	4	6	5
Monteiro's Hornbill	0	2	2	9
Damara Hornbill	0	0	0	1
Lilac-breasted Roller	0	0	0	2
Green Woodhoopoe	0	0	0	1
Pearl-spotted Owlet	0	1	1	0
Ashy Tit	1	0	1	0
Cape Glossy Starling	1	1	2	3
Burchell's Starling	0	0	0	12
Southern Grey-headed Sparrow	0	1	1	1
Total for birds	4	9	13	34
% of bird breeding attempts to available boxes - excluding boxes used by bees and mammals	31%	75%	52%	94%

There were only four bird breeding attempts in the 13 boxes not occupied by bees and tree rats *Thalamys paedulcus* on the Regenstein plateau, i.e. 31% compared to 75% below the Regenstein Plateau and 94% at Aris. This is an unexpected result because

if natural cavities are limiting to the bee population on the Regenstein plateau they are presumably also limiting to cavity-nesting birds and we would expect high nest box occupancy by birds. It is possible that birds respond more slowly than bees to the presence of nest boxes in areas with few natural tree cavities. This will be revealed by monitoring these nest boxes in future years.

Figure 3: Percent of nest boxes occupied by cavity-nesting birds during the 2013/14 breeding season





Six bird species nested in the boxes at Regenstein and eight at Aris. Four species were common to both sites. African Grey Hornbill, Monteiro's Hornbill and Cape Glossy Starling were the most common breeders in boxes at Regenstein while at Aris they were Burchell's Starling, Monteiro's Hornbill and African Grey Hornbill.

Nesting began in the boxes in November 2013 at Aris and in the beginning of December at Regenstein. It peaked from late January to mid-March 2014 at Regenstein and from February to end April at Aris. All nesting was concluded by end May 2014 at both sites (Figure 3).

Nest boxes (and presumably natural tree cavities) may be used sequentially by birds for multiple breeding attempts in a season, particularly where nest sites are limited. This did not happen during the 1st year at Regenstein, but it did at Aris. Seven boxes had two nesting cycles and one box had three (Table 3). The two nesting cycles involved two records of African Grey Hornbill followed by Monteiro's Hornbill and one record of each of Burchell's Starling – African Grey Hornbill, Cape Glossy Starling – Burchell's Starling, African Grey Hornbill – Burchell's Starling, Lilac-breasted Roller – Burchell's Starling, and Burchell's Starling – Burchell's Starling. The box in which there was a sequence of three breeding cycles was of Cape Glossy Starling – Burchell's Starling – Cape Glossy Starling.

At Regenstein there were two cases of sequential use where one of the box occupants was not a bird: Ashy Tit – honeybees and African Grey Hornbill – tree rat.

Table 3: Number of times nest boxes were used sequentially by birds during the 2013-14 breeding season.

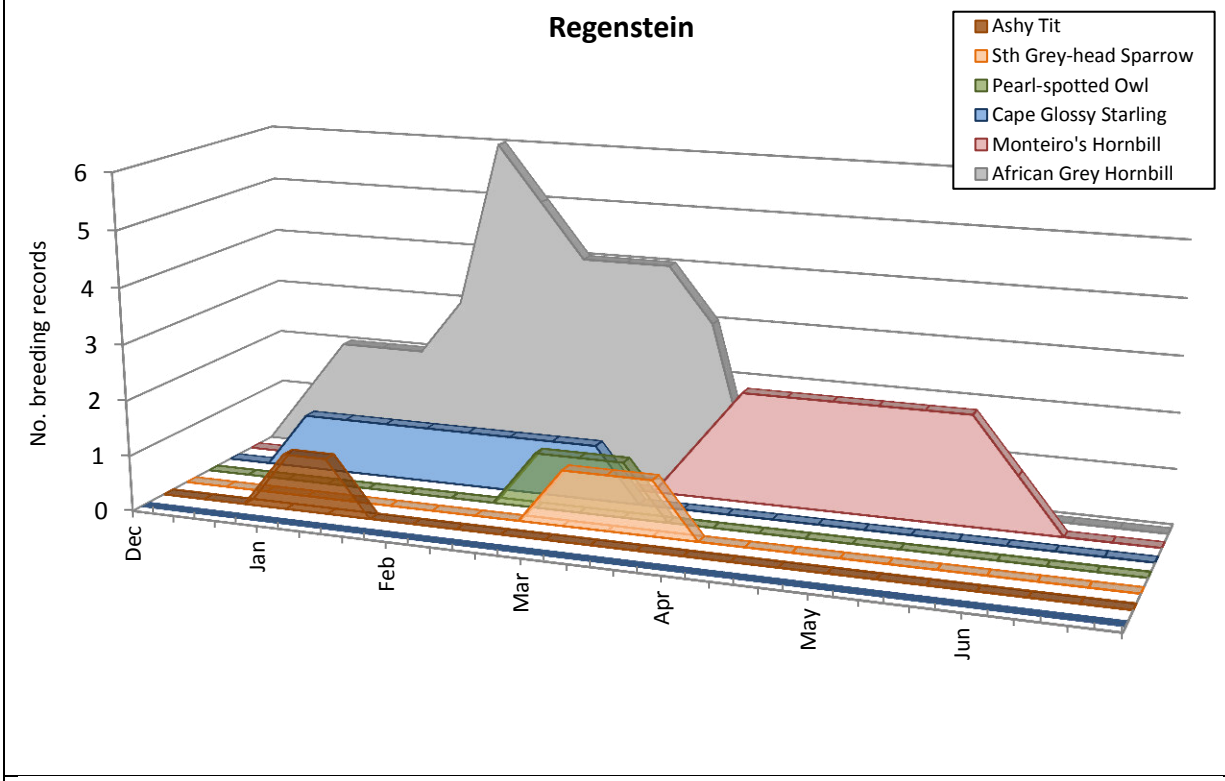
No. times nest box used during the 2013-14 breeding season by birds (excluding boxes used by bees and mammals)	**No. nest boxes**	
	Regenstein (25 available boxes)	**Aris (37 available boxes)**
0	14	12
1	13*	17
2	0	7
3	0	1

