The Ecology and Conservation Biology of the Black-cheeked Lovebird *Agapornis nigrigenis* in Zambia

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DEDICATION

This dissertation is dedicated to an African Grey Parrot I call Harvey;
wishing that I could give you back the freedom you lost,
that I found,
and cherished,
with the lovebirds.

PREFACE

This work by Louise S. Warburton and supervised by Prof. M.R. Perrin is the first long term ecological study of a Lovebird. The study was carried out in the School of Botany and Zoology, University of Natal, Pietermaritzburg, from February 1998 to May 2003.

This dissertation represents the original work of the author and has not otherwise been submitted in any form for any degree or diploma to another University. Where use has been made of the work of others it is duly acknowledged in the text.

Chapters 3 – 12 are presented in chapters representing papers for due submission to international journals. As such each chapter is set to read independently and some repetition is therefore unavoidable.

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ABSTRACT

This study was undertaken to investigate the ecology of the Black-cheeked Lovebird *Agapornis nigrigenis* in the wild. Prior to this study little was known about the ecology of this parrot or other members of the genus *Agapornis*. The Black-cheeked Lovebird is classified as Vulnerable and has suffered a severe population decline and reduced distribution, from which, for largely speculative reasons, it has never recovered. The overall aim of this project was to elucidate the basic biology of the Black-cheeked Lovebird and determine the conservation actions which are necessary to conserve the species in the wild.

Fieldwork was conducted across the species' range in south-west Zambia over twenty-two months between May to December 1998; March to December 1999; and February to May 2000. An education project focussing on Black-cheeked Lovebird conservation was conducted with local schools, villagers and Zambia Wildlife Authority scouts during September 2001.

Historical records pertaining to distribution of the Black-checked Lovebird, both within and beyond Zambia are few, anecdotal and often discredited, and it is suggested that the species should be considered as endemic to Zambia. Within its core range the species has a clumped and localised distribution, associated with Mopane woodland and permanent water sources. Two sub-populations occur and appear to be distinct.

Black-cheeked Lovebirds were most active, in the early morning and late afternoon, forming the largest daily flocks sizes during these times, which correlated with drinking and feeding activities. The smallest flock sizes occurred when roosting. Overall flock sizes were significantly larger during the dry (non-breeding) season.

Black-cheeked Lovebirds were observed feeding on 39 species. Food items included seeds, leaves, flowers (especially nectar), fruit pulp, invertebrates, bark, lichen, resin, and soil. Various foraging techniques were used. Terrestrial foraging was dominant, with little temporal or spatial variability. Arboreal foraging in plants varied seasonally and by availability. Feeding preferences were not specialised and there was no dependence on a limited food resource.

Black-cheeked Lovebirds fed on two agricultural crops. There was no evidence to suggest an extended foraging range during the crop-ripening season, or the reliance on crops for survival. The crop-ripening season coincided with the lovebird breeding season. The species is widely perceived as a crop pest, with 18% of seed heads of millet crops suffering more than 20% damage during the ripening season. Local farmers attempted to protect their crops in a variety of ways, however, these were largely ineffective and rarely lethal to lovebirds. The importance of elevating local tolerance for the species through education programmes is highlighted.

This study presents the first collection of breeding data on the species. Breeding occurred from mid-late January to early May. A single clutch was raised by most pairs per breeding cycle. Seventy-eight nests were found and characteristics measured. Fidelity to nest-sites is suspected. Although breeding behaviour was non-cooperative most nests were found in a loosely clumped distribution. No nesting requirement appeared to be in limited supply, or had reason to affect the population's reproductive output. Behavioural data on nest location, building, defence and predation are presented. In addition courtship, copulation, parental care and juvenile behaviours are reported. Data on clutch size, laying intervals and hatching success with captive birds are included. One nestling tested positive for Psittacine Beak and Feather Disease Virus (PBFDV). Other observations suggest PBFDV is present in the wild population. Implications for research and conservation are discussed.

Black-cheeked Lovebirds roosted inside naturally formed cavities in live Mopane trees. Roost cavities were found in a loosely clumped distribution. No roosting requirement appeared to be in limited supply.

Black-cheeked Lovebirds are highly dependent on surface water supplies and need to drink at least twice daily. The lovebirds are highly cautious drinkers that will not drink if the water resource was actively disturbed by humans or livestock. Water availability is a limiting factor to the Black-cheeked Lovebird. The gradual desiccation of its habitat appears to be the major cause behind the reduction of occupancy within its small range. Over the last 45 years (1950 – 1997) the annual rainfall in the Black-cheeked Lovebird's habitat has decreased resulting in further reduction of its already highly localised distribution increasing the species dependence on artificial water supplies.

The conservation management of the species should be prioritised towards maintaining and creating water resources with minimal external disturbance; upholding the wild-caught trade ban in the species, continuing environmental education with local schools promoting lovebird conservation, and monitoring populations through dry season water source counts.

ACKNOWLEDGEMENTS

'There is a silence in the imminence of animals and also in the echo of their noise, but the dread silence is the one that rises from a wilderness from which all the wild animals are gone'

Peter Matthiessen, Sand Rivers, 1981.

This project would not have been possible without a lot of help from a wide-range of people and sponsors. All contributions are gratefully acknowledged.

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Pietermaritzburg
Prof. Mike Perrin for supervising the project, for the loan of the vehicle and his dedication to parrot conservation. Drs. Jaishree Raman, Tee Taylor and Colleen Downs for their voluntary proof-reading, which came complete with humour and encouragement – huge thanks and I know i.o.u's!; Drs. Stuart Taylor, Sarah Pryke and Colleen Downs for stats advice; and Riyad Ismail at the Department of Geography UNP for assistance creating the distribution map.

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Doug and Dee Evans from Chundukwa, Livingstone are thanked for their vital support when and where it mattered most – Doug orientated me to the wilds of the Nanzhila region in south Kafue National Park, showed me the places he'd seen the lovebirds and inspired me with a love for the place (as well as providing G&Ts *with* ice when he brought guests up to his Nanzhila camps!). Dee helped me keep in touch with the world beyond, handled urgent E-mails in my absence and advised me on many a practicality where I would otherwise have failed miserably. Jeanette at Maramba, Livingstone and Vic and Moyra in Gibson Road, Vic' Falls, provided comforts and friendship on the monthly pit-stops. Bob Stjernstedt, Vincent Katenekwa, Pete Leonard & Ian Bruce-Millar are also thanked for their help and support - Pete risked amputation (but escaped without a scar) when we ringed the lovebirds. Ilsa Mwanza is gratefully acknowledged for her help in obtaining a Zambian study visa and Zambia Wildlife Authority for their permission to work in Kafue National Park and

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Field assistants

Two Zambian field assistants: Alex Mwenda in 1998 and Aaron Muchindu in 1999-2001 became my right-hand, and many-a-time my left as well. Together we made tracks into the Mopane, pitched camps, and sought the lovebirds. I am very grateful to Alex and Aaron for all their assistance and humour but most of all for their interest and shared affection for those cikweles we travelled down so many paths to find... Also the scouts from Kalenje, Kafue National Park for their armed escorts into the bush – at least at the start of the study, before my mornings became too early for them!

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In response to various requests for captive data I was fortunate in receiving responses and data from an international group of bird keepers breeding Black-cheeked Lovebirds: Grant Scopes, D.v.d.W. Hofmeyer, and Bjarne Polvsen sent me their detailed breeding records; also Pat Lehmgrubler, Marnie Potgieter, Johan Badenhorst, Ken Plege, Rob Sedice, P.W.E. du Plessis, Denis de Klerk, Joop Boomker, Calvin Bradley, Mikael Andersson, Gary Burdmn, Kat Lamke, Sean Waters, Deb Sandidge, N.S. Smith, Pat Drew, Ulrich Künzel, Alan Rost, Petro Senekal, and Hennie de Beer contributed.

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Tim Dodman who shared his knowledge gained during his 1994 lovebird survey, and who left a trail of goodwill in his footsteps.

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Coping without many of the material privileges I have always taken for granted, and meeting and living with people who have never known them, is a humbling experience, which will always stay with me.

For many reasons parrots have always been of special interest to me, which has developed into an obsession. It is a privilege to observe these birds in the wild and an experience I wish each caged-bird owner could similarly enjoy and appreciate. It would be my wish that all parrots could be left in the wild, and freedom be all their inheritance.

CONTENTS

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CHAPTER ONE

INTRODUCTION

"Quite incredibly little has ever been published about the habits of the Agapornis species in the wild state.....we have not the faintest idea of the vital statistics of these important birds"

R.E. Moreau, June 1945
Tanganyika Notes and Records No.19. Pp. 23 - 33.

The genus *Agapornis* is confined to Africa and Madagascar and consists of a group of allopatric species. Nine species are generally recognised. The Black-cheeked Lovebird *Agapornis nigrigenis* is Africa's most localised parrot, with a core range estimated at 2,500 km^2 in south-west Zambia, (Dodman 1995, Dodman *et al.* 2000) and is considered Vulnerable (Birdlife International 2000). The ecology of the species in the wild was virtually unknown until this study was undertaken. Currently the species is uncommon in captivity. The overall aim of this project was to elucidate the basic biology of the Black-cheeked Lovebird and determine the conservation actions which are necessary to conserve the species in the wild.

This is the first detailed ecological study of any of the nine species of lovebird. Ecological data are essential for the formulation of a long-term management regime for the species (Wilkinson 1998, Snyder *et al.* 2000).

This study elucidates the biology of this Vulnerable and poorly-known lovebird. It determines the basic ecological requirements, availability of resources, and threats facing the lovebird's survival, in addition to collating knowledge from anecdotal records scattered in obscure literature sources concerning the Black-cheeked Lovebird and other members of the genus. Behaviours during major activities are described for the first time from observations made of lovebirds in the wild, and similarities and differences of the behaviours described in captive studies (e.g. Phillipps 1908, Dilger 1960, 1964) are commented on.

Key aims of the study are listed as:

1. To collate and present the historical data and records concerning the Black-cheeked Lovebird.
2. To determine the diet of the Black-cheeked Lovebird in the wild.
3. To quantify the seasonal drinking habits of the Black-cheeked Lovebird across their range.
4. To investigate the nesting requirements and nesting success of the Black-cheeked Lovebird in their natural habitat.

5. To report on roosting habits and requirements of the Black-cheeked Lovebird.
6. To determine areas where Black-cheeked Lovebirds currently face greatest survival threats.

Questions we wanted to answer included the following: Are the two sub-populations distinct and is the Black-cheeked Lovebird a Zambian endemic? What do the lovebirds feed on, when and where do they feed, are food sources specialist and limiting (spatially, seasonally and temporally)? Is the Black-cheeked Lovebird a crop pest, is the Black-cheeked Lovebird persecuted as a crop pest, and are the lovebirds dependent on agricultural crops for their survival? When and where do the lovebirds breed, are nest-sites limiting, what is the function of building a nest inside a tree cavity, and how successful are breeding attempts? What water resources are available to lovebirds across their range and do they have habits and behaviours which limit the use of available resources? Which other species interact and share resources with the lovebirds? In answering the above it is then possible to answer questions on why the range of the Black-cheeked Lovebird is so localised and currently decreasing in size, and identify what the major threats to the species' survival are; and lastly, to recommend what measures need to be taken and what opportunities exist to ensure the long-term survival of the species in the wild.

This thesis presents the following aspects prepared as chapters in paper format: a review of the genus; distribution; water requirements; feeding ecology; an investigation of the species as an agricultural crop pest; ; nest-site characteristics; breeding biology; evidence of Psittacine Beak and Feather Disease Virus in the wild population; roosting ecology; and a summary bringing together the aspects of the species ecology into suggestions for the long-term conservation biology of the Black-cheeked Lovebird.

Fieldwork was conducted across the species' range in south-west Zambia over twenty-two months between May to December 1998; March to December 1999; and February to May 2000. An education project focussing on Black-cheeked Lovebird conservation was conducted with local schools, villagers and Zambia Wildlife Authority scouts during September 2001.

STUDY AREA

Zambia is a landlocked country in southern-central Africa, lying between 8° - 19°S and 22° - 34°E, with an approximate area of 750 000 km². Black-cheeked Lovebirds inhabit the driest region of Zambia, a vast plain area, altitude 914 - 1 341 m, intersected by the floodplains and tributaries of the Zambezi and Kafue Rivers within the Southern and Western Provinces. Maps of the study area and distribution of lovebirds observed during the study are presented in chapter 3. Black-cheeked Lovebirds exist in two distinct but adjacent geographical ranges between 16° - 17°S and 25° - 26°E (Dodman 1995, Dodman *et al.* 2000). The Lovebird's range is marked by two distinct seasons. A rainy season, usually from November to March, with a mean annual rainfall of 600 mm

(NPWS/JICA 1999), and a long dry season from April to November, with April being a transition month. The coldest month, July, has a mean maximum temperature range of 22 - 28°C, and mean minimum range of 5 - 7°C; while October is the hottest month, with a mean maximum range of 31 - 35°C, and mean minimum range of 15 - 18°C (NPWS/JICA 1999). The lovebird's range suffers serious water shortages from June to December, as all rivers in the region, with the exception of the Zambezi and Kafue Rivers are ephemeral. The only other naturally occurring water sources are scattered shallow pools, few of which last throughout the dry season. The mean duration of the dry season expressed as a percentage of the year is estimated at 65% (240 days or more) (Chaplin 1954). Water is generally abundant during the rainy season and the subsequent inundation of the floodplains and pans. During the dry season distribution of surface water is irregular, and scarce, with their distribution and quality depending primarily on the previous rainy season.

The dominant vegetation within the range of the Black-cheeked Lovebird is Mopane *Colophospermum mopane* woodland. Within Zambia, Mopane woodland occurs principally in the middle Zambezi and Luangwa Valleys, with a block north-west of Livingstone. The isolated Mopane of the Kalomo Plateau, where *A.nigrigenis* occurs is associated with alkaline soils left by an ancient lake drained by the defaulting of the Zambezi trough (Bingham 1994).

Mopane often forms pure stands to the exclusion of other species, but within the range of the Black-cheeked Lovebird is commonly associated with several other prominent trees and shrubs, including *Adansonia digitata*, *Combretum imberbe*, *Diospyros mespiliformis*, and *Balanites aegyptiaca*, mixing with Miombo woodland at the bottom of escarpments and savanna species, typically *Acacia* spp., *Combretum* and *Terminalia* species in areas with a high water table. Mopane communities show considerable variation in height and density (White 1983), trees in dense woodland or open savanna reach heights of 10 to 15 m, and some up to 25 m in what is referred to as 'cathedral mopane' (Smith 1998). It can also be stunted and shrubby (1 to 3 m) where it occurs on impermeable alkaline soils (Smith 1998). These two structural forms and grades in between them often occur together in a mosaic, depending on soil conditions and micro-climatic factors (White 1983, Smith 1998). In areas that annually flood tall trees maybe confined to growing from termitaria (*pers. obs.* L. Warburton).

The Mopane tree has a dense yet shallow rooting system and is able to grow on a wide variety of soils, although it is a poor competitor and thus more characteristic of poor soil types. The herbaceous component of Mopane communities differs according to soil conditions and vegetation structure. Dense swards are found beneath gaps in the Mopane canopy on favourable soils, whilst in other areas grass cover is typically sparse comprising annual species owing to competition for soil moisture, or an impermeable soil structure (Low & Rebelo 1996, Smith 1998).

The ecoregion is one of the most important areas for vertebrate diversity in southern Africa, although poor in endemic species (Crowe 1990). Only five bird species can be considered near endemics, which include the Black-cheeked Lovebird and Lilian's Lovebird *Agapornis lilianae* that are found in allopatric ranges.

Human settlement within the study area has been largely controlled by the demarcation of nationally protected land (Kafue National Park and surrounding Game Management Areas (GMAs)) in the north of the Black-cheeked Lovebird's range and in general by water availability. The area is relatively remote, with generally poor soils and bad communications. The human population comprises mostly cattle owners, subsistence farmers and seasonal fishermen and hunters. In some areas, including the lower-mid Machile River, local humans shift their settlements according to the season, living on the floodplains during the drier winter months, and on higher ground during the summer rains.

In general Mopane woodlands in southern Africa have a "healthy" conservation status, and occur in areas of low human population density, which correlates with the poor agricultural potential of the region (Huntley 1978). The most widespread threat to the ecoregion is poaching and exploitation of wildlife (Stuart *et al.* 1990, *pers. obs.* L. Warburton), in addition to settlement in protected areas (e.g. Game Management Areas), and uncontrolled bushfires (IUCN 1992, *pers. obs.* L. Warburton).

FIELDWORK SEASONS

Fieldwork was planned to start in March 1998, although late heavy rains prevented access into the region until May. Between May and December 1998 all fieldwork was concentrated on the northern sub-population of Black-cheeked Lovebirds, conducted in south Kafue National Park, largely by myself, with one reconnaissance trip to the southern lovebird population in September accompanied by Vincent Katenekwa and Bob Stjernstedt. In 1998 fieldwork ceased with a broken-down vehicle in early December at the start of the rains. It was ascertained that it would not be possible to access this region, and in particular the Mopane woodland habitat, by vehicle during the height of the rainy season.

In 1999 fieldwork commenced in April and ended in mid December, and was largely conducted around the range of the southern sub-population of lovebirds, particularly concentrating on the populations along the Machile and Sichifulo Rivers. Few birds were found along the Ngweze River. Every 4 to 5 weeks, up to 10 days was spent in south Kafue National Park monitoring the lovebird populations identified during 1998. Surveys to investigate the 'gap' area between the northern and southern sub-populations were conducted during the early dry season (April), height of the dry season (August) and the early rainy season (November). During most of 1999 two observers (myself and a volunteer assistant) collected data. During September two weeks was spent observing Lilian's Lovebirds in the Lower Zambezi region, Zimbabwe. In October, with help from the headman of Mutelo village, we were able to identify a route west of the Machile River that we could use to access the lovebird's range by vehicle during the wet season.

During 2000, fieldwork ran from the end of January until the beginning of May, with two field assistants in addition to myself collecting data. Observers were divided into two teams, one collecting data on lovebird feeding in agricultural crops, in the region of the mid Machile River (Mutelo village), which was the furthest point we could get the vehicle; and the other at a breeding site 9 km east of the river. One team member swapped sites every six days.

In general, data were collected every day for three weeks of every month, followed by a four day refuelling and restocking trip to Livingstone and Victoria Falls. Accommodation was self-sufficient camping with no on-site facilities.

DIFFICULTIES

Much of the lovebird's range is undeveloped, roadless, and almost totally inaccessible by vehicle during the rainy season. In addition widespread illegal poaching of wildlife in the Game Management Areas (GMAs) and within the southern section of Kafue National Park made some areas inadvisable to traverse. In particular it was regretted that the areas of Mopane woodland west of the Nanzhila River could not be explored for lovebird activity.

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CHAPTER TWO

AN OVERVIEW OF THE GENUS *AGAPORNIS* WITH SPECIAL EMPHASIS ON THE BLACK-CHEEKED LOVEBIRD *Agapornis nigrigenis*

"It is a lively bright little fellow, and although very nervous after its terribly long journey shows a disposition to be friendly and even familiar "

Mr. R. Philips, The Black-cheeked Lovebird,
The Avicultural Magazine, Vol VI, 1907-1908.

SYSTEMATICS

Members of the Psittaciformes, in spite of their wide morphological diversity (Juniper & Parr 1998), are easily recognised by their hooked bill, fleshy cere, zygodactylous feet, various internal morphological structures and certain behavioural characteristics (Smith 1975, Homberger 1980). Determining the phylogenetic origins of parrots in relation to other avian groups is not clear cut, this is reflected by the wide range of proposed classifications based upon various morphological, behavioural and genetic studies. A review based on DNA hybridisation techniques suggests there are three main subgroups of parrots: Australasian, African and American species and indicates that parrots are not particularly close to either pigeons or cuckoos as had been previously suggested (Sibley & Ahlquist 1990). It is considered that the parrots cannot be aligned with any other bird groups and thus have no close living relatives (del Hoyo *et al.* 1997, Juniper & Parr 1998). Currently two sub-families within Psittacidae are recognised (Loriinae and Psittacinae), although evidence (Adams *et al.* 1984, Brown & Toft 1999, Christidis 1991[a,b], Madsen *et al.* 1992) suggests separate family status for the cockatoos (Cacatuidae) is appropriate (del Hoyo *et al.* 1997). Currently there are 332 extant species recognised, with the number likely to increase as isolated sub-species are given species status (del Hoyo *et al.* 1997).

Continental Africa is home to 18 species of parrot within four genera, with most species having allopatric distributions (Forshaw 1989, Snyder *et al.* 2000). The genus *Agapornis* has been considered both close to, or alternatively, distant from the Indo-Australian genus *Loriculus* (Racheli 1999). However, systematists have not reached common agreement (Homberger 1980). The current view is that *Agapornis* belongs to the family Psittacidae, sub-family Psittacinae and tribe Psittaculini, encompassing 66 species in 12 genera (Forshaw 1989). Psittaculini originate predominantly from Asia, although species of this tribe are found in Africa, through Mauritius, India, New Guinea and Australia with little sympatry between species (Forshaw 1989, del Hoyo *et al.* 1997). The tribe is characterised by a contrasting coloured rump or under-wing covert plumage and a smooth-surfaced, usually pale bill, although this may be red or orange in some genera, and lacks a pronounced culmen ridge (Forshaw 1989). Other members of the Psittaculini comprise *Psittinus*, *Psittacella*, *Geoffroyus*, *Prioniturus*, *Tanygnathus*, *Eclectus*, *Alisterus*, *Aprosmictus*, *Polytelis*, *Psittacula* and *Loriculus*. *Agapornis* is considered a completely separate taxon from the three other African parrot genera (*Poicephalus*, *Psittacus*, and *Coracopsis)*.

TAXONOMY AND MORPHOLOGY

The genus *Agapornis* Selby, 1836, comprises nine near-allopatric forms confined to Africa and Madagascar. Whilst there are nine taxa, the number of species recognised depends on the treatment of the four white-eye-ringed (periophthalmic) taxa (*A. personata, A. fisheri, A. lilianae and* A. *nigrigenis*) from southern-central and eastern Africa. *A. personata* and *A. fisheri* are naturally sympatric over part of their Tanzanian range, although there is no evidence of gene flow between the populations (Turner 1991, Gerhart 1977, Baker & Baker 2003). Of the non white eye-ringed forms *A. swinderniana* and *A. pullaria* are also partially sympatric, with *A. pullaria* apparently extending its range into areas cleared of forestry, (Chapin 1939, Moreau 1948, Snow 1978, Juniper & Parr 1998). However, all the white eye-ringed species and *A. roseicollis* are able to hybridise and produce fertile offspring in captive and feral situations, which indicates a recent disjunction in range.

Sclater (1924) recognised nine species of *Agapornis*: (*cana, taranta, pullaria, swinderniana, roseicollis, personata, fisheri, lilianae* and *nigrigenis)*. Neunzig (1926 in Moreau 1948) recognised four species, placing *A. pullaria* with *A. roseicollis* and *A. cana*; *A. swinderniana* (and *A. s. zenkeri*); *A. taranta;* and the four white-eye-ringed forms together. Other authorities, for example Hampe (1957), considered that only the four white-eye-ringed forms should be considered as sub-species of each other, and the rest as separate species. Peters (1937) concurred with Sclater's original nine species.

Studies in the evolution of the genus were pioneered by Moreau (1948). In proposing a new classification for the genus he split the nine forms into two groups, termed 'primitive' (pleseomorphic) and 'advanced' (apomorphic) on the basis of seven morphological and behavioural characters. Moreau (1948) noted the close relationship between the white-eye-ringed species, but did not consider them separate species, although he considered *A. lilianae* and A. *nigrigenis* as conspecific. Further work by Dilger (1960, 1964, 1975) included detailed behavioural observations on captive birds (except *A. swinderniana*). This work concurred with Moreau's (1948) groups, and further suggested *A. roseicollis* as an intermediate between the two. Dilger considered the genus to comprise six species with *A. personata* forming a super-species with *A. fisheri*, A. *lilianae* and A. *nigrigenis*.

Forshaw (1973) recognised nine separate species in the genus, thus giving *A. nigrigenis* species status. This was supported by Dowsett and Dowsett-Lemaire (1980, 1993) on the basis that the whole *Agapornis* genus is homogeneous in nature, with all forms exhibiting slight differences; and to include all the white eye-ringed forms into a super-species complex may obscure the continuing evolution and inter-relationships between the constituent forms. Moreau (1948) comments that the allopatric nature, inter-fertility and minor ecological differences between the white periophthalmic forms are extraordinary to find in the middle of a continent and would rather be expected in a marine archipelago. Snow (1978), Rowan (1983) and Sibley and Monroe (1990) followed Dilger (1960). Fry *et al.* (1988) also recognised six species with *A. nigrigenis* conspecific with *A. lilianae*.

Nine separate species were considered by Juniper and Parr (1998) and del Hoyo *et al* (1997), although the latter notes that *A. personata/A. fisheri* and *A. lilianae/A. nigrigenis* are sometimes treated as conspecifics, and suggests that all four be considered to form a super-species. (However, it is stated that their treatment as a separate species would follow the general trend in taxonomy and conservation towards recognising distinctive allopatric forms (del Hoyo *et al.* 1997)).

Recent genetic analysis (Eberhard 1998) of captive lovebirds (all species except *A. swinderniana*) supported Dilger (1960), with little sequence divergence was observed between the white-eye-ringed species (0.5% *A. personata* - *A. fisheri* and A. *nigrigenis* - *A. lilianae* with the latter being a slightly closer relationship), and suggested they should be considered sub-species of *A. personata*. Cladistic analysis (Racheli 1999) using 17 external morphological characters and five ethological characters supported Dilger (1960) and Eberhard (1998) showing two different groups within the genus *Agapornis* with *A. roseicollis* as an intermediate between the two groups, although related slightly closer to the derived *A. personata* (white eye-ringed) complex.

EVOLUTION

Pioneering work by Moreau (1948) (see above) followed by further captive behavioural studies by Dilger (1960) suggested an evolutionary trend from *A. cana* as the ancestral form to *A. nigrigenis* as the most derived . The proposed order of evolution in lovebird taxa from plesiomorphic to apomorphic being from *A. cana*, A. *taranta*, A. *pullaria*, A. *swinderniana*, A. *roseicollis*, A. *fisheri*, A. *personata*, A. *lilianae* to A. *nigrigenis*. The evolutionary trend was considered uniform, involving gradual loss and acquisition of various behavioural and morphological characters (Dilger 1960). The position of *A. swinderniana* had to be determined in the absence of observational study as the species in unknown in captivity, it was considered to be a more evolved type in the primitive group, or alternatively as a link between the two groups (Racheli 1999). Recent analysis of mitochondrial DNA (mtDNA) (Eberhard 1998) and cladistic analysis (Racheli 1999) confirmed the presence of two distinct groups within the genus *Agapornis*.

FIRST DESCRIPTION AND COLLECTION OF A. NIGRIGENIS

The first *A. nigrigenis* specimen was collected by Dr A.H.B. Kirkman in September 1904, and described by W.L. Sclater in the 1906 edition of the Bulletin of the British Ornithologists Club, Vol.16: 61-62. It was the last *Agapornis* taxa to be discovered, 116 years after the first species *A. cana*, and 12 years after *A. lilianae.* The type locality was described as the Muguazi River 15 miles upstream from its confluence with the Zambezi in north-western Rhodesia (now Southern Province, Zambia). As Dowsett (1972) comments there is no river of this name in the locality, but concludes that Ngwezi (Ngweze) River was meant. In 1905 Kirkman collected a further specimen from the Majelie River, "twenty miles further on" from the Muguazi, Dowsett (1972) concluded this should be the Machili River. The labels on the original specimens at the South African Museum in Cape Town were checked by J.M. Winterbottom, Sclater's handwriting was perfectly legible (Dowsett 1972). Further investigation to try and trace Kirkman's travels were attempted by Dowsett (1972) and the author with no success.

Wild capture and trade in the species started almost immediately, *A. nigrigenis* was the first white-eye-ring species to be imported into Europe, preceded in the genus by *A. cana, A. roseicollis* and *A. pullaria*, the latter had been imported into the UK at least as early as 1806 (Butler 1911). Philips (1908) was the first aviculturalist to describe *A. nigrigenis* in captivity. He received five birds, followed by a further pair via a German bird trader, Reiche, who had obtained them via a correspondent in German East Africa (Namibia), who apparently supplied a 'considerable number'. Zoological gardens in Pretoria and London were exhibiting the species by 1909. Haagner (1909) refers to a shipment of nearly 1000 Black-cheeked Lovebirds brought from Zambia to South Africa. The birds kept by Philips (1908) almost immediately started to exhibit breeding behaviour; he was the first to observe their habit of carrying nest material in the bill. By 1911 Philips had bred three generations. In a report from the 1910 Crystal Palace show Seth-Smith (in Prestwich 1952) records that *A. nigrigenis, 'have produced their kind so freely of late that they are now common'*. The captive breeding records collated by Prestwich (1952) indicate early captive breeding success of the Black-cheeked Lovebird and considerable avicultural interest in the species.

However, by 1925, only one breeding record is known indicating that the European home-bred stock had apparently died-out. Several factors probably contributed to the decline in captive *A. nigrigenis*. During World War I, supplies of wild-caught stock ceased, correct feedstuff became unobtainable and Europe's economy was in recession (Vane 1958). In addition, during the mid-1920's, the first imports of the other white-eye-ringed appeared, shifting the avicultural novelty value away from *A. nigrigenis*.

Large numbers of Black-cheeked Lovebirds were apparently imported into Europe in June 1926 by the London dealer Chapman and continued until the 1930 Zambian ban on capture and trade in wild-caught Black-cheeked Lovebirds (Prestwich 1952, Vane 1958). In researching information for his work on the evolution of the genus *Agapornis,* Moreau corresponded (letter dated 10/12/45) with D. Gordon Lancaster, then Director of Game and Tsetse Control for the National Parks Service in Zambia, (copies of the Moreau and Lancaster originals are given in Appendix I) whose reply indicates the huge scale of the capture operations. Lancaster recalls some 16 000 Black-cheeked Lovebirds being caught in four weeks during June-July 1928/9. This constitutes the only historical record of a previously much more numerous population than is found today.

Aviculturalists were quick to breed hybrids between the white-eye-ringed species. Probably the first hybrid involving *A. nigrigenis,* was with *A. roseicollis*; two pairs were exhibited at the 1925 Crystal Palace Show and London Zoo (Prestwich 1952). In 1927 the hybrid mix was recorded as producing fertile offspring. In 1926 a record was made of hybrids between *A. nigrigenis* and *A. lilianae*, and *A. nigrigenis* and *A. personata* (Prestwich 1952). Also a consignment of wild-caught Black-cheeked Lovebirds and Lilian's Lovebirds were believed to include some wild caught hybrids between the two forms (Prestwich 1952), although the record is unconfirmed and the wild source of the hybrids is unlikely (chapter 3). Later records of hybrids include, in 1928 a cross between *A. nigrigenis* and A. *fisheri* and 1929 *A. nigrigenis x A. personata* (Prestwich 1952).

It is unknown how many Black-cheeked Lovebirds are currently kept in private collections, but the species in its pure form appears to be uncommon, except with international specialist breeders, with largest numbers likely kept within South African collections (*pers. obs.* L. Warburton).

PREVIOUS STUDIES ON WILD BLACK-CHEEKED LOVEBIRDS

Apart from a few opportunistic sightings records from members of the Zambian Ornithological Society (between 1977 and 1994), and Leppan (1944), no specific studies were conducted until Kilmer (1994). Kilmer spent 36 days in Mutwanjili and Siamakondo villages along the Ngweze River in July-August 1994, with the aim of gathering data on the lovebird's abundance, ecology and behaviour. Data were collected from interviewing local villagers and direct observations. Kilmer's study found the lovebirds foraging in harvested fields and dependent on daily access to water, which was only available through man's intervention (digging of wells in an otherwise dry river-bed). Birds were reportedly caught for local consumption, as a crop-pest and for locally held pets.

A comprehensive survey of the distribution and status of the Black-cheeked Lovebird was conducted between October-December 1994 by Tim Dodman's team (Dodman 1995[a,b,c,d], Dodman & Katenekwa 1995, Dodman *et al.* 2000), as part of the Zambia Bird Atlas and Important Bird Areas project. The survey encompassed the lovebird's entire potential range and relied on both lovebird counts at waterholes and interviewing local people. Results included a population estimate of 10,000, which appeared to be closely correlated with the occurrence of Mopane woodland and permanent standing water. No birds were found outside Zambia. The total area of Mopane woodland utilised was estimated at 4,550 km^2, although the actual range occupied by the lovebirds was estimated at 2,500 km^2. Within the species' core range a break in the Mopane vegetation was suggested to possibly divide the lovebirds into two sub-populations. The major threats to the conservation of the Black-cheeked Lovebird, which concurs with the findings of this study, was identified as a desiccation due to climate change, causing a reduction in availability of surface water during the dry winter months, particularly in southern river catchments (including the Ngweze River) (chapters 3 & 12).

Other ecological lovebird studies have focused on Fischer's Lovebird largely in relation to trade (Bhatia *et al.* 1992), status and trade (Moyer 1995), and the effect of the feral Fischer's x Masked Lovebird hybrids at Lake Naivasha (Kenya), in relation to agriculture and indigenous avifauna (Thompson 1987[a,b], Thompson & Karanja 1989).

- Bhatia *et al.* (1992) found that the Fischer's Lovebird had been subject to heavy trading in wild-caught birds with poor regulation from local Tanzanian authorities. The effects on the wild population were not known, and any claim of socio-economic benefits as a result of trade were dubious. With no indication of improved trade control or monitoring a ban on the importation of the species from Tanzania into Europe was recommended.
- A follow-up study, commissioned by The World Conservation Union (IUCN) Species Survival Commission (SSC) aimed to assess the present status of Fischer's Lovebird, to establish a methodology to do this, evaluate aspects of the trade, and elaborate recommendations for the management and conservation of the species, and was published by Moyer in 1995.
- At Lake Naivasha Thompson's study (1987 [a,b]) estimated the lovebird population size by comparing two census methods and assessed the impact on the local avifauna and agricultural productivity of the feral hybrid lovebirds.

The recently published IUCN Parrot Action Plan (Snyder *et al.* 2000) considers 28% of psittacine species to be threatened with extinction, and discusses priority conservation projects and recommendations for conservation strategies. Four projects were prioritised for Africa, and included identifying the ecological requirements of the Black-cheeked Lovebird so that a conservation strategy for its survival can be prepared (Perrin *et al.* 2000). This has been the overall aim of the study presented in this thesis.

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CHAPTER THREE

DISTRIBUTION OF THE BLACK-CHEEKED LOVEBIRD *Agapornis nigrigenis* IN ZAMBIA

"In many ways they betray their likings for particular localities. In the wild state, doubtless they keep much to that part of the forest to which they have been accustomed from their fledgeling state"

Mr. R. Phillipps, Breeding of the Black-cheeked Lovebird, The Avicultural Magazine, Vol V, 1907-1908.

ABSTRACT

The Black-cheeked Lovebird *Agapornis nigrigenis* has a highly localised distribution in south-west Zambia. Historical records pertaining to distribution both within and beyond Zambia are few, anecdotal, and often discredited, and it is suggested that the species should be considered as endemic to Zambia. A comprehensive survey in 1994 found that even within its core range the species has a clumped and localised distribution associated with Mopane woodland and permanent water sources. Two sub-populations are distinct, separated by 45 km of a mosaic of unsuitable habitat and waterless Mopane. A distribution map of Black-cheeked Lovebirds based on field observations made over twenty-two months during this study (using geographically referenced data) is presented.

INTRODUCTION

The genus *Agapornis* is confined to Africa and Madagascar and consists of a group of allopatric species. Nine species are generally recognised, however, this depends on the treatment of the white eye-ringed species, which make up the *A. personata* complex. This complex consists of four species: Fischer's Lovebird *A. fischeri*, Masked Lovebird *A. personata,* Lilian's Lovebird *A. lilianae*, and the Black-cheeked Lovebird *A. nigrigenis* (chapter 2). The non white eye-ringed species are Black-collared Lovebird *A. swinderniana*, Grey-headed Lovebird *A. cana*, Red-faced Lovebird *A. pullaria,* Black-winged Lovebird *A. taranta*. The Rosy-faced Lovebird *A. roseicollis* is considered the intermediate form. The Black-cheeked Lovebird is one of the smaller lovebirds (13 - 14 cm long; 39g (Maclean 1984, Warburton 2001 & 2002), with the most restricted distribution of all the different forms, and is considered Vulnerable under IUCN criteria (Birdlife 2000).