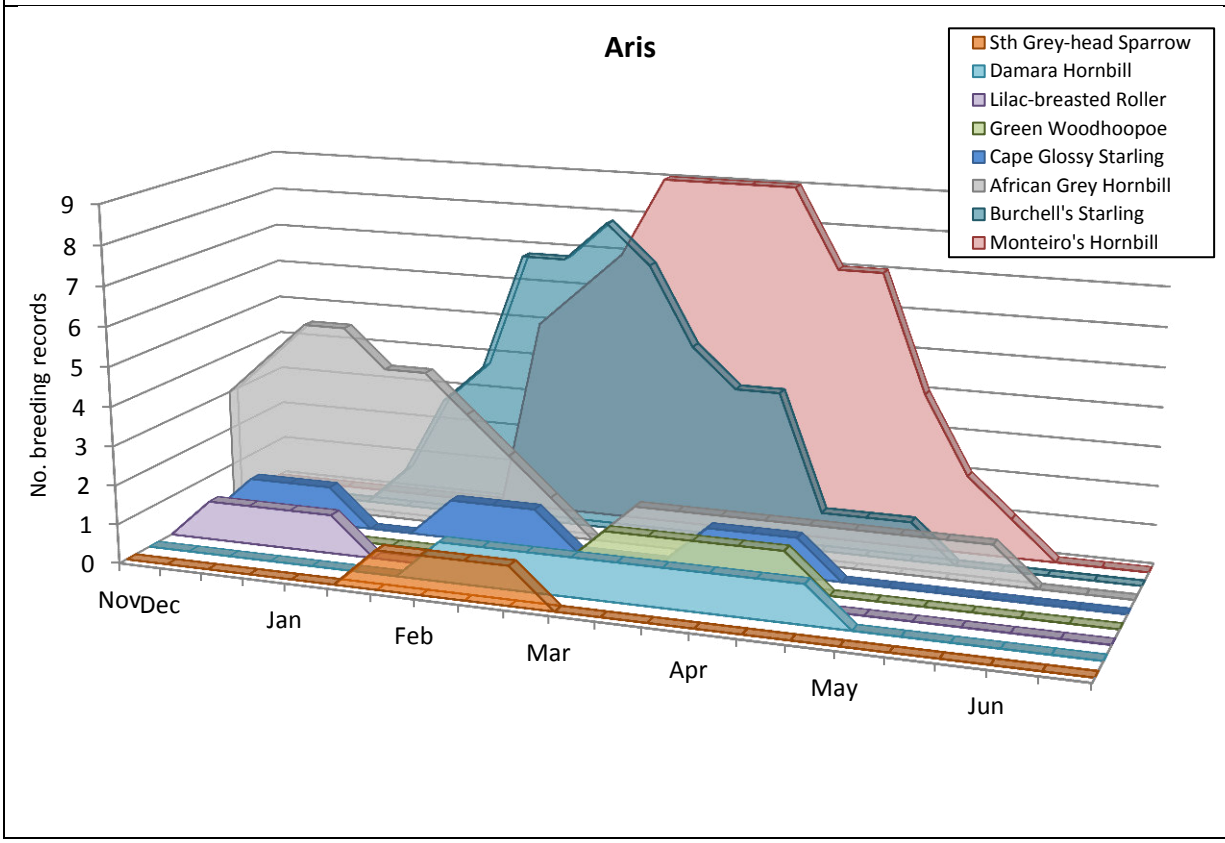
* two nesting cycles were completed in different boxes before the boxes were taken over by bees and tree rats respectively.