Although all the white eye-ringed species and *A. roseicollis* are able to hybridise and produce fertile offspring in captive and feral situations, no incidences of hybridisation are known in free-ranging birds. There are few areas of sympatry between the nine forms which include the following: *A. swinderniana* and *A. pullaria* occur in the western part of the Congo forest block. *A. swinderniana* is a forest specialist with A. *pullaria* penetrating the forest habitat by accessing clearings and it appears to be extending its range following the path of forest clearance (Chapin 1939, Moreau 1948, Snow 1978). *A. personata* and *A. fischeri* overlap in parts of their Tanzanian range, although there is no evidence of gene flow between the populations (Turner 1991, Gerhart 1977, Baker & Baker 2001). Reports of *A. lilianae* encroaching on the range of the *A. nigrigenis* in the south of Kafue National Park (ZOS 1980, 1981, 1982) are disputed as misidentifications (*pers. obs.*). There is no historical evidence of any overlap in their range (Lancaster 1946 in Moreau 1948 & Appendix I), and distribution ranges of both species are separated by at least 160 km of Miombo woodland and the gorges of the Zambezi River below Victoria Falls (Benson *et al.* 1967, Dodman 1995, Dodman *et al.* 2000), although some authors believe that the ranges may have overlapped in the past (Dowsett & Dowsett-Lemaire 1980).

As part of a base-line ecological study of the Black-cheeked Lovebird the historical data pertaining to its distribution was reviewed. Following on from the intensive survey efforts of Dodman (1995), this study did not attempt to further define or map the distribution of the Black-cheeked Lovebird. Fieldwork over 22 months in south-west Zambia enabled the construction of a distribution map of Black-cheeked Lovebirds observed during this study, using geographically referenced data points The specific purpose of this map is to illustrate that lovebirds were sought and their behaviours observed from across the species' range. In general, lovebirds were sought for the purposes of observation, rather than range information, exceptions were surveys made in the Caprivi Strip area of north-eastern Namibia and in the area of disjunction between the two sub-populations in south-west Zambia, following the recommendations of Dodman's report (1995), to determine whether the lovebirds extended their range seasonally (Dodman, 1995, Dodman *et al.* 2000).

A previous comprehensive survey of the distribution and status of the Black-cheeked Lovebird were conducted between October-December 1994 (Dodman 1995[a,b], Dodman & Katenekwa 1995, Dodman *et al.* 2000), and as part of the Zambia Bird Atlas (Aspinwall *et al. in prep.*) and for the Important Bird Areas project (Leonard 2001). The survey encompassed the lovebird's entire potential range and relied on lovebird counts at waterholes and interviewing local people. Results included a population estimate of 10 000 individuals, based on counts at water sources and extrapolations per river catchment, which appeared to be closely correlated with the occurrence of Mopane woodland and permanent standing water (Dodman 1995[a,b], Dodman & Katenekwa 1995, Dodman *et al.* 2000). The total area of Mopane utilised was estimated at 4 550 km^2, with a core range occupied by Black-cheeked Lovebirds of 2 500 km^2, which was hypothesised to extend during the 'crop-ripening or non-breeding' season. Overall, the lovebird population density was estimated at 2.2 birds/km^2 in the core range, although this is considered a less useful parameter than population estimates per river catchment because of the birds clumped distribution around permanent water sources. A breakdown of lovebird population estimates per catchment area are given in Dodman (1995 & Dodman *et al.* 2000). Within the species' core range a break in the Mopane vegetation was suspected to divide the lovebirds into two (apparently) distinct sub-populations with the northern population, about 40% of the total population, focussed around the Nanzhila River, and the southern birds, and about 60%, focussed largely around the Sichifulo, Machile and Ngweze Rivers. No birds were found outside Zambia during surveys in the Caprivi Strip and Impalila Island. Prior to Dodman's work only one other specific study had been conducted on the lovebirds (Kilmer 1994) who spent 36 days in two villages along the Ngweze River in July-August 1994, with the aim of gathering data on the lovebird's abundance, ecology and behaviour.

METHODS AND MATERIALS

Study site

Zambia is a landlocked country in southern-central Africa, lying between 8° - 19°S and 22° - 34°E, with an approximate area of 750 000 km². Black-cheeked Lovebirds inhabit the driest region of Zambia, a vast plain area, altitude 914 - 1 341 m, intersected by the floodplains and tributaries of the Zambezi and Kafue Rivers within the Southern and Western Provinces. Black-cheeked Lovebirds exist in two distinct but adjacent geographical ranges between 15° - 17°S and 24° - 26°E (Dodman 1995, Dodman *et al.* 2000). The Lovebird's range is marked by two distinct seasons. A rainy season, usually from November to March, with a mean annual rainfall of 600 mm (NPWS/JICA 1999), and a long dry season from April to November, with April being a transition month. The coldest month, July, has a mean maximum temperature range of 22 - 28°C, and mean minimum of 5 - 7°C; while October is the hottest month, with a mean maximum of 31 - 35°C, and mean minimum 15 -18°C (NPWS/JICA 1999). The lovebird's range suffers serious water shortages from June to December as all rivers in the region, with the exception of the Zambezi and Kafue Rivers, are emphemeral. The only other naturally occurring water source are scattered shallow pools, few of which last throughout the dry season. The distribution of surface water is irregular, and scarce, with their distribution and quality depending primarily on the previous rainy season. The dominant vegetation within the range of the Black-cheeked Lovebird is Mopane *Colophospermum mopane* woodland.

Methods

A 1994 species survey (Dodman 1995, Dodman *et al.* 2000), museum skin collections, anecdotal records, and sightings were used to interpret the present and historical distribution of the Black-cheeked Lovebird. Lovebird activities were studied over 22 months (May to December 1998; March to December 1999; February to May 2000) of intensive fieldwork using Swift 8x42 binoculars and a Kowa 10x telescope. Locations were recorded using a Garmin 12XL GPS (Appendix II). Observations were generally not standardised using transects or observation points owing to the clumped and localised distributions of the parrots. However, line transects though Mopane woodland and sorghum fields (likely lovebird habitats) were used in the eastern Caprivi where location of likely lovebird-usable water sources was unknown. Whenever lovebirds were encountered geographical position was recorded, together with details on habitat, time of day, lovebird activity and flock size.

In the field, data collection followed two main methods, after Dodman (1995) and Dodman *et al.* (2000). Black-cheeked Lovebirds were searched for in the area of south-west Zambia shown in figure 1. Interviews with local people were also conducted, via an interpreter, usually in siLozi or chiTonga languages. Parrot skins (from the National Museum, Livingstone, Zambia) of all three parrot species (Grey-headed Parrot *Poicephalus fuscicollis suahelius*, Meyer's Parrot *P. meyeri*, and Black-cheeked Lovebird) found in the locality and field guides were shown during these interviews. Regional bird guides and older long-term residents in Livingstone were also interviewed.

Following the identification of a disjunction in the Black-cheeked Lovebird's distribution into a northern and southern sub-population (Dodman 1995, Dodman *et al.* 2000), three trips were made to search the 'gap' area for lovebirds. Trips were timed to coincide with the beginning and end of the rainy seasons (while the area was still accessible to vehicles) and the height of the dry season (April, August and November 1999). Areas examined in particular were water sources close to and in areas of Mopane woodland. Potential prime lovebird locations were investigated by watching water pools (in the early morning and late afternoon to coincide with expected lovebird drinking times).

For map production, in the absence of other data, minor rivers were digitised from a 1:750 000 map (Surveyor General 1991) in ArcGIS and distribution of Mopane from 1:500 000 maps (Edmonds 1976). GPS points (n = 239) were downloaded and converted to shapefiles using the add x,y function. Game Management Areas (GMAs) and National Park data sets were obtained from USAID.

Skins of 49 specimens were examined from five museums (National Museum, Livingstone Zambia; Transvaal Museum, Pretoria & Durban Museum of Natural History, S.Africa; Bulawayo Museum of Natural History, Zimbabwe & the Zoological Museum, Tring, UK), for location details, (label information is recorded in Appendix III). Livingstone Museum had the most skins (n = 22) although most were water damaged.

Difficulties

Much of the lovebird's range is undeveloped, roadless, and almost totally inaccessible by vehicle during the rainy season. In addition widespread illegal poaching of wildlife in the GMAs and within the southern section of Kafue National Park made some areas inadvisable to traverse. In particular it was regretted that the areas of Mopane woodland west of the Nanzhila River could not be explored for lovebird activity. Discussions with Zambian Wildlife Authority Scouts, who occasionally traversed the area on anti-poaching patrols failed to confirm or refute the presence of lovebirds (or permanent water sources). In addition, previous surveys (Kilmer 1994, Dodman 1995) did not use a GPS, which made return to specific sites difficult.

RESULTS AND DISCUSSION

Current distribution

The expanse of the study site is highlighted in figure 1, which details the location of the major rivers mentioned in the study, the southern section of Kafue National Park, surrounding GMAs and the southern national boundary. The geographical position of Black-cheeked Lovebirds recorded in the study was plotted together with the distribution of Mopane woodland and major rivers (figure 2). It was not possible to plot the distribution of water sources since these vary annually depending on the extent of the rains the previous season, although most sources were located in isolated pools along river courses. The positions of lovebirds plotted (figure 2) do not represent discrete sub-populations and in some cases likely represent feeding, drinking and roosting sites for the same sub-populations of lovebirds. The most northern, southern, eastern and western limits of the Black-cheeked Lovebirds range were found at: S 16° 6' 50.8 E 25° 58' 28.7, S 17° 22' 84.2 E 25° 5' 99.7, S16° 33.808 E 26° 0'.859, S 17° 11' 5.5 E 25° 4' 22.9 respectively. Distance from the most northerly to southerly birds was ~ 192.4 km and from westerly to easterly limits ~ 151.3 km. GPS waypoints for all lovebird geographical positions are recorded in Appendix II.

Overall, the distribution of Black-cheeked Lovebirds appears to be closely allied with Mopane woodland and permanent water sources (Dodman 1995, Dodman *et al.* 2000, this study). In figure 2, the lovebirds appear to be more widely distributed in areas where there is agricultural cropping (in the southern part of their range, Chapter 5) suggesting that their numbers may be sustained by access to agricultural land – however, this is not considered probable, and the apparently wider distribution in this region is more likely to be a function of greater dry season water resources in the area (mostly man-made), as well as being a region of easier access to the researcher and hence the greater number of recorded lovebird positions.The Mopane within the Black-cheeked Lovebird's range is associated with deposits left behind by an ancient lake, which was drained by the downfaulting of the Zambezi trough (Bingham 1994) and forms a relatively isolated stand. This explains the localised nature of the lovebirds' range, but does not explain the clumped nature of their distribution within this range. In the northern part of the species range, there appears to be some anomalies between the distribution of Mopane woodland and the distribution of the parrots. This may be explained by several factors including, inaccuracies of the vegetation map used (1:500 000, Edmonds 1976), limitations on the observer's access into the Mopane woodlands in the area (due to poacher and dangerous game species with access largely being limited to being on foot), and the concentration of sightings in the Mopane areas close to the Nanzhila river, particularly in the Kalenje region which, given the scale of the map presented in figure 2, obliterates the illustrated area of Mopane woodland.

Black-cheeked Lovebirds were found in clumped distributions, throughout the year, even within areas of fairly uniform habitat that contained both Mopane woodland and permanent water sources. This pattern of a low-density clumped distribution, or 'locally common', even within preferred habitat types appears typical of other white-eye ringed lovebird species (Fischer's Lovebird (Britton 1980, Moyer 1995); Lilian's Lovebird (Winterbottom 1938, Smith 1950); and Masked Lovebird (Turner 1991)). The reasons for this localised clumping remain uncertain, but is hypothesised to be related to the lovebird's intrinsic gregariousness and habits of semi-colonial roosting and nesting, in addition to the lovebird's cohesive flocking habits, and traditional use of foraging and drinking sites (chapters 4, 6, 9, 11). Food, nest and roosting sites do not appear to be in limited supply (chapters 4, 6, 9). Water is the most likely limiting resource in determining lovebird distribution within areas of suitable habitat, although the availability of accessible water does not necessarily guarantee the bird's presence even with prime habitat type (Dodman 1995, chapter 10).

Habitat requirements

Paradoxically, Black-cheeked Lovebirds have been described as being both 'ecologically non-specialised' (Moreau 1948) and 'ecologically very sensitive' (Benson *et al.* 1971), with 'curiously restricted' ranges (Moreau 1948). The range limits of all the other white eye-ringed lovebird species seem to correlate with the distribution of suitable habitat with Miombo woodland (dominated by *Brachystegia-Isoberlinia*), which appears incompatible with lovebird habitation (Moreau 1948). In this study Black-cheeked Lovebirds were only occasionally found on the margins of Miombo and *Baikiaea* woodland. The findings of this study are in agreement with Benson & Irwin (1967) and Dodman (1995), and contrary to Winterbottom (in Moreau 1948). The Black-cheeked Lovebird's prime habitat type is Mopane woodland rather than *Baikaea*-Mopane woodland ecotone.

Are the two sub-populations distinct?

The disjunction between the two sub-populations at its widest was 44.86 km, between the most northerly of the southern sub-population and most southerly of the northern sub-population. The distance between the areas of highest lovebird densities of both sub-populations (i.e. mid-Machile River and Mabiya Pools region) are separated by ~133 kms. The most obvious explanation for the gap in the distribution is lack of surface water in areas of suitable habitat (i.e. Mopane woodland) in the region, as scattered areas of Mopane woodland could be found throughout most of the 'gap' area but with little surface water in the proximity.

The sub-populations are likely to be distinct, on the basis that the surveys were done during the early dry season (April), height of the dry season (August) and the early rainy season (November), following the hypothesis that lovebirds may expand their range during the non-breeding/crop ripening season (Dodman 1995, Dodman *et al.* 2000). In fact, contrary to this idea, mixing between the two sub-populations is unlikely to occur during the crop-ripening (rainy) season as this coincides with the lovebird's breeding season when local wandering is at a minimum (chapter 7). Also, four uniquely coloured lovebirds in the mid-Machile River region (one yellow and three light green birds) were observed in the same foraging areas and drinking sites from May 1999 to May 2000, indicating that individual lovebird flocks were spatially and temporally stable.

Figure 1. Study site showing the major rivers mentioned in the study, southern section of Kafue National Park, surrounding Game Management Areas (GMAs) and the southern national boundary.

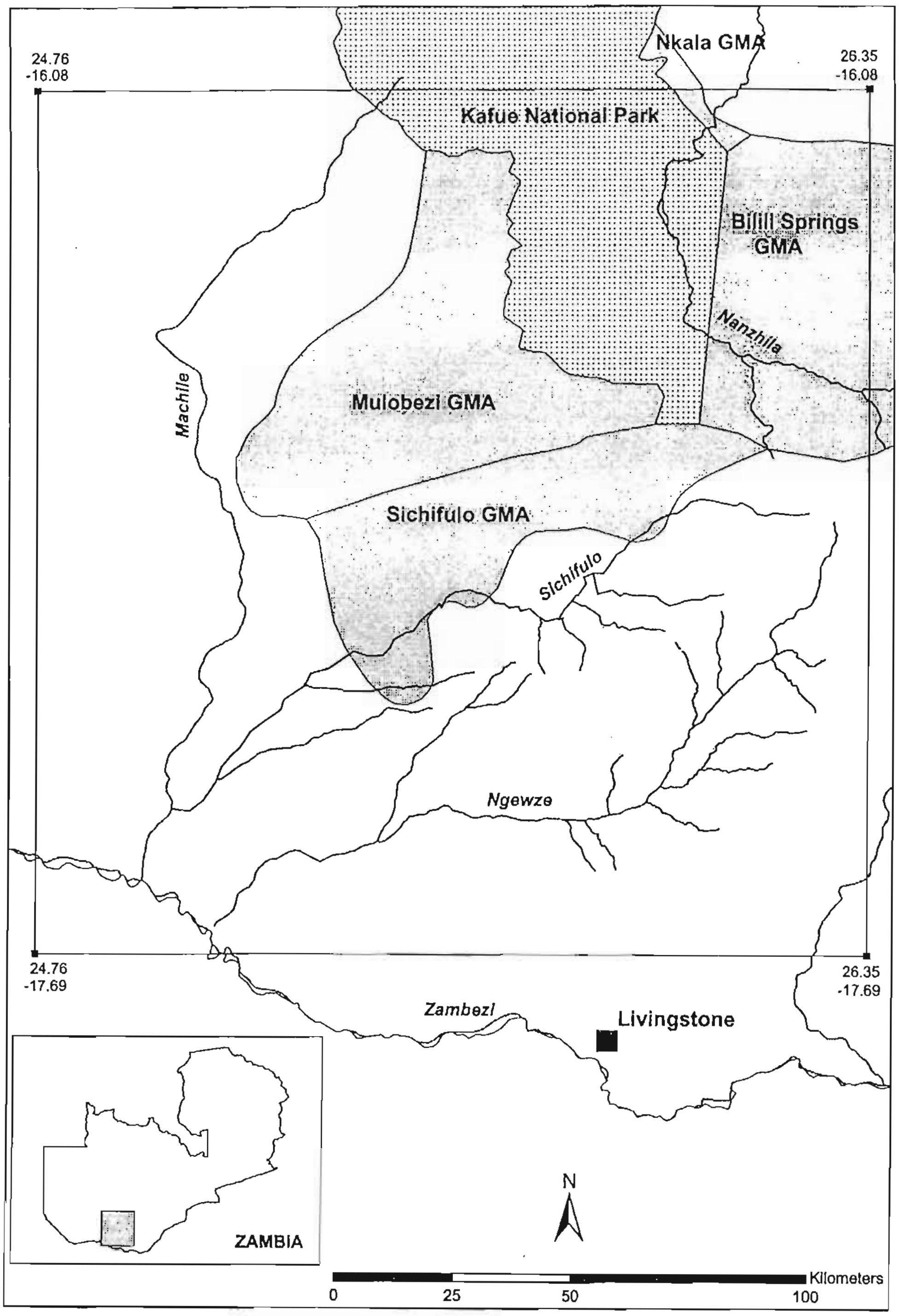
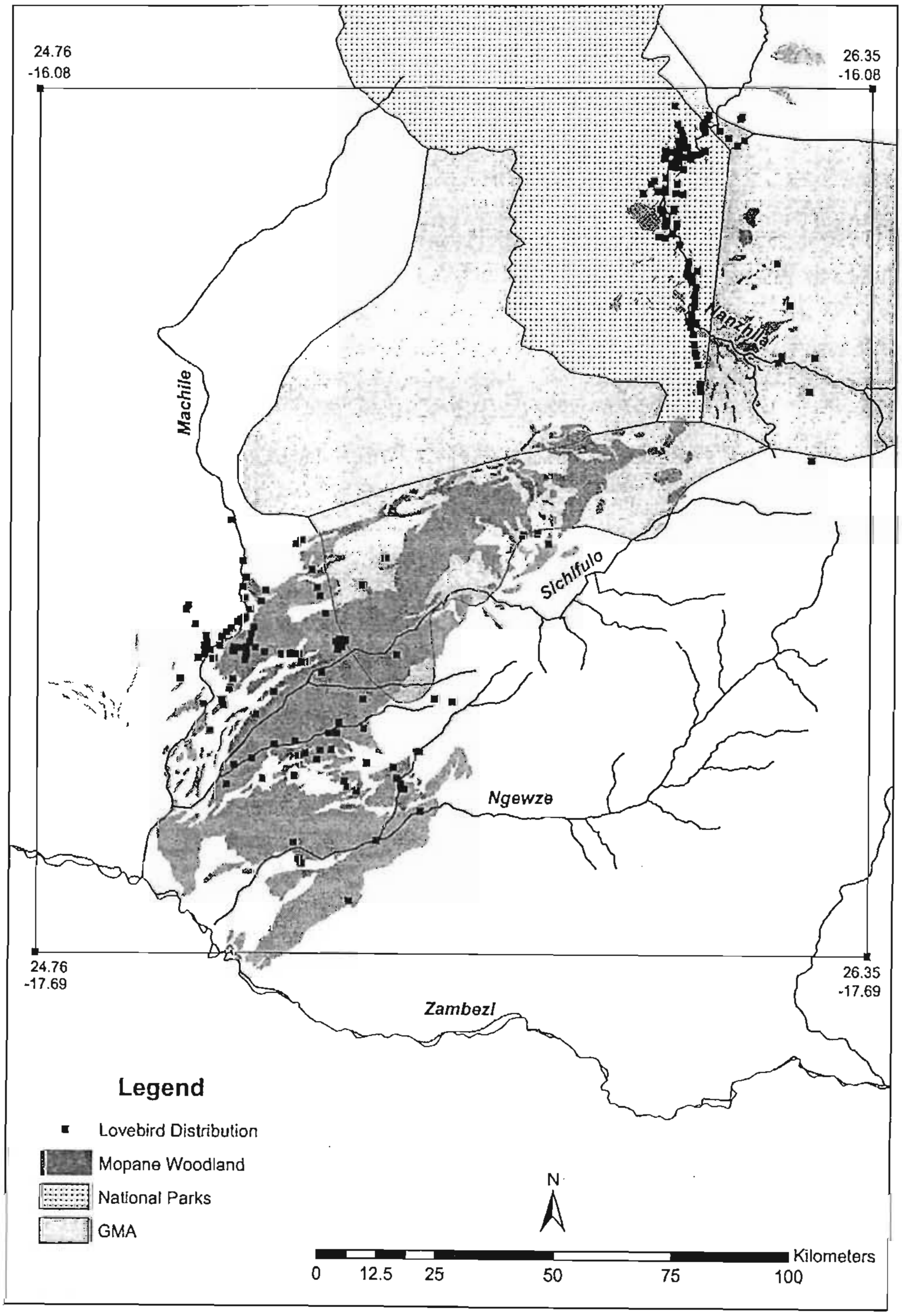


Figure 2. Study site showing the geographic position of Black-cheeked Lovebirds recorded during the study together with the distribution of Mopane woodlands and the major rivers.



Historical records of the distribution of the Black-cheeked Lovebird

The first *A. nigrigenis* specimen was collected by Dr A.H.B. Kirkman in September 1904, and described by W.L. Sclater (1906). The type locality was described as the Muguazi River fifteen miles upstream from its confluence with the Zambezi in north-west Rhodesia (now Southern Province, Zambia). However, as Dowsett (1972, 1980) comments there is no river of this name in the locality, he therefore concludes that the Ngwezi River was meant. Skead (1973) quotes the type locality as Kasungula at the junction of the Ngwezi-Zambezi Rivers, and gives co-ordinates of 17° 40'S, 25° 05'E. However, the Ngweze River is some 25km north of Kasungula: corrected co-ordinates for the type locality are given as 17° 30'S, 25° 10E, and not at the junction of the river, about 25km up the Ngweze (Dowsett 1980). In 1905, Kirkman collected a further specimen from the Majelie River, "twenty miles further on" from the Muguazi, Dowsett (1972) concludes this should be the Machili(e) River, the findings of this study confirm this.

The Black-cheeked Lovebird was described as being common in Mopane woodland along parts of the Ngwezi(e) River, with the overall range of the species extending from Livingstone west to the Machile River and north to the southern end of Kafue National Park (Dowsett 1972), with the total range extending 100 by 200 kilometres (Clancey 1985). This study has shown that this is an underestimate of around 98 by 49 kilometres, i.e. a total range of 200 x 250 km.

Is the Black-cheeked Lovebird a Zambian endemic?

Caprivi Strip, Namibia

The presence of the Black-cheeked Lovebird in the southern African bird list (i.e. south of the Zambezi River) is generally attributed to the observations made by Leppan (1944). He described 'plentiful' flocks around water sources in the eastern Caprivi (Namibia), although the credibility of his record was questioned by Benson & Irwin (1967). Two of the Black-cheeked Lovebird specimens in the Transvaal Museum, Pretoria were recorded as having been collected in German South-West Africa (Namibia) by C. Wilde, in August 1906. Haagner, an assistant in the Museum in 1909 records that the Museum collection held three specimens collected from the area between the Chobi (sic) and Zambezi Rivers (i.e. Impalila Island, Namibia) whilst the rest were collected from 'Barotse Country' (Western Province, Zambia). Records of eggs collected from Sesheke and Victoria Falls in 1918 by F.E.O. Mord for J.C. Carlisle's breeding register (Brooke 1967) were rejected as unreliable by James (1970). Koen's descriptions (1988) of lovebirds in the eastern Caprivi are attributed to being of Rosy-faced Lovebirds (Dodman *et al.* 2000) although at least one of Zambia's respected birders (the late Dylan Aspinwall *pers. comm.* 1995) believed that Koen's comments may be ascribed to the Black-cheeked Lovebird. During 1994 Dodman conducted 31 interviews with local people in the eastern Caprivi Strip, Namibia and eight in Victoria Falls, Zimbabwe (Dodman 1995). There were no confirmed observations of Black-cheeked Lovebirds although 'lovebirds' at genus level were recognised, reportedly coming to feed on crops in the early morning and late afternoon.

During the present study the eastern Caprivi was visited by the author for one week in April 1999. Eight local people were interviewed and five 2 km line transects following a compass bearing were walked through Mopane woodland bordering fields (with ripening maize and sorghum crops). No lovebirds were seen, although the habitat looked suitable, and in interviews lovebirds were recognised by some to genus level, with three interviewees identifying Rosy-faced Lovebirds as the species they had observed. One local birder (and aviculturist) Christo Kruger reported to have observed Black-cheeked Lovebirds on Impalila Island during August and September 1998, and Lisikili Island in July 1998, although these observations are rejected by the resident bird guides (since 1994) at Impalila Lodge (*pers. comm.* Lawson 2002). Kruger also reported observations of Rosy-faced Lovebirds at Bakalo (near Katima Mulilo) during the late winter months. In 1998 an experienced Windhoek birder recorded a single Black-cheeked Lovebird near Katima Mulilo feeding in an area that contained piles of harvested sorghum (Kaestner 1988, *pers. comm.* 2001). In view of the rather conspicuous nature (in terms of regular daily habits and frequent calling) of lovebirds in their natural habitat it seems unlikely that a resident population of Black-cheeked Lovebirds has been overlooked in the eastern Caprivi Strip or Impalila Island in Namibia, particularly given that the region has become an increasingly popular birding destination with resident ornithological guides (Maclean 1992, Hines 1996). The sighting of the single bird (Kaestner 1988) is believed by the author to likely have been an ex-captive escapee. This study found several collections of captive parrots in and around Katima Mulilo. The escapee theory might also explain the sightings of Rosy-faced Lovebirds in the region, which is outside the species' natural range (Simmons 1997).

Victoria Falls, Zimbabwe

Various accounts refer to Black-cheeked Lovebirds being found in the vicinity of Victoria Falls and Livingstone. Winterbottom (1952) describes the species as being rare at the Falls themselves, irregularly common in Livingstone and locally very common 100 miles downstream (east) the Zambezi. Jensen (1966) records observing the species south of the Zambezi at the Victoria Falls (Zimbabwe).

As part of this study, interviews with local bird guides (Bob Stjernstedt (Livingstone), Chris Pollard (Victoria Falls), Richard Randall (Kasane), Simon Parker and Bruce Lawson (Impalila Island)) revealed no Black-cheeked Lovebird sightings. Three older Livingstone residents (Murray Evans, Rob Hart, Aaron Muchindu) were also interviewed and could recall a few 'lovebirds' flying around Livingstone Town in the 1930's until about the 1960's, an aviary of birds in the municipal gardens and various 'Europeans' with captive lovebirds at their homes around town. Mitchell (in Benson & Irwin 1967) also recalls occasional sightings of Black-cheeked Lovebirds around Livingstone, and comments on the possibility of their being captive-escapees. Virtually all wild-caught birds would have been transported out of the bird's habitat on the Mulobezi Sawmills railway track via Livingstone and Victoria Falls town, giving rise to situations where birds may have escaped during transport as well as the opportunity for local purchasing. Given the current absence of lovebirds in the vicinity of Livingstone and Victoria Falls, the distance (~ 60 kms) from these areas to todays naturally occurring populations and the paucity of historical records, it seems likely that Black-cheeked Lovebirds did not naturally occur here and birds observed were escapees from a captive situation.

Feral lovebirds in the range of the Black-cheeked Lovebird

Both feral and daily-released-from-an-aviary lovebirds confuse the distribution of the Black-cheeked Lovebird (Dodman 1995). At least one Black-cheeked Lovebird was identified (*pers. obs.* L. Warburton) in a mixed flock of Rosy-faced Lovebirds and Lilian's Lovebirds (plus some hybrid-types) in the Gibson Road area of Victoria Falls town, Zimbabwe and a second flock consisting of Rosy-faced Lovebirds was commonly encountered in the industrial estate and behind the main post-office during the course of this study. Some of these birds were observed returning to aviaries at night. Other lovebirds, of mixed species, but including some Black-cheeked Lovebirds, are also known to have been released from aviaries on a farm 25 km east of Livingstone, which likely explains the intermittent sightings of single or small flocks of lovebirds flying across the Zambezi at Tongabezi and Kubu Cabins (*pers. comm.* R. Stjernstedt 1998). In 1967, seven Black-cheeked Lovebirds were released in Choma (Southern Province, Zambia) and survived at least nine months (Duval 1969), although none are found there today (*pers. comm.* P. Leonard 1998). Six Livingstone Museum skins collected in 1963 by Col. E.A. Zaloumis, are labelled as originating from Choma, which likely indicates previous escapees or released birds (Appendix III). In 1959, 14 escaped from an aviary at Sinazongwe in the Middle Zambezi Valley (Duval 1969) although apparently do not survive today (Dodman 1995). Two specimens at Bulawayo Museum of Natural History originated from the Mazabuka area (Southern Province, Zambia), indicating a past presence of escapees, and presumably on the basis of the specimen labelling, this area was included as part of the species' natural range in the national bird checklist (Benson & White 1957). Feral Lilian's Lovebird have also been recorded in Choma (White & Winterbottom 1949) and at Lundazi (Eastern Province, Zambia) where they formed a breeding colony (Benson & White 1957). Black-cheeked Lovebirds were recorded within the natural range of Rosy-faced Lovebirds in Okaukuejo, Etosha National Park in Namibia (de Vries 1998) but are apparently part of a mixed flock of daily released birds from an aviary (Osbourne 1999).

CONCLUSION

The status of the Black-cheeked Lovebird outside Zambia is historically confusing and remains unconfirmed. Current distribution of the species is closely allied to the areas with permanent water sources along the Nanzhila, Machile and Sichifulo Rivers close to or adjoining Mopane woodland. The lovebirds are found in locally common clumped distributions. Data presented here suggest that the Black-cheeked Lovebird should be listed as a Zambian endemic, based on the fact that no lovebird flocks have been sighted despite presence of full-time professional birders in the eastern Caprivi and the popularity of the area as a regional bird-watching destination, especially given the relative conspicuousness of the species. No lovebirds were found outside the squares (30' x 30', with boundaries at 00' and 30') previously identified in the Zambian Bird Atlas project (1624:D; 1625:B,C,D; 1626:A,C; 1725: A,B,C) (Aspinwall *in prep.*). However, unrecorded lovebird populations were found further west along the Nanzhila River, east from the Machile River and north between the Ngweze and Sichifulo Rivers (along the Lunungu tributary), unfortunately precise comparison is difficult given the lack of GPS data from the 1994 survey. It is likely that the range of the Black-cheeked Lovebird appears to be further decreasing as a result of diminishing surface water in the dry season. In a follow-up to Kilmer (1994) project, the present study failed to locate any lovebirds in Mutwanjili (S 17° 25'.50 E 25° 30' 41.2), one of the village areas used by Kilmer in 1994 along the Ngweze River. Interviews with local villagers confirmed the lovebird's absence, which is likely caused by reduction in surface water, as a result of increased well depth and translocation of cattle watering sites (chapter 2).

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CHAPTER FOUR

FORAGING BEHAVIOUR AND ECOLOGY OF THE BLACK-CHEEKED LOVEBIRD *Agapornis nigrigenis* IN ZAMBIA

ABSTRACT

Foraging behaviour and ecology of the Black-cheeked Lovebird *Agapornis nigrigenis* was studied in Zambia from May 1998 to April 2000. The birds were observed feeding on at least 39 species. Food items eaten included seeds, leaves, flowers (especially nectar), fruit pulp, invertebrates, bark, lichen and resin, and ingesting soil. Various foraging techniques were observed. Terrestrial foraging was dominant, with little temporal or spatial variability. Arboreal foraging in plants varied seasonally and in relation to availability. Feeding preferences were not specialised and there was no dependence on a limited food resource. Although birds fed throughout the day, Black-cheeked Lovebird foraging activity peaked in early morning and late afternoon. Foraging flocks normally comprised solely Black-cheeked Lovebirds, but 40 different bird species were on occasion recorded at different times feeding with the lovebirds. Flocks favoured certain locations to forage, but their clumped distribution within a highly localised range, does not appear to be correlated with food source. Implications of feeding ecology for conservation management are discussed.

INTRODUCTION

Although the Black-cheeked Lovebird *Agapornis nigrigenis* has the most restricted distribution of any African psittacine species, and is one of the species most seriously threatened with extinction, its ecology is poorly understood. The Black-cheeked Lovebird is a small parrot (13 - 14 cm long; 38.85 g): (Maclean 1988, Warburton 2001, 2002) occupying a core range of 2,500km^2 in south-west Zambia (Dodman 1995, Dodman *et al.* 2000). It is primarily found in Mopane *Colophospermum mopane* woodland, but moves into adjoining habitats, such as riverine vegetation and agricultural areas, to forage and drink.

Despite a recent spate of studies of foraging and diet of African parrots, including the Cape Parrot (Wirminghaus *et al.* 2001), Rüppell's Parrot (Selman *et al.* 2000), Brown-headed Parrot (Taylor & Perrin *in press*), Grey-headed Parrot (Fynn 1991, Symes & Perrin *in press*) and African Grey Parrot (Chapman *et al.* 1993) few feeding data exist for the species of the genus *Agapornis* (table 1). Prior observations and interview information suggest that the Black-cheeked Lovebird's diet consists of grass and *Acacia* spp. seeds, supplemented with a variety of fruits, leaves and flowers (Benson & Irwin 1967, Kilmer 1994, Dodman 1995).

Table 1. Plant species eaten by other lovebird (*Agapornis)* species, including feral hybrids.

Species	family name	Part eaten	Species of Lovebird	Reference
Tree				
Ficus bussei	Moraceae	P	*A.lilianae*	Maasdorp 1995
Ficus sur (capensis)	Moraceae	P	*A. fisheri*	Moyer 1995
Ficus sycomomorus	Moraceae	P	*A.taranta*	Forshaw 1989
Ficus spp.	Moraceae	P	*A.cana*	Cunningham-van Someran 1948
Ficus spp.	Moraceae	P	*A. swindernianus*	Del Hoyo 1997
Commiphora spp.	Bureraceae	P	*A.fisheri*	Moyer 1995
Rhus villosa	Anacardiaceae	P	*A.fisheri*	Moreau 1945
Tridax procumbens	Asteraceaea	S	*A. fisheri*	Moreau 1945
Tridax procumbens	Asteraceaea	S	*A.fisheri*	Moreau 1945
*Acacia seyal**	Mimosaceae	S + L	*A.fisheri*	Moyer 1995
*Acacia drepanolobium**	Mimosaceae	S	*A.fisheri*	Moyer 1995
Acacia spp.	Mimosaceae	S	*A.roseicollis*	Juniper & Parr 1998
*Faidherbia albida***	Mimosaceae	F	*A.lilianae*	Benson *et al.*1971
Albizia spp.	Mimosaceae	S + F	*A. roseicollis*	Juniper & Parr 1998
Cassia siamea	Fabaceae	S	*A.fisheri + A. personata*	Moreau 1945
Cassia spp.	Fabaceae	S	*A.personata****	Del Hoyo *et al.* 1997
Euphorbia spp.	Euphorbiaceae	L	*A. roseicollis*	Juniper & Parr 1998
Euphorbia ingens	Euphorbiaceae	F	*A.roseicollis*	Ian Davidson (pers.obs.)
Macaranga spp.	Euphorbiaceae	P	*A.swindernianus*	Fry *et al.* 1988
*Syzgium cordatum***	Myrtaceae	Fb	*A.lilianae*	Button 1953
*Erythrophloeum africana***	Caesalpiniaceae	F	*A.lilianae*	Benson *et al.* 1970
Vitex duamiana	Verbenaceae	F	*A.lilianae*	Benson *et al.* 1970
Cordyla africana	Caesalpiniaceae	F	*A.lilianae*	Benson *et al.* 1970 & Warburton pers. obs. 1999
Juniperus spp.	Juniperus	P	*A.taranta*	Forshaw 1989
Psidium spp.	Myrtaceae	P	*A.pullarius + A.cana*	Juniper & Parr 1998 , Chapin 1939
Rauvolfia	Apocynaceae	P	*A.swindernianus*	Fry *et al.* 1988
Spathodea	Bignoniaceae	P	*A.swindernianus*	Fry *et al.* 1988
Creeper				
Combretum paniculatum	Combretaceae	F	*A.lilianae*	Warburton pers.obs. 1999
Grass				
*Digitaria macroblephara**	Poaceae	S	*A.fisheri*	Moyer 1995
Penisetum mezianum	Poaceae	S	*A. fisheri*	Juniper & Parr 1998
Panicum maximum	Poaceae	S	*A.cana****	Juniper & Parr 1998
Stenotaphrum micranthum	Poaceae	Ls	*A.cana****	Del Hoyo *et al.* 1997
*Oryza perennis**	Poaceae	S	*A.lilianae*	Fothergill 1984

Part eaten: F=flower; Fb=flower bud; P=fruit pulp; L=leaves; Ls=leaf stem; Lb=leaf bud; Li=lichen; S=seed; Sud=undeveloped seed; T=twig; R=resin; I=invertebrate.
=likely, but not positive observation; **=same species foraged by A. nigrigenis; *=feral lovebird population.*
References for plant identification: Arnold & de Wet (1993).