The first birds to begin breeding at both study sites were African Grey Hornbills which peaked from December through to April. Other early breeders were Ashy Tit, Lilac-breasted Roller and Cape Glossy Starling, the last continuing throughout the season. Burchell's Glossy Starling was a mid-season breeder at Aris, peaking in February and March while Monteiro's Hornbill bred later in the season, peaking in March and April (Figure 4).

At Aris most of the chicks and incubating female hornbills were ringed as well as one adult African Hoopoe and one adult Green Wood-Hoopoe. This allowed us to establish that one of the female African Grey Hornbills bred twice. A clutch of five eggs was laid in November 2013 in box A1. While in

Figure 4: The sequence and duration of breeding by different bird species in nest boxes during the 2013-14 season.





the nest box incubating and brooding, the female underwent a full feather moult. All chicks had left the nest box by mid-January 2014. The same female occupied nest box A3 about 50m away from the first box

and laid a clutch of four eggs in early March 2014. A brood of three chicks was successfully raised, which left the nest box by mid-May 2014. While in the nest box the female underwent a second full moult. This is very unusual. Dr Alan Kemp, a world hornbill expert, commented as follows: "I know of no records of a breeding female hornbill moulting a second time within one potential breeding season - in fact we have very few records of second clutches/broods for any (hornbill) species, and most/?all are circumstantial in that the females were not ringed".

Another unusual observation was finding single chicks to full clutches dead and covered in mites. We assume that the nest boxes became infested with mites which killed the birds. This was observed at both Regenstein (a clutch of four Cape Glossy Starling nestlings and a single African Grey Hornbill chick) and at Aris (three Grey Hornbill chicks in a nest box in January 2014 and in the same nest box in April, three Burchell's Starling chicks; and in another nest box, a female Monteiro's Hornbill with her very young chicks was found dead and full of mites. Over many years of monitoring nest boxes in Daan Viljoen we have not seen anything similar.

Although no adult Great Spotted Cuckoos were seen at Aris while checking the nest boxes, despite concurrently bird atlasing, one Great Spotted Cuckoo chick was found and ringed in a nest box occupied by breeding Burchell's Starlings (Figure 5A).

Figure 5: Cavity-nesting birds in nest boxes at farm Aris. A = Great Spotted Cuckoo and Burchell's Starling chicks, B = Damara Hornbill chicks, C = the female African Grey Hornbill that bred twice in one season with her 2nd clutch, D = large Green Wood-Hoopoe chicks. Photos Dirk Heinrich.

Concluding remarks

This report covers the 1st year of what we hope will be a long-term project. We know from other studies, particularly those at Daan Viljoen, that:

- In the first year of a nesting box project the number of birds breeding in nest boxes is usually relatively small compared to future years, as the birds begin to find the boxes and become comfortable with them;
- The results from the first year of a nest box study can be especially informative in that the occupancy of boxes is not influenced by the previous nesting history of that box.
- Over the years the bird species composition usually changes as the dominant species displace smaller, less aggressive species;
- The population sizes of some cavity-breeding bird species can be expected to increase in the study area as a result of the increase in nest sites and breeding output;
- There is considerable year-on-year variation in breeding seasons, clutch and brood sizes and the number of young birds successfully fledged, mainly dependent on climatic conditions;
- And finally, as projects such as these continue, new insights are gained and new research ideas are generated to better understand the complex interrelationships between birds and other animals with their environment. We welcome the participation of interested birders and young researchers in this project, as well as new research ideas in answering some of the interesting questions on the biology and ecology of cavity-nesting birds and other animals at these study sites.

Acknowledgement

We extend our thanks to all the shareholders of farm Regenstein and the owners of farm Aris, Mr. and Mrs. Heiner and Margret Frowerk, for allowing us to put up and monitor nest boxes on their land.

This project was funded by grants to Dr. Mark Stanback (Davidson College, USA) from the Columbus Zoo (USA), the Fresno-Chaffee Zoo (USA), and the National Bird of Prey Trust (UK).

In addition to formal funding, it is perhaps insightful to look at the in-kind financial contributions to this project made by the authors who have committed their time and expertise and covered travel costs. Using a modest N$2,000 daily rate and a 4x4 vehicle rate of N$4.5/km, the in-kind contribution to this project in year one amounted to about N$80,000 in time and N$6,325 in transport costs, in total about N$86,325. The value of in-kind contributions to research, monitoring and other citizen science initiatives are seldom calculated. As a result they are often under-valued and their important contribution to science is not fully appreciated.

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