Previous studies of African parrot species suggest a dietary diversity, with some species specialising on one or a few food types, usually confined to a single habitat type (Wirminghaus *et al.* 2001), whilst others forage on a range of food types changing with seasonal availability (Selman *et al.* 2000, Symes & Perrin *in press*, Taylor & Perrin *in press*) encompassing a variety of habitat types. Many parrot species consume seeds, probably because of their great energy content (Gilardi 1987), few forage at ground level.

The aim of this study was to determine the foraging habits of the Black-cheeked Lovebird in the species' natural range throughout the year. The foraging behaviours and foods eaten by the parrots were documented over a 22 month observation period. It was necessary to determine whether the diet of the Black-cheeked Lovebird was confined to the species' range and whether food resources were limiting in supply. It was hypothesised that the species' highly localised range could be explained by the Black-cheeked Lovebird's dietary requirements. The staple diet was expected to be primarily granivorous, in addition to seeds of *Acacia* spp. as this is what has been observed for other lovebird species (table 1). It was also predicted, based on interview information with local farmers (Dodman 1995, Dodman *et al.* 2000), that lovebirds would show extended foraging movements during the agricultural crop-ripening season. Foraging in agricultural crops is detailed in chapter 5.

METHODS AND MATERIALS

Study site

Zambia is a landlocked country in southern-central Africa. Black-cheeked Lovebirds inhabit the driest region of Zambia, a vast plain, altitude 914 - 1 341 m, intersected by the floodplains and tributaries of the Zambezi and Kafue Rivers within the Southern and Western Provinces. The lovebird's range is marked by two distinct seasons; a rainy season, usually from November to March, with a mean annual rainfall of 600 mm (NPWS/JICA 1999), and a long dry season from April to November, with April being a transition month. July, the coldest month, has a mean maximum temperature range of 22 - 28°C, and mean minimum of 5 - 7°C; while October is the hottest month, with a mean maximum of 31 - 35°C, and mean minimum 15 - 18°C (NPWS/JICA 1999). Black-cheeked Lovebirds exist in two distinct but adjacent geographical ranges between 15° - 17°S and 24° - 26°E (Dodman 1995, Dodman *et al.* 2000). The northern population occurs along the Nanzhila River, largely confined to Kafue National Park and surrounding Game Management Areas. The southern population is centred around the Machile and Sichifulo Rivers, with the Simatanga River to the north and Ngweze River in the south forming the limits of the species' range. The lovebird's range is exposed to serious water shortages from June to December as are all rivers in the region, with the exception of the Zambezi and Kafue Rivers, which are ephemeral. The dominant vegetation within the Black-cheeked Lovebird range is Mopane *C. mopane* woodland. Data were collected from across the lovebird's range.

Methods

Black-cheeked Lovebird feeding activity was studied during 22 months (May to December 1998; March to December 1999; February to May 2000) of intensive fieldwork in south-west Zambia using Swift 8x42 binoculars and a Kowa 10x telescope. Locations were recorded using a Garmin 12XL GPS.

Feeding observations were not standardised using transects or observation points as this would have resulted in very few data points owing to the clumped and localised distribution of the parrots. Instead birds were followed as they moved through the habitat to feeding areas. No attempt was made to quantify the seed supply of grasses. Grasses were identified from plant specimens or from seed collected from foraging sites.

A comprehensive dataset of the diet of the Black-cheeked Lovebird was constructed based on observations of foraging behaviour. Lovebirds were sought mainly on foot and generally located by their vocalisations. Once located birds were observed until lost from sight. Foraging birds could usually be approached to within 15 m without disturbance. Whenever foraging lovebirds were encountered the following data were recorded: the plant species foraged, part of the plant consumed, feeding bout duration, flock size, presence of other species (within 5 m of the lovebirds), foraging technique, time of day, location and habitat type. Birds in foraging flocks were not all assumed to be feeding unless observed to be doing so. Birds were recorded as feeding arboreally when positioned in trees or off the ground on shrubs and woody vegetation.

All behaviours were timed to the nearest minute. A single feeding bout was timed from the commencement of feeding to the cessation of feeding, or when they changed to another food source, or they moved to another location. If the parrots either resumed feeding, or returned to the same food source, this was recorded as a second feeding bout (after Galetti 1993, Renton 2001). A distinction was made between the parrots feeding (and ingesting) on plant parts and solely mandibulating. Observations of foraging on agricultural crops are presented elsewhere (chapter 5). Specimens of most of the plants eaten by the Black-cheeked Lovebird are deposited in the University of Natal Herbarium (Pietermaritzburg).

Factors including seed size, fire damage to parent plants and windblown aggregates of seed, made it virtually impossible to identify the seed species consumed at ground level, and therefore foraging was simply recorded by substrate type. However, during the summer months, when the plants set seed, identification of certain species was possible. At other times seeds from feeding sites were collected, and sent to the National Botanical Institute (Pretoria) for identification.

The birds were observed feeding in various habitat types, which were categorised into units of similar plant species, ecological processes, land use and relation to water. Types included: Mopane woodland (shrub and bushveld types, after Low *et al.* 1998, with the dominant species being *Colophospermum mopane* associated with *Combretum imberbe, Adansonia digitata, and Balanites aegyptiaca*); riverine vegetation (evergreen linear vegetation stands following water courses, typically comprised *Diospyros mespiliformis, Syzygium cordatum, Trichilia emetica, Acacia polyacantha, Kigelia africana* and *Ficus* spp.), grassland plain interspersed with vegetated termiteria (non-Mopane, typically *Boscia albitrunca*, *Capparis tomentosa*, *D.mespiliformis*, and *C. paniculatum*), agricultural field (any area of agricultural production), village (area of human habitation), water source and other woodland (*Acacia* spp. dominated or Kalahari type characterised by *Acacia erioloba, B. albitrunca, Lonchocarpus capassa*).

Mann-Whitney U-tests were used to test for significant differences between total numbers of ground and arboreal level foraging observations, and between the duration of ground and arboreal feeding bouts.

Although foraging lovebirds were found during every month of fieldwork (February to December), their location and observation was more difficult during certain months. In July, windy conditions made the birds nervous and thus difficult to find, while during the summer rainy season locating them was hampered by two factors. First, newly sprouted grasses made ground-feeding lovebirds more cryptic and second observer mobility was restricted to one area of the mid-Machile River region because of extensive flooding. Additionally, the lovebird breeding season extends from mid-January until April when flock size is reduced (chapter 11) and their diet included ripening agricultural crops of millet and sorghum (chapter 5). During this period observer effort concentrated in agricultural areas and nest locations; other foraging observations became opportunistic.

RESULTS

Foraging habitats

Lovebirds were observed foraging in seven habitat types detailed above. Percentage frequency of total foraging observations per habitat type and frequency of ground and arboreal foraging observations per habitat are shown in figure 1. The majority (53%) of foraging observations were recorded in Mopane woodland, followed by fields (27.1%). In village areas only ground level foraging was observed. Arboreal foraging was observed most frequently in Mopane and field habitats.

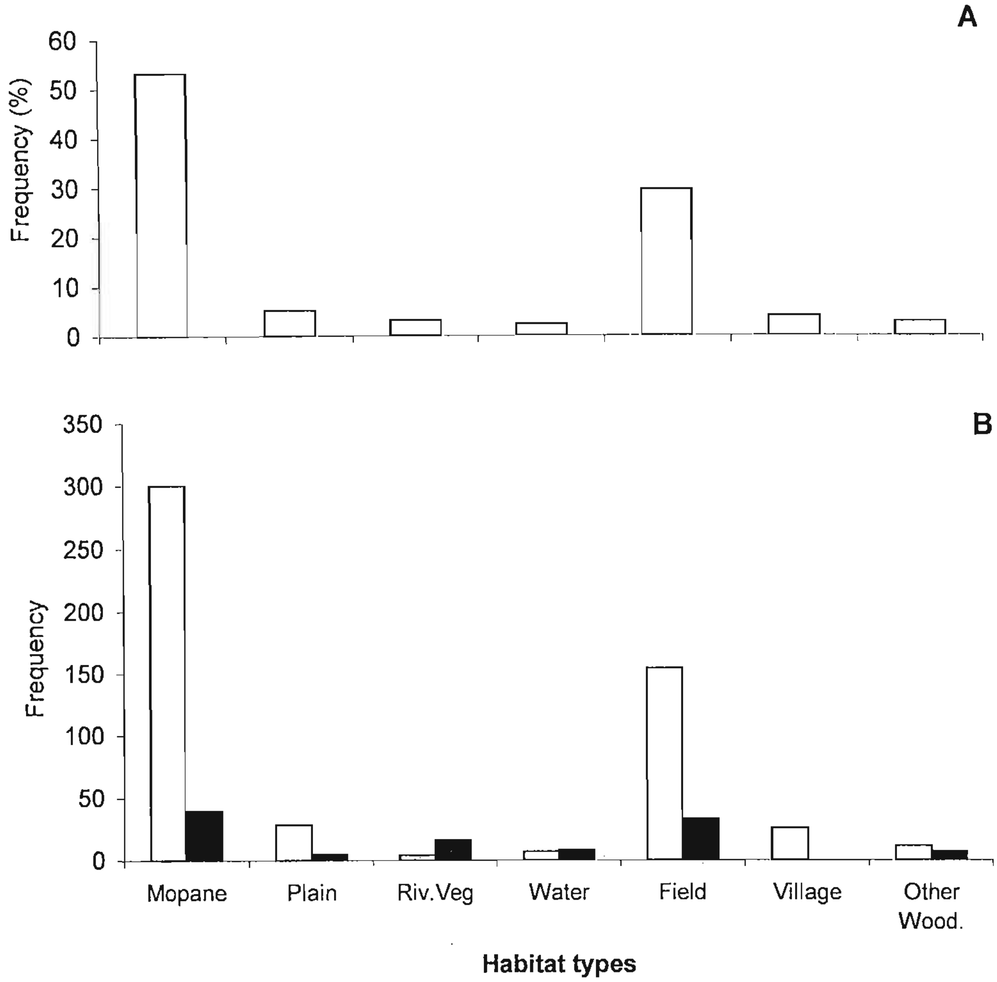

Figure 1 (A) **Percentage frequency of total foraging observations of the Black-cheeked Lovebird across various habitats.**

Figure 1 (B) **Frequency of ground (white) and arboreal (black) foraging observations in respective habitats of the Black-cheeked Lovebird.**

Where: Mopane = Mopane woodland; Plain = grassland plain with vegetated termitaria; Riv.Veg = riverine vegetation following river courses; Field = land under agricultural production; Village = place with human dwellings; Other wood. = woodland other than Mopane

Four uniquely coloured lovebirds in the mid-Machile River region (one yellow and three light green birds) were observed in the same foraging areas from May 1999 to May 2000, indicating that feeding flocks were spatially stable over time.

Flock sizes

Flock sizes of feeding lovebirds varied depending on whether the lovebirds were feeding on the ground, arboreally or on agricultural crops. The mean largest flocks were found foraging on the ground and smallest on agricultural crops.

Table 2. A summary of Black-cheeked Lovebird flock sizes during foraging activities

Foraging level	Mean ± S.D.	range	n
ground	21.55 ± 34.89	1 – 300	453
arboreal	13.15 ± 23.5	1 – 150	99
agricultural crops	6.72 ± 7.82	1 - 60	442

However, most observations (19%) were made of Black-cheeked Lovebirds feeding individually, or in flocks of between 11 to 20 individuals.

There was a significant difference in flock size between lovebirds feeding on the ground to feeding arboreally (Mann Whitney U-Test). Overall, flocks feeding on the ground were larger than birds feeding at canopy height (table 2). Flock size of ground feeding birds differed significantly between the breeding and non-breeding seasons (Mann Whitney U-test z = -3.04, P = < 0.001, n = 62, 583) being generally larger during the dry (non-breeding) season between May to December, mean ± SD = 21.16 ± 33.4 (range = 1 – 300, n = 583) than during the wet (breeding season), mean ± SD = 6.94 ± 10 (range 1 – 52, n = 62) between January to April (too few data for arboreal feeding in the breeding season were collected for analysis).

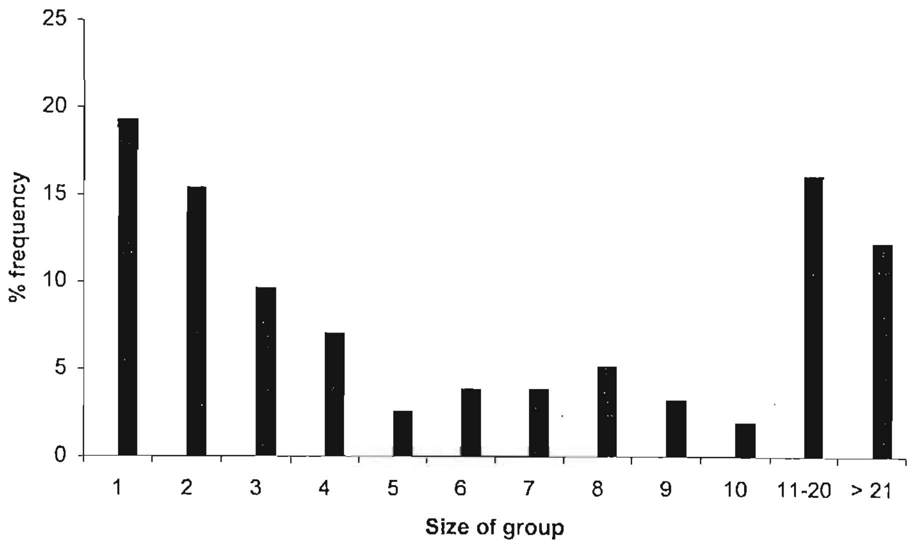

Figure 2. Percentage frequency of observed feeding flock sizes (n = 559).

Feeding flock sizes also varied during different times of the day, with the largest flocks forming early and late in the day. The largest flocks gathered between 08:00 – 08:59h with a mean of 31 birds, and between 15:00 – 15:59h, with a mean flock size of 25 birds, and smallest flock sizes in the middle of the day with a mean of 7 birds feeding between 11:00 – 11:59h (figure 3).

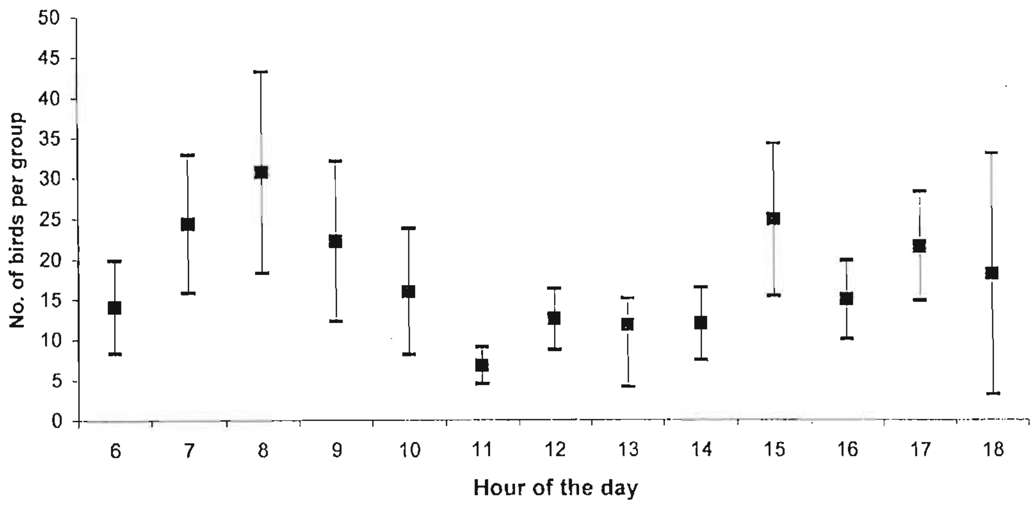

Figure 3. Mean number of Black-cheeked Lovebirds feeding together during each hour of the day (from sunrise to sunset) n = 559. Vertical lines indicate 95% confidence limits

Feeding bout duration

Feeding bouts on the ground were shorter than those in trees (Mann Whitney U test, z = -4.0, $P >$ 0.001, n = 375, 36). Lovebirds foraged on the ground for a mean ± SD duration of 5.07± 6.39 minutes, mode = 2 (n = 375, range = <1-50), and arboreally for a mean ± SD duration of 11.67±11.86 minutes, mode = 3 (n= 36, range = 1-53).

Foraging behaviour

Black-cheeked Lovebirds foraged largely at ground level. During the study 83% (n = 529) of the observations were of terrestrial level foraging. The remaining 17% (n = 108) were examples of arboreal foraging. Between May to December ground level foraging formed >70% of feeding observations in any one month, ranging between 72.83% in December to 92.15% in June (figure 4). A significant difference was found between the total number of ground and arboreal level feeding observations between May to December (Mann Whitney U test, z = 50.5, $P >$ 0.001, n = 481, 106).

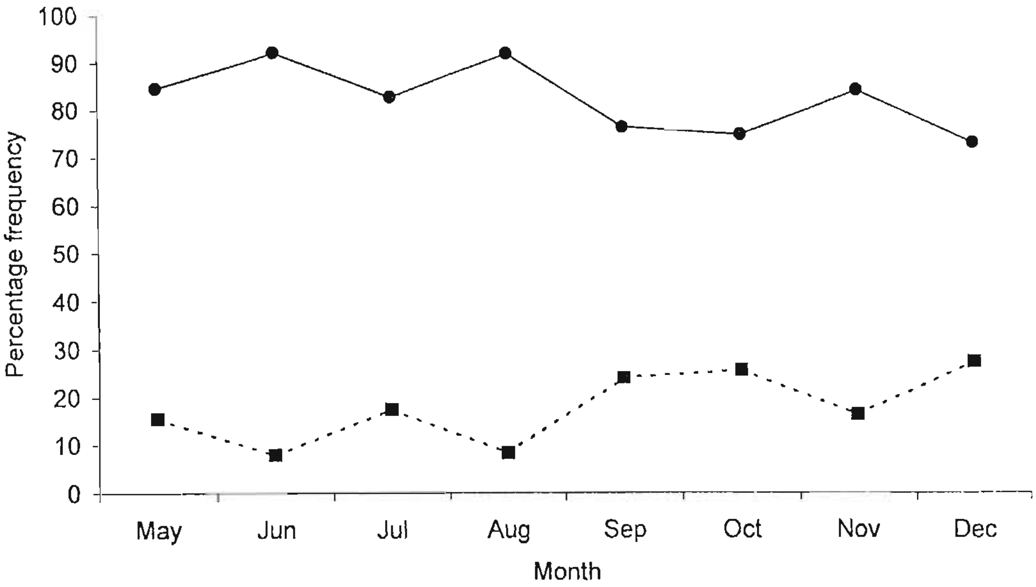

Figure 4. Monthly percentage frequencies of ground (solid line) and arboreal (dashed line) feeding observations of Black-cheeked Lovebirds, n = 637.

Ground

Whilst on the ground, lovebirds foraged primarily for seeds, on plants, or more commonly, from the ground after seeds had been shed from the plant. Ground foraging generally occurred in shallow depressions, where water had gathered during the rainy season (and wetland-suited, prolific seeding, annual grasses had grown), or in dried out elephant tracks where windblown seeds had gathered. Occasionally birds were observed climbing onto robust herb plants, particularly Upright Starbur *Ancanthospermim hispidum* or tall tussock grass to reach seedheads. Inflorescences were also reached by lovebirds ascending to grasp the seedhead using the bill and then secure it on the ground with a foot before biting off seeds. Undeveloped seeds of Wing-stemmed Daisy *Calostephane angolensis* were reached by perching on the side of a tree-trunk, reaching out to the seed-head with the bill then holding the seed-head by the foot against the trunk to feed.

Although flocks moved over the ground as a unit, each bird foraged independently. Birds at the rear of the flock attempted to reach the front by either fluttering over other feeders or by making rapid short running spurts through the feeding flock. The birds rapidly covered the ground with their direction of movement constantly changing. Occasionally, large groups split from the main flock forming temporary separate units. Ground feeding lovebirds were usually silent, as were birds arriving and departing. Although the ground foraging birds rarely responded to the contact-calling of other lovebirds in the immediate locality, they did however attract those in flight causing them to land and join the foraging flock.

No vigilance behaviour was observed, which might have suggested an anti-predation 'look-out' strategy. Occasionally, individual birds would be alarmed by observer (or some other) presence and would silently retreat into the nearest canopy and would not always 'alarm-call' to other flock members. Generally, ground-feeding lovebirds were the easiest for observers to approach.

Arboreal

Movement through the canopy was usually rapid, with the birds dispersed through the arboreal layer. Flowers, leaves, and fruit were eaten directly from branchlets. No fruit was observed being plucked directly from plants. Lovebirds fed on the Common Cluster Fig *Ficus sycomorus* extracting both seeds and flesh from the fruit. Ripe (yellow) and ripening (green) fruits were consumed. Tree blossoms were usually foraged by removing the flowerlets then mandibulated at the base, probably to remove nectar or eat the ovary, before being dropped. To feed on flowers and fruits that hung beneath a branchlet, lovebirds hung upside down, grasping the flower or fruit in a foot to keep balance, although Black-cheeked Lovebirds were not observed to be 'prehensile footed' (after Smith 1971), and did not use feet to take food to the bill. Whilst feeding arboreally lovebirds almost constantly softly contact-called.

During both ground and arboreal feeding events there was no evidence of a dominance hierarchy. Juvenile lovebirds were observed feeding on the ground in mixed flocks with adults (chapter 7).

Occurrence of single and mixed species feeding flocks

Although lovebirds generally foraged in a single species flock (68.7% of observations, n = 438), at least one other species was present during the remaining 31.2% (n = 199). The number of other species foraging with the lovebirds during any one observation ranged from 1 to 10. Feeding with one other species was most common (62.3%, n = 124), followed by foraging with two other species (24.1%, n = 48).

Most species feeding with the lovebirds were wild bird species (table 3). The most common being the White-browed Sparrow-weaver *Plocepasser mahali*, although 40 different species were recorded at different times. It was observed foraging with lovebirds in 23% (n = 76) of the mixed species foraging flocks, (12% of total foraging flocks observed); followed by Southern Grey-headed Sparrow *Passer griseus* (17.53%, n = 57). The only other species present in >10% of the mixed foraging flocks was the Cape Turtle Dove *Streptopelia capicola* (10%, n = 33).

Mixed species foraging flocks were observed each month, and were most common in June (1998/99), August (1998/99) and November (1999), (figure 5). There were few interactions between the lovebirds and the other species in mixed foraging flocks. The lovebirds did not necessarily take refuge when other species did and vice versa.

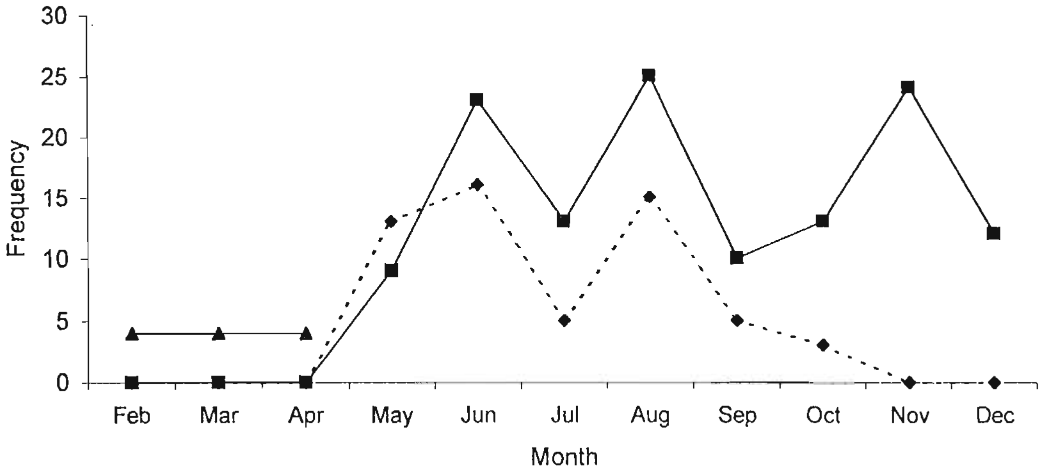

Figure 5. Frequency of mixed species foraging flock observations by month and data collection years, n = 199. 1998: dashed line; 1999: solid line with square; 2000: solid line with triangle.

Table 3. Species which foraged with Black-cheeked Lovebirds, including percentage occurrence within mixed foraging flock observations, number of observations and whether foraging was at the ground (G) or arboreal (A) level.

Species		**%**	**n**	**Ground / Arboreal**
Common name	**Scientific name**			
White-browed Sparrow-weaver	*Plocepasser mahali*	23.38	76	G
S. Grey-headed Sparrow	*Passer diffuses*	17.53	56	G+A
Cape Turtle Dove	*Streptopelia capicola*	10.15	33	G
Meve's Long-tailed Starling	*Lamprotornis mevesii*	7.07	23	G
Blue Waxbill	*Uraeginthus anglolensis*	6.15	20	G
Red-billed Hornbill	*Tockus erythrorhynchus*	4	13	G+A
*Mopane Squirrel	*Paraxerus cepapi*	4	13	G+A
Swainson's Francolin	*Francolinus swainsonii*	3.38	11	G
Red-billed Quelea	*Quelea quelea*	2.76	9	G
**Chicken	-	2.46	8	G
Laughing Dove	*Streptopelia senegalensis*	2.15	7	G
Redbilled Buffalo-weaver	*Bubalornis niger*	1.53	5	G
Black-cheeked Waxbill	*Estrilda erythronotos*	1.23	4	G
Grey Loerie	*Corythaixoides concolor*	1.23	4	A
Steel-blue Widowfinch	*Vidua chalybeata*	0.92	3	G
Yellow-eyed Canary	*Serinus mozambicus*	0.92	3	G
Greater Blue-eared Starling	*Lamprotornis chalybaeus*	0.92	3	G+A
Black-collared Barbet	*Lybius torquatus*	0.61	2	A
Dark-capped Bulbul	*Pycnonotus nigricans*	0.61	2	A
Violet-eared Waxbill	*Uraeginthus granatinus*	0.61	2	G
Namaqua Dove	*Oena capensis*	0.61	2	G
Scarlet-chested Sunbird	*Nectarinia senegalensis*	0.61	2	A
White-bellied Sunbird	*Nectarinia talatala*	0.61	2	A
Red-eyed Dove	*Streptopelia semitorquata*	0.61	2	G+A
African Green Pigeon	*Treron calva*	0.61	2	A
Crested Barbet	*Trachyphonus vaillantii*	0.3	1	A
Red-faced Mousebird	*Colius striatus*	0.3	1	A
Grey Hornbill	*Tockus nasutus*	0.3	1	A
Melba Finch	*Pytilia melba*	0.3	1	G
Purple-banded Sunbird	*Nectarinia bifasciata*	0.3	1	A
Coppery Sunbird	*Nectarinia cuprea*	0.3	1	A
Black Sunbird	*Nectarinia amethystina*	0.3	1	A
Meyer's Parrot	*Poicephalus meyeri*	0.3	1	A
Trumpeter Hornbill	*Bycanistes bucinator*	0.3	1	A
Lesser Masked Weaver	*Ploceus velatus*	0.3	1	G
Greenspotted Dove	*Turtur tympanistria*	0.3	1	G
Arnot's Chat	*Thamnolaea arnoti*	0.3	1	G
Jameson's Firefinch	*Lagonostica rhodopareia*	0.3	1	G
* **Pig	-	0.3	1	G

Composition of diet and temporal patterns

The staple diet of the Black-cheeked Lovebird comprised seeds particularly of grass species (table 4), predominantly *Echinochloa colona* (table 5 provides a nutritional analysis) and the herb *Acanthospermum hispidum* (mean seed weight ± S.D. = 9.1 ± 2.8 mg, range 1.3 - 12.8).

Table 4. Species of grass seeds eaten by Black-cheeked Lovebirds found in their foraging localities

Species	Annual (A) or Perennial (P)	Identification method
Species eaten:		
*Echinochloa colona**	A	1
Chloris virgata	A	1
Species possibly eaten:		
Digitaria veluntina/Digitaria sanguirialis	A	1
Tricholaena monachne	P	1
Dactyloctenium aegyptium	A	1
Sprobulus (ioclados?)	P	1
Digitaria (milanjiana)	P	1
Panicum (repens)	P	1
Urochloa mosambicensis	P	1
*Panicum ***	P	1
Brachiaria deflexa	A	2
Courtoisina cyperoides	?	2
Crotalaria sp.	?	2
Triumfetta sp.	?	2
Poaceae sp.	?	2

Identification method: 1 = identified from parent plant; 2 = identified by seed (National Botananical Institute, Pretoria)
*see table 4 for nutritional analysis of species;
**= 2 Panicum species identified but not *P.maximum*.

Table 5. Nutritional analysis of ***Echinochloa colona*** Jungle Rice

Protein (%)	Fat (%)	Moist Milled (%)	Crude Fibre (%)	Ash (%)	GE (MJ/kg)
10.71	4.69	9.5	16.00	11.16	16.572

Although lovebirds fed less above ground level, the diversity of the plants parts and species consumed increased, and included 30 species of trees belonging to 14 families; 3 species of creeper in 2 families; 9 species of herb in 7 families; and 2 agricultural crop species in 1 family (table 6) in observations made between February to December.

Table 6. Food items (non-grass) recorded in the diet of the Black-cheeked Lovebird

Species	Family	Common name (English)	Part eaten	Month	No. of obs	Reference
Tree species						
Euphorbia ingens	Euphorbiaceae	Common Tree Euphorbia	F	June	2	3
Ficus sycomorus	Moraceae	Common Cluster Fig	P	June, Oct	3	#2 & 3
Ficus ingens	Moraceae	Red-leaved Fig	P	Not recorded		#2
Manilkara moschisa	Sapotaceae	Lowveld Milkberry	I	Sept	2	3
Manilkara zeyheri	Sapotaceae	Transvaal Red Milkwood	P	Not recorded		#2
Capparis tomentosa	Capparaceae	Woolly Caper-bush	F	Sept	4	3
Boscia albitrunca	Capparaceae	Shepherd's Tree	F	August	1	3
Diospyros mespiliformis	Ebenaceae	Jackal-berry	T, L, P	July, Aug	1,5,2	3
Syzgium cordatum	Myrtaceae	Water-Berry	Fb	Aug	3	3
Syzgium guineense	Myrtaceae	Water Pear	S	Not recorded		1
Combretum collinum	Combretaceae	Variable Bush-willow	F	June	1	3
Combretum imberbe	Combretaceae	Leadwood	L, B	June, Aug	2,1	3
Combretum paniculatum	Combretaceae	Flame Creeper	F	Sept-Oct	9	3
Terminalia sericea	Combretaceae	Silver Cluster-leaf	L	May	2	3
Garcinia livingstonei	Clusiaceae	African Mangosteen	I	May	1	3
Balanites aegyptiaca	Balanticeae	Simple-thorned Torchwood	F, L	Oct-Nov	2	3
Colophospermum mopane	Caesalpiniaceae	Mopane	I, L, Ls, Li	June, Oct-Dec	5,14, 3	3
Kigelia africana	Bignoniaceae	Sausage Tree	L	May	1	2** & 3
Sclerocarya birrea	Anacardiaceae	Marula	Ls	May	1	3
Rhus quartiniana	Anacardiaceae	River Rhus	S	Not recorded		1
Acacia nigrescens	Mimosaceae	Knob Thorn	F, L, Ls	June	2	3
Acacia polyacantha	Mimosaceae	White Thorn	L	May, Oct-Nov	6	3
Acacia arenaria	Mimosaceae	Sand Thorn	R	May	1	3
Acacia erioloba	Mimosaceae	Camel Thorn	F, L	Aug	4,1	3
Acacia nilotica	Mimosaceae	Scented Thorn	L	May	1	3
Acacia sieberana	Mimosaceae	Paperbark Thorn	F, L	June-July, Dec	12,1	3
Faidherbia albida	Mimosaceae	Ana Tree	L	June-Aug	5	3
Albizia anthelmintica	Mimosaceae	Worm-bark False-thorn	Not recorded	Aug		2
Albizia antunesiana	Mimosaceae	Purple-leafed False-thorn	F	Oct	2	3
Albizia harveyi	Mimosaceae	Common False-thorn	F	Oct	8	3
Albizia versicolor	Mimosaceae	Large-leafed False-thorn	Lb	Aug	1	3
Erythrophleum africanum	Caesalpiniaceae	Ordeal Tree	F	Aug	1	3

Table 6 (continued)

Herb species					
Triumfetta rhomboidea	Tilaceae	-	S	July-Aug, Nov	3
**Ancanthospermum hispidum*	Asteraceae	Upright Starbur	S	March-Dec	3
Pupalia lappaceae	Amaranthaceae	-	S	Aug	3
Calostephane angolensis	Asteraceae	Wing-stemmed Daisy	Sud	April	3
Aspilia mossambicensis	Asteraceae	-	S	April	3
Portulaca oleracea	Portulacaeae	-	L, Sud	March-April	3
Ocimum canum	Lamiaceae	-	Sud	Feb	3
Leucas martinicensis	Lamiaceae	-	Not recorded	Not recorded	2**
Oxygonum sinuatum	Polygonaceae	Devil's Thorn	S	March	3
Creeper species					
Fockea multiflora	Asclepediacea	Python Creeper	L	May	3
Phyllanthus reticulatus		-	P	Sept-Oct	3
Combretum mossambicense		Knobbly Creeper	Not recorded	Aug	2
Agricultural crop					
Pennisetum typhoideum	Poaeceae	Bulrush Millet	Sud, S	Jan-May	3
Eleusine coracana		Finger Millet	Sud, S	Jan-May	3
Sorghum bicolor		Sorghum	Sud, S	March-May	3

Part eaten: F = flower; Fb = flower bud; P = fruit pulp; L = leaves; Ls = leaf stem; Lb = leaf bud; Li = lichen; S = seed; Sud = undeveloped seed;
T = twig; B = bark; R = resin; I = invertebrate.
** = exotic species; ** = report from questionnaire.*
Reference: 1 = Benson & Irwin 1967; 2 = Kilmer 1994; 3 = Warburton (this study).

Above ground level 11 plant parts (undeveloped seed, shed seed, flower buds, flowers, leaf buds, leaves, leaf stems, fruits, twigs, bark, and resin) were eaten. Lovebirds fed more on flowers than any other plant part, constituting 39.8% (n = 43) of arboreal observations, followed by leaves at 35.2% (n = 38). Collective foraging on flowers and leaves accounted for 75% of all arboreal observations (n = 81), and 12.7% of all foraging observations. Leaves were eaten during 10 of the 11 months of observation and flowers in 7 months. Most leaves eaten came from trees (n = 14 species), with single observations of leaves eaten from a creeper and a herb (table 6). All flowers were foraged from trees. Two species of tree and one creeper species were visited for fruit (table 6). The only other arboreal foodstuff constituting >10% of arboreal observations, were insect larvae (10.2%, n = 11), but only comprised 1.7% of foraging observations. Only one arboreal feeding observation was made between February and April, although this may be partially attributed to lack of observer mobility around the study-site during the rainy season.

Frequency of foraging on flowers, leaves, and invertebrates are shown (figure 6). Flowers were eaten during the 6 months between May and December, with a peak during September and October. Feeding on leaves was observed during 4 months, peaking in July of 1998 and 1999, and August and December during 1999. Insect foraging mirrored that of leaf foraging and may account for some of the apparent leaf foraging observations.

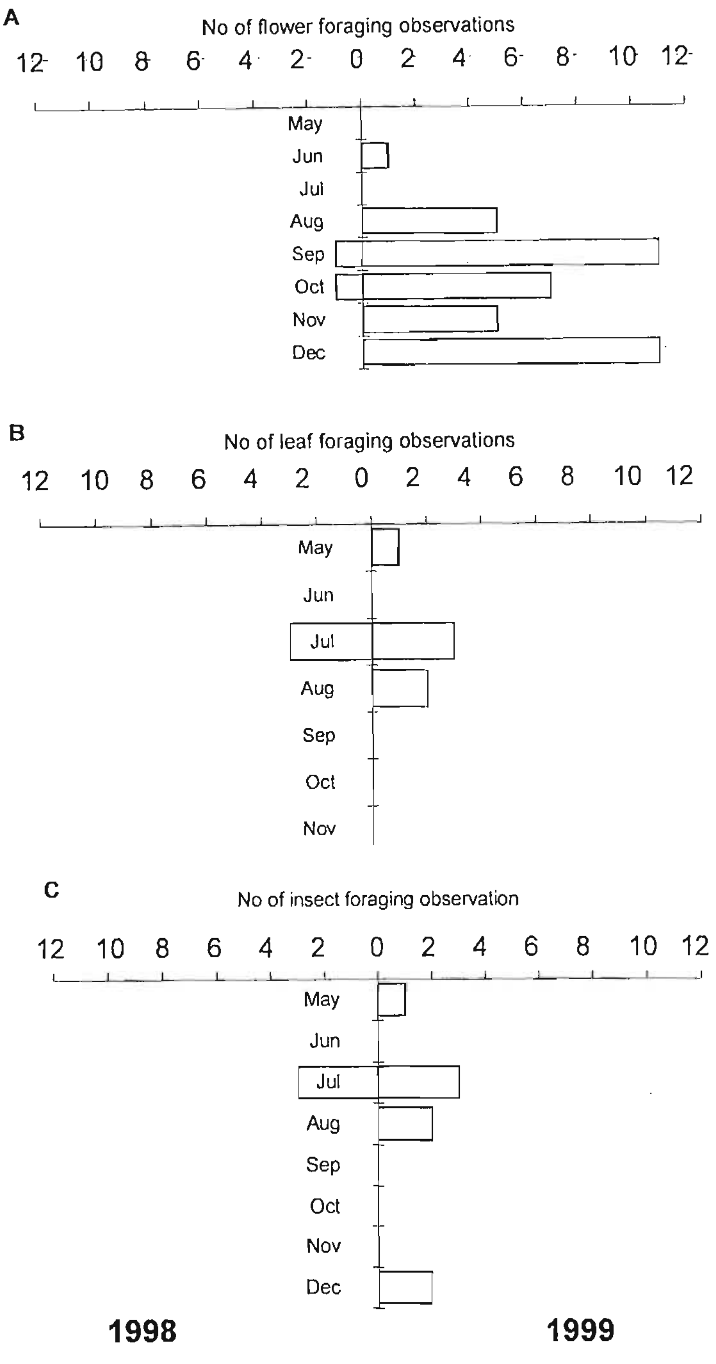

Figure 6. Frequency of three respective plant parts: (A) flower; n = 42; (B) leaf, n = 35; and (C) insect, n = 10; in the diet of the Black-cheeked Lovebird in 1998 and 1999.

Between 1 and 9 plant species per month were consumed above ground level between May and December (mean ± SD, 4.88 ± 2.80). The number of species consumed per month peaked in May, August and October (figure 7). Temporal patterns of plant part consumption within the arboreal layer, between the same period showed that between 1 and 4 plant parts were consumed monthly (mean 2.55 ± SD 0.72, figure 7). During six of the nine months when data were analysed, three plant parts were consumed each month. More than one plant part was eaten from 7 (22%) tree species (table 6), with Mopane *C. mopane* being foraged for four different plant parts including insects. Bark from Leadwood *C. imberbe* and lichen from Mopane were foraged on single occasions in August and November respectively.

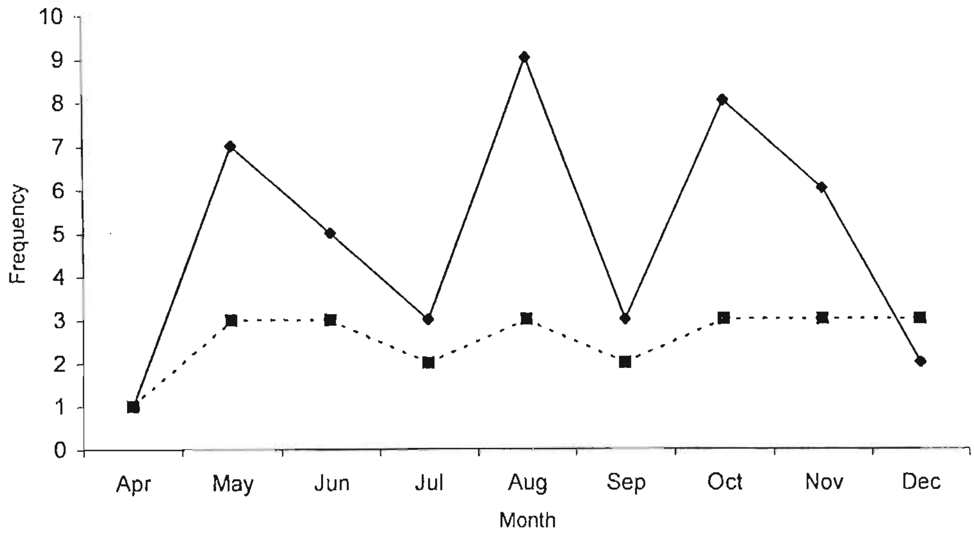

Figure 7. Number of plant species (solid line) and plant parts (dashed line) eaten above ground level between April to December 1998 and 1999 by Black-cheeked Lovebirds (n = 95).

Lovebirds also ingested invertebrate larvae. At least one invertebrate family (Psyllidae, Order Hemiptera) was foraged on three tree species. The Jumping Plant Lice *Retroacizzia mopanei* found on Mopane were foraged by lovebirds which probably ingested both the nymphs and their exudates. Other psyllids foraged were found inside galls on Lowveld Milkberry *Manilkara zeyheri* and African Mangosteen *Garcinia livingstonei* leaves. The lovebirds clearly selected the galls, leaving small holes on the leaves where insects had been removed. It is also possible that the fruits of Common Cluster Fig *F. sycomorus* were foraged for their internal insect load, likely comprising mainly of host-specific agaonid wasps. All fruits examined were found to contain wasps.

Geophagy (the ingestion of soil) was observed on two occasions, in March and May. During the May observation one lovebird, in a flock of five White-browed Sparrow-weavers, was observed taking bites from dry soil clumps in Mopane woodland. In April a mated pair were observed taking bites from damp ground again in Mopane woodland. In both incidents mud remnants were clearly visible on the bill. Following the burning of foraging sites Black-cheeked Lovebirds ingested charred vegetative and soil remains.

DISCUSSION

Although primarily granivorous, feeding terrestrially on grass seeds in Mopane woodland, Black-cheeked Lovebirds were not dependent on a specialised food source limited to the species' range. The sedentary nature of the species, and year round feeding at the same localities implies a stable supply of grass seed during periods of variable rainfall and temperature. Difficulties for the observer due to regional flooding during the rainy season precluded observations of feeding habits across the lovebird's range between December to April. This needs further investigation to discover whether natural food shortages occurred during this season. During this study no observations were made during the period of annual grass-seed germination which occurred during late December through January.

The number of plant species and plant parts consumed by the lovebird's demonstrated considerable complexity and flexibility in foraging habits. Lack of specialisation made a wider array of seeds available. Overall the original hypothesis that Black-cheeked Lovebirds are granivorous was accepted, whilst the suggestion that lovebirds extend their foraging range during the rainy season was rejected. It was however surprising that the Black-cheeked Lovebirds did not feed on *Acacia spp.* seeds or maize, as has been observed for other lovebird species (table 1, Thompson 1987[a], Moyer 1995, Juniper & Parr 1998).

The lovebird's ability to utilise various food sources including insects, flowers and leaves involves several different feeding techniques. They also switch between food sources (species and plant part) daily, including when grass seed is apparently most abundant. This flexibility may allow the lovebirds to remain in the same locality throughout the year, switching between available arboreal food resources to supplement a staple diet of grass seed, and may also have enabled the lovebirds to adapt to, and exploit, the more human-disturbed environment in the south of their range.

The significant difference in bout duration during ground-foraging and arboreal-foraging suggests that lovebirds are less disturbed whilst feeding above ground level as they feed for longer periods. Lovebirds also vocalised more frequently whilst foraging arboreally, probably to keep contact with flock members when visual contact was impaired by foliage, and might indicate a 'sense' of greater security when arboreal. Smaller flock sizes feeding in the canopy when compared with ground feeding flocks may be a response to reduced space in the canopy and could also be a function of greater flock size on the ground improving an individual's ability to gather information about predators (after Westcott & Cockburn 1988) or resource availability (Manning & Dawkins 1998).

Foraging site stability

Although physically capable of long-distance flight, Black-cheeked Lovebirds exploit localised patterns of primary production. This contrasts with the nomadic habits of other African parrot species, such as the Cape Parrot (Wirminghaus *et al.* 2001), Brown-headed Parrot (Taylor & Perrin *in press*) and Grey-headed Parrot (Symes & Perrin *in press*) although less so the Rüppell's Parrot

(Selman *et al.* 2000). The observations of colour morphs (see above) found in the same foraging locations between May-December 1999, and in nearby nesting areas in 2000, suggest that Black-cheeked Lovebirds do not extend their range during the crop-ripening season. Dodman (1995) suggested that the lovebirds extended their foraging range during the crop-ripening season on the basis of information from interviewing local people, who claimed to notice lovebirds in their area only during this season. However, this information may be biased, as local people likely pay more attention to the presence of the lovebirds during the crop-ripening season, because they are physically in the fields themselves at that time with the purpose of scaring off crop-predators, and also may not notice the birds remaining in the near locality once the crops have been harvested (chapter 5).

Black-cheeked Lovebirds favoured certain feeding locations, within their general feeding areas. This was probably related to seed abundance, lack of disturbance, distance to trees for cover, and distance from drinking and roosting sites. Fidelity to feeding localities has additional social benefits. Lovebirds flying into an area, for example from roosting or drinking sites, located other lovebirds by sight, as ground-foraging lovebirds are typically silent, even when other birds fly into the locality contact calling. Also, location of perching sites for retreat from potential predators and to shelter from rainfall are likely to be known from previous experience. These frequently used sites are often located within Mopane woodlands in shallow depressions where water collects in the summer, allowing the annual proliferation of seed-bearing grasses, such as, the primary food item in its diet, Jungle Rice *Echinochloa colona* (see above).

Fields containing the weed *A. hispidium*, were also visited during most of the year (April to December), by lovebirds whose range overlapped agricultural areas (i.e. the southern sub-population, containing around two-thirds of the total population (Dodman 1995)). Directional flight of lovebird flocks from roost areas to fields containing *A. hispidium* again indicates an awareness of the site locations. Flocks flew from roosting and drinking areas over 8 - 12km away, crossing unsuitable foraging habitat (Miombo woodland) and cultivated areas devoid of the weed. Once this food was setting seed the lovebirds ceased to forage in these areas, indicating that the primary food resource, and reason for visiting these sites were the seeds of *A. hispidium*.

Fire

Fire regimes are known to affect seed abundance. Negative effects include seed destruction, weakening of plants (Lightfoot 1976), decreased grassland heterogeneity (Collins 1996), habitat drying, elimination of some species and exposure to erosion (Primack 1993). Positive outcomes include exposure of seeds on the ground (Woinarski 1991), promotion of flowering in seed-producing species, fertilisation of the soil (Peek 1986) and increased rate of decomposition (Primack 1993). Fires are therefore beneficial and detrimental to granivores. Short-term responses may be different from long-term ones. Burning regimes within the range of the Black-cheeked Lovebird are unmanaged, largely anthropogenic, and occur annually from May until the rains begin in November-December. Lovebirds foraged in recently burnt areas, although this could be attributed to site fidelity rather than an increased availability of seeds. Sites of soil disturbance, including villages and agricultural fields may also enhance the numbers of plant food species available to the lovebirds, as has been previously shown in the habitat of the Hooded Parrot *Psephotus dissimilis* (Garnett & Crowley 1995).

Food species shared with other African parrot species

Although the lovebirds were commonly observed perching in six Acacia tree species and foraging on blossoms, leaves and resin, they did not forage on seeds of Acacia spp. This was unexpected since several lovebird species, *A. fisheri* (Moyer 1995), *A. lilianae* (Pitman 1934), *A. personata* (Moreau 1945), *A. roseicollis* (Juniper & Parr 1998) and *A. fisheri* x *personata* wild hybrids (Thompson 1987[a & b]) forage on *Acacia* spp. seeds. Moreau (1945) had even suggested that leguminous seeds might form an important part of the *Agapornis* diet.

Absence of specialisation to any food sources confined to Mopane woodland makes it unlikely that the relationship between Black-cheeked Lovebirds and Mopane is diet related. Rather, factors such as abundant cavity availability in Mopane trees for roost and nest-sites may cause habitat association. The absence of the lovebirds from sites within the Mopane woodland may therefore not be correlated to food availability. Other factors, including the distance to surface water during the dry season, and level of disturbance at drinking sites may also influence distribution of the species (chapters 3 & 11).

Some plant species foraged by the Black-cheeked Lovebird are also eaten by other African parrot species (tables 1, & 6). Lilian's Lovebird also feeds on *F. albida* flowers (Feely 1965, Benson *et al.* 1971), *S. cordatum* flower buds (Button 1953) and flowers of the creeper *C. paniculatum* (Warburton pers. obs. 1999). Other food plant families fed on by the Black-cheeked Lovebird and other *Agapornis* species include, *Ficus, Acacia, Albizia* and *Euphorbia* (tables 1 & 6). Rüppell's Parrots forage the same plant parts and species from *B. albitrunca, A. anthelmintica* and Mopane; (and the same species but not plant part on *A. erioloba* and *F. albida* (Selman *et al.* 2000). Grey-headed Parrots ingest the same plant part from *E. ingens* (Symes & Perrin *in press*), but not on *S. cordatum* (Fynn 1991), and the *Combretum* and *Terminalia* genera. Brown-headed Parrots share seven food species with the Black-cheeked Lovebird: *A. nigrescens, A. nilotica, A. sieberana, C. imberbe, T. sericea, F. sycomorus* and *D. mespiliformis*, although only the latter two share identical foraged plant parts (Taylor & Perrin *in press*). The Cape Parrot shares no food species with the Black-cheeked Lovebird, but is recorded foraging on *Acacia* and *Ficus* spp. (Wirminghaus *et al.* 2001). The Grey Parrot *Psittacus erithacus* shares no recorded food species (Chapman *et al.* 1993).

Foraging on invertebrates and lichen

Although there are few published records of parrots foraging on invertebrates, psittacines as a group are more insectivorous than initially suspected (Forshaw 1989) and may nutritionally require a protein source. Invertebrate foragers include the Black Parrot *Coracopsis nigra* which feed on insect galls on *Afzelia bijuga* (Juniper & Parr 1998); Jardine's Parrot *Poicephalus gulielmi* (Chapin 1939); Meyer's Parrot *Poicephalus meyeri* forage on insects including caterpillars (Wilson 1979 in Forshaw 1989); Rüppell's Parrot on adult hemiptera and the larvae of lepidoptera and coleoptera; and also small spiders (Selman *et al.* 2000); Brown-headed Parrots on lepidopteran larvae (Taylor & Perrin *in press*) and Cape Parrots on Bagworms (family Psychidae) in Wattle (Wirminghaus *et al.* 2001). The crop of a deceased Grey-headed Parrot nestling contained the remains of a Scaraboid species (Symes & Perrin *in press*). The Grey-headed Lovebird *A. cana* feeds on caterpillars and white (possibly beetle) larvae (Chapin 1939), and Black-collared Lovebirds *A. swinderniana* on insects and caterpillars (Chapin 1939). Black-cheeked Lovebirds eat at least two species of Psyllids. Widespread opportunistic use of Psyllid lerps by Australian parrots has been recorded, including Red-capped Parrots *Purpureicephalus spurius*, Green Rosellas *Platycerus caledonicus*, and Swift Parrots *Lathamus discolor* (Forshaw 1989).

Black-cheeked Lovebirds infrequently ate Leadwood *C. imberbe* bark and lichen. Grey-headed Parrots also feed on the bark of Leadwood, *Combretum* and *Adansonia* species (Symes & Perrin *in press*). Although ingestion was not confirmed, Rüppell's Parrots chew on Leadwood bark amongst other tree species, and pieces of bark have been found in the crops of two Rüppell's Parrot chicks (Selman *et al.* 2000). Bark may be eaten for its nutritional value or act as a grinding agent in the gizzard, particularly in parrots that feed arboreally (Selman *et al.* 2000, Symes & Perrin, *in press*), or as a detoxifying agent (*pers. comm.* J. Gilardi 2001). Bark, recorded in the breeding season diet of the Puerto Rican Parrot *Amazona vittata*, contains more than twice the level of calcium in its usual diet (Snyder *et al.* 1987). Bark foraging in the Black-cheeked Lovebird was observed outside the breeding season. A few parrot species including the Meek's Pygmy Parrots *Micropsitta meeki* and Buff-faced Pygmy Parrot *Micropsitta pusio* (Forshaw 1989) have been observed foraging on lichen.

Geophagy

Although geophagy was only observed on two occasions, Black-cheeked Lovebirds likely ingest soil daily, given their largely terrestrial level foraging habit. Geophagy has been documented for numerous parrot species: in South America (Gilardi 1987, Toyne *et al.* 1997, Sosa *pers. comm.* 1999), Central America (*pers. comm.* Macias 1999), Australasia (Cooper 2000, Diamond *et al.* 1999) and in Africa, African Grey Parrots in CAR and Cameroon, (*pers. comm.* I. Pepperberg 1999) and Cape Parrot (unconfirmed sighting) (*pers. comm.* C. Symes 2001). In addition small pebbles have occasionally been found in the stomachs of Red-faced Lovebirds *A. pullaria* (Fry *et al.* 1988). The function of intentional soil ingestion remains unclear, although most ornithologists assume that the grit assists with the mechanical grinding of ingested food (Diamond *et al.* 1999). Other possible biochemical functions include the acquisition of essential minerals, adsorption of toxic plant secondary compounds (Diamond *et al.* 1999), acid-buffering capacity, gastro-intestinal cytoprotection and may encourage dietary breadth (Gilardi 1987).

Charcoal and bark ingestion may also serve a detoxifying function (*pers. comm.* J. Gilardi 2001). In the Cockatiel *Nymphicus hollandicus*, pieces of charcoal were found in 29% of sampled crops (n = 95) (Jones 1987), and has been observed in the crops of other Australian species including Red-capped Parrot, Western Rosella *Platycercus icterotis* and Port Lincoln Parrot *Barbardius zonarius* (Long 1984).

Behaviour

During foraging events, there were few incidents of intra- and inter-specific aggression, this is typical of most parrot species (Gilardi 1987, Wyndham 1980[b]). Isolated 'bill-pushing' incidents in ground-foraging flocks were conducted in silence and did not disrupt other feeders. Other foraging species were generally ignored, even in body contact situations. This contrasts with general observations of white eye-ringed species of lovebird (and Rosy-faced Lovebirds) in captivity, which emphasise agonistic behaviour, probably resulting from the inhibition of natural behaviour patterns. Similar observations have been made for Budgerigars *Melopsittacus undulatus* (Wyndham 1980[a]).

The regular use of certain foraging locations daily and seasonally (the latter primarily in relation to arboreal foraging) suggest that Black-cheeked Lovebirds, like most parrot species, depend on learning survival skills from other flock members. Juvenile lovebirds learn from experienced birds the location of foraging sites, and the plant part to forage there, including the necessary skills to do this. Foraging is a highly sociable activity, reasons for this may be explained in terms of optimising the location of food resources (Ward & Zahavi 1973); increasing foraging efficiency (Krebs 1972, Moriarty 1977, Cannon 1984) or may indicate scattered food resources or shortages (Jones 1987), although in this study repeated use throughout the annual cycle of the same foraging areas by Black-cheeked Lovebirds largely refutes these suggestions. Previous studies suggest that social groupings are correlated with food abundance and distribution, with anti-predatory benefits as a secondary adaptation (Murton 1971). Increased aridity may cause gregariousness (Brereton 1971, Cannon 1984). The results of this study indicate that Black-cheeked Lovebirds are gregarious, flocking throughout the year, during most diurnal activities and throughout their life cycle; group foraging may be primarily an extension of this habit.

Conservation implications

Despite their popularity in the international avicultural trade, our understanding of the behaviour and ecology of lovebird species is limited. Black-cheeked Lovebirds are sedentary and do not travel long distances tracking ephemeral food resources, which suggests that a relatively small area is required to maintain the population. This is supported by the species' highly localised range. This localisation is not related to any specialised food source, as no plant species foraged by

Black-cheeked Lovebirds was confined to the limits of their natural range, nor appeared to be in limited supply within the area. 'Syndromes' of decline amongst granivorous birds have been reported recently in Great Britain, North America and Australia (Marchant & Gregory 1992, Robbins 1995, Franklin 1999), although these declines correlate with changes in land-use specifically within intensively settled areas. The Australian case may be more relevant to Zambian granivores, which suggests changes in land management, in particular relation to fire and grazing regimes, may have affected the abundance and range of up to 30% of indigenous species, with pigeons and doves, followed by finches and parrots being the most affected families (Franklin 1999). The effect of burning on grass seed availability may be a profitable further line of inquiry, although there are no data to suggest whether burning regimes have changed since the 1920s when Black-cheeked Lovebird populations are believed to have been very much higher than today (D.Gordon Lancaster personal letter 1946: Moreau 1948, Appendix I).

As food sources do not appear limiting for Black-cheeked Lovebirds, it is unlikely that supplementary feeding or other conservation action in relation to the diet (specifically feeding not including drinking) is required in the foreseeable future. In general, the foraging habitats of the species remain intact, and the species has demonstrated its adaptability to use human disturbed habitat for foraging areas. The potential reduction in food availability as a result of change in local cropping patterns, away from millet and sorghum to maize, is unlikely to be a serious threat to the long-term conservation of the species as had been suggested by Dodman *et al.* (2000), as lovebirds fed on various non-agricultural food sources during the height of the crop-ripening season. Also, most of the lovebirds in the northern part of their range are unlikely to include agricultural crops in their diets given the distance of agricultural areas from roost and nest sites (chapter 5).

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CHAPTER FIVE

IS THE BLACK-CHEEKED LOVEBIRD *Agapornis nigrigenis* AN AGRICULTURAL PEST ?

ABSTRACT

This study investigated the status of the Black-cheeked Lovebird *Agapornis nigrigenis* as an agricultural crop pest, by quantifying flock size, damage level to crops and the presence of other crop pests. Black-cheeked Lovebirds fed on two agricultural crops (millet and sorghum) where their distribution overlapped village areas in Zambia practicing subsistence agriculture. There was no evidence to suggest an extended foraging range during the crop-ripening season, or reliance on crops for survival. The crop-ripening season extended from mid-January to April and coincided with the lovebird breeding season and annual maximum rainfall. Most lovebirds foraging in fields were male, as females remained at nesting localities. Feeding activity on agricultural crops peaked in the early morning and late afternoon. Feeding duration was longer and flock size larger when lovebirds fed on sorghum rather than millet. Most foraging flocks were monospecific, although eight other avian species fed on the same crops. Lovebirds showed a preference for ripening crops. Local farmers widely perceived the Black-cheeked Lovebird as a serious agricultural pest. Analysis of transect data showed < 30% of the total millet crop showed any signs of damage, with 18% of seed heads suffering > 20% damage during the ripening season. Local farmers attempted to protect their crops in a variety of ways that were largely ineffective and rarely lethal to lovebirds. As the long-term survival of the Black-cheeked Lovebird is closely allied with local people, particularly in relation to water sources during the dry season, the importance of elevating local tolerance for the species through education programmes is highlighted.

INTRODUCTION

Parrots exhibit several adaptations, including behaviours, such as dietary opportunism (Wiens 1977), morphology, high levels of mobility, and feeding and roosting in flocks (Bucher 1992), which are commonly associated with successful granivorous pest species. Eight of the nine *Agapornis* lovebirds, and nine *Poicephalus* species feed on cultivated crops, particularly maize *Zea mays*, millet *Eleusine coracana* and sorghum *Sorghum bicolor* (table 1), and also feral hybrid lovebirds in Kenya (Thompson 1987). In Australia, Cockatiels *Nymphicus hollandicus*, Little Corellas *Cacatua pastinator*, and Galahs *C. roseicapilla* are described as causing serious damage to summer sorghum and millet crops (Bomford & Sinclair 2002). Although records of parrot crop damage go back over six hundred years (Bibar 1558 in Bucher 1992), few studies have quantified the damage caused (Long 1985), and techniques that produce reliable estimates of crop damage are often crop specific (Bomford & Sinclair 2002). Although human-wildlife conflicts have been described as one of the major conservation problems in Africa today (Adams & McShane 1996), it is a relatively new research area for conservation biologists and there are few quantitative data available to make informed conservation and management suggestions (Naughton-Treves 1998). Pest species are generally understood to be animals that compete with humans by consuming or damaging food, fibre, or other materials intended for human use (Allaby 1994). The level of competition remains indeterminate, and is unimportant, where human perceptions take precedence. This study concurs with the definition of a bird pest as '*Any bird that has a detrimental impact on economic, social or conservation values or resources*' after Bomford & Sinclair 2002.

The Black-cheeked Lovebird is a small parrot (13 - 14 cm long; 38.9g) (Maclean 1998, Warburton 2001), classified as a Vulnerable species (Birdlife International 2000). The species has a highly localised range of approximately 2 500 km², occurring in a clumped distribution between 15° - 17°S and 24° - 26°E in two distinct populations in south-west Zambia (Dodman 1995, Dodman *et al.* 2000) The northern population occurs in suitable areas along the Nanzhila River, largely confined to the southern Kafue National Park and surrounding Game Management Areas (GMA). The southern population is centred on the Sichifulo and Machile catchments, with the Simatanga River to the north and Ngweze River to the south forming the species range limits (chapter 3). The Black-cheeked Lovebirds reside mainly in Mopane *Colophospermum mopane* woodland, and also use adjacent habitats for foraging and drinking, including riverine vegetation, agricultural fields and grassland plain with vegetated termiteria.

Table 1. African parrot species which feed in cultivated areas.

Species name	Agricultural crop	Reference
Black-cheeked Lovebird *Agapornis nigrigenis*	Millet	Gordon Lancaster 1945 in Moreau 1948
Grey-headed Lovebird *A. cana*	'Grain' & rice	Forshaw 1989, del Hoyo *et al.* 1997, Juniper & Parr 1998
Red-faced Lovebird *A. pullaria*	Sorghum; guavas	Mackworth-Praed & Grant 1952; Chapin 1939
Black-collared Lovebird *A. swinderniana*	Millet, maize; rice* & sesame	Chapin 1939; Juniper & Parr 1998
Rosy-faced Lovebird *A. roseicollis*	'Grain'; sunflowers	Mackworth-Praed & Grant 1952; del Hoyo *et al.* 1997, Juniper & Parr 1998
Fischer's Lovebird *A. fischeri*	Maize; millet	Friedmann & Loveridge 1937; Forshaw 1989
Masked Lovebird *A. personata*	Millet & sorghum	Fry *et al.* 1988, Forshaw 1989
Lilian's Lovebird *A.lilanae*	Millet & sorghum	Fry *et al.* 1988, Forshaw 1989
Cape Parrot *Poicephalus robustus*	Pear, apple, pecan nuts	Wirminghaus *et al.* 2000
Grey-headed Parrot *P. fuscicollis suahelicus*	Maize & sorghum	Fry *et al.* 1988, Juniper & Parr 1998
Brown-necked Parrot *P.f. fuscicollis*	Peanuts*	Hopkinson 1910
Red-fronted Parrot *P. gulielmi*	Oil palm nuts	Serle 1954
Niam-Niam Parrot *P. crassus*	Millet	Forshaw 1989
Senegal Parrot *P. senegalus*	Millet & peanuts*	Forshaw 1989, del Hoyo *et al.* 1997
Red-bellied Parrot *P. rufiventris*	Maize	Forshaw 1989, del Hoyo *et al.* 1997
Meyer's Parrot *P. meyeri*	Sorghum & maize; oranges	Juniper & Parr 1998, Warburton *pers. obs* 2000
Yellow-fronted Parrot *P.flavifrons*	(unspecified)	Juniper & Parr 1988
Vasa Parrot *Coracopsis vasa*	(unspecified)	Juniper & Parr 1988
Lesser Vasa Parrot *Coracopsis nigra*	(unspecified)	Wilkinson, R. 1988
Grey Parrot *Psittacus erithacus*	Maize & oil palm	Fry *et al.* 1988, Juniper & Parr 1998

* = heaped crops post harvest

As part of a regional avian survey for the Zambia bird atlas (Aspinwall *et al.* in prep) and Zambian Important Bird Areas project (Leonard *in prep.*), a pilot study of the status and distribution of Black-cheeked Lovebirds had previously been conducted in which dietary information and local attitudes towards lovebirds were obtained by interviewing local people (Dodman 1995, Dodman *et al.* 2000). The survey showed that most people living within the lovebirds range associated the species with the crop-ripening season and time of peak lovebird abundance (Dodman 1995). Interviewees also stated that grain crops, particularly millet and sorghum, were favoured, although maize and sunflowers were foraged occasionally (Dodman 1995).

The aim of this aspect of the study was to investigate the agricultural crop pest status of the Black-cheeked Lovebird throughout the crop-ripening season by quantifying lovebird flock size, the crops foraged, level of crop damage caused and presence of other pest species during a single crop-ripening season. It was important to assess whether lovebird conservation is compromised in agricultural areas, as some form of anthropogenic intervention was anticipated involving lethal control (after Dodman 1995). It was pertinent to establish whether lovebirds were dependent on crops for their survival during the crop ripening season, as it has been suggested that a change in local cropping patterns, away from millet and sorghum towards maize, may have negatively impacted on Black-cheeked Lovebird populations (Dodman 1995, Dodman *et al.* 2000, Warburton 1999).

Based on predictions from prior lovebird studies (Dodman 1995, Dodman *et al.* 2000, Thompson 1987) the following predictions were tested. Black-cheeked Lovebird flock size should peak during the crop-ripening period. Lovebirds should show a preference for ripening crops, (as suggested by observant local farmers). Counter to Dodman and colleagues (1995, 2000) predictions, a wider distributional range of the species was not anticipated. Breeding was expected to occur during the crop-ripening season, with nesting associated with year round stable roosting locations. Timing of breeding with range extension would, therefore, appear paradoxical. Contrary to Kilmer (1994) it was further hypothesised that lovebirds would not depend solely on agricultural crops during this period.

MATERIALS AND METHODS

Study site

Zambia is a landlocked country in southern-central Africa. Black-cheeked Lovebirds inhabit the driest region of Zambia, a vast plain, altitude 914 - 1 341 m, intersected by the floodplains and tributaries of the Zambezi and Kafue Rivers within the Southern and Western Provinces. The lovebird's range is marked by two distinct seasons; a rainy season, usually from November to March, with a mean annual rainfall of 600 mm (NPWS/JICA 1999), and a long dry season from April to November, with April being a transition month. July, the coldest month, has a mean maximum temperature range of 22 - 28°C, and mean minimum of 5 - 7°C; while October is the hottest month, with a mean maximum of 31 - 35°C, and mean minimum 15 - 18°C (NPWS/JICA 1999). Black-cheeked Lovebirds exist in two distinct but adjacent geographical ranges between 15° - 17°S and 24° - 26°E (Dodman 1995, Dodman *et al.* 2000). The northern population occurs along the Nanzhila River, largely confined to Kafue National Park and surrounding Game Management Areas. The southern population is centred around the Machile and Sichifulo Rivers, with the Simatanga River to the north and Ngweze River in the south forming the limits of the species' range. The lovebird's range is exposed to serious water shortages from June to December, as all rivers in the region, with the exception of the Zambezi and Kafue Rivers, which are ephemeral. The dominant vegetation within the Black-cheeked Lovebird range is Mopane woodland. Data were collected from across the lovebird's range.

Methods

Lovebird behaviour and ecology during crop-ripening were studied during three months (February-April 2000) of intensive fieldwork, as part of a longer study spanning 20 months (from May-November 1998, April-December 1999, February-April 2000). Widespread seasonal flooding imposed limitations on observer mobility. One area in the mid-Machile River region where lovebirds had been observed and where roosting, feeding and drinking localities were known, was only accessible from May to December during 1999. In fact the mid-Machile River region was identified by Dodman (1995) as being "home to" the largest density of Black-cheeked Lovebirds. Observations were made using Swift 8x42 binoculars and a Kowa 10x telescope. Number of birds, time, location, activity, feeding behaviour and presence of other species were noted during each observation. Geographical positions were recorded using a Garmin 12XL GPS.

A feeding bout was timed only if observed in its entirety (after Galetti 1993, Renton 2001), with feeding duration per seedhead recorded in seconds. Growth stage (emerging, flowering, unripe, ripe, 'dark' (> 75% seeds already removed), 'finished' (all seeds removed) of each seedhead foraged by lovebirds was noted. Flock size was recorded by direct counting of the birds as they flew into, or departed from the fields. Once perched, the lovebird's cryptic colouring and crop plants impaired observer visibility.

To gain a quantitative measure of agricultural crop availability, line transects were walked along footpaths, totalling 37 km, recording land use (village (area of human habitation); fallow land (unplanted land previously cleared for agriculture); Mopane woodland; dambo (seasonally flooded grassland); maize crop; millet crop; sorghum crop and other crops (typically beans, ground nuts, pumpkins and sunflowers)), crop type and presence/absence of lovebirds every 50 m.

Synchronised 'field watches' involving three observers in six different millet fields were conducted over two consecutive days. Three fields per day were assessed consecutively for lovebird activity in synchronised time periods (07:00 – 09:45h; 12:45 - 15:30h; 16:15 - 18:15h) to establish if lovebird feeding activity was scattered throughout the area or concentrated at particular sites. The observation points were 1.2 – 2.7 km apart. A single observer collected all other data during daily rotating time shifts.

In February, during the main millet ripening period, stage of crop growth and crop damage were determined weekly by walking three 40 m transects through five different millet fields (120 m transect per field). The transect line followed a compass direction or tape measure from a random point, with growth stage and level of crop damage being estimated for each millet plant. Growth stages were visually assessed and divided into three categories: unripe to ripe (show set-fruit), flowering, and emerging (young inflorescence). It was not possible to distinguish between unripe and ripe inflorescences without disturbing foraging flocks. Five increments of crop damage were recorded (1 - 19%, 20 - 39%, 40 - 59%, 60 - 79%, > 80%).

The Chi-square test was used to determine if pest species showed a preference for targeting the different crop growth stages. Mann-Whitney U-tests were conducted to test for significant differences between feeding durations by each avian species on different types of crop, differences between various bird flock sizes feeding on the same crop, and between crop types. Two sample t-tests were used to test for significant differences in mean flock sizes of birds feeding on agricultural and non-agricultural plants.

It was not possible to quantify all sources of crop damage, particularly when identifying sources of damage at the avian species level. It was difficult to measure sorghum use using this method, as when sorghum seeds ripened the plants were hoed flat to dry and covered with ground-nut leaves to try and prevent bird damage. Thus, potential damage to the unripe-ripe class will be under represented in transect counts.

As part of the wider study lovebird feeding on non-agricultural food sources were recorded, the results are presented elsewhere (chapter 4).

RESULTS

Human settlement within the range of the northern sub-population of Black-cheeked Lovebirds has largely been controlled by the demarcation of nationally protected land. Within the lovebirds' southern population's range the human population is limited to cattle owners, subsistence farmers, seasonal fishermen and hunters, with settlements following the river courses so water can be found throughout the year. Farm plots varied in size (the largest being no more than a couple of hectares and the smallest a few square metres), and quality, with millet and sorghum generally grown in small plots, often between maize fields. No weeding took place and few agrochemicals were used (none on millet or sorghum). All crops were sown and harvested by hand. Although maize, cotton and beef production have commercial value and are increasing in popularity, agricultural practices within the region are largely subsistence based. For home consumption the most common crop grown as a staple food is maize, plus millet and sorghum largely for beer production. Other crops grown include ground-nuts, beans, pumpkins, sunflowers and cotton.

Agricultural crops were sown as the rains commenced in November and December with the crop-ripening season extending from February to April. Millet is the first crop to ripen in February, with sorghum and maize ripening around mid-March, although the exact timing depends on when the rains commence. There is some overlap between late ripening millet and early sorghum maturation. As previously discussed widespread flooding of the region during this season imposed limitations on observer mobility. Only one area in the mid-Machile River region where lovebirds had been observed from May to December during 1999 was accessible.

Black-cheeked Lovebirds only fed on two agricultural crops: millet and sorghum. Although observed to feed on these two plants for six months of the year (January to June), consumption peaked between February to April as the crops ripened in the fields. Lovebirds also foraged in the fields during the ripening season on weed seeds (*Ancanthospermum hispidum* and *Oxygonum sinuatum*); and during the non-crop ripening season (May to December), on weed and grass seeds, particularly *A. hispidum*, *O. sinuatum*, and tree blossoms of *Albizia antunesiana*, *A. harveyi*, *Acacia erioloba*, *A.sieberana* and *Erythrophloeum africanum* (chapter 4).

Feeding times

In agricultural areas between February to April Black-cheeked Lovebirds fed on millet and sorghum, with activity peaks in the early morning (6:00 to 6:59h) and late afternoon (15:00 to 16:59h) (figure 1). From February to April day-length gradually decreased by 23 minutes with sunrise occurring at 06:07h on 1/2/00 to 6:29h on 25/4/00; and sunset at 18:58 to 18:01h. Morning feeding peaks occurred soon after sunrise with afternoon peaks ending one hour before sunset. After the morning peak, lovebirds departed towards Mopane woodlands where breeding and roosting sites had been observed, and returned for afternoon feeding from the same direction. Synchronised observations within these breeding areas reported lovebirds departing to and arriving from the direction of fields, which correlated with these foraging peaks. In addition to feeding in the nesting locality, a few birds foraged in the Mopane woodland adjacent to, or close to, the fields.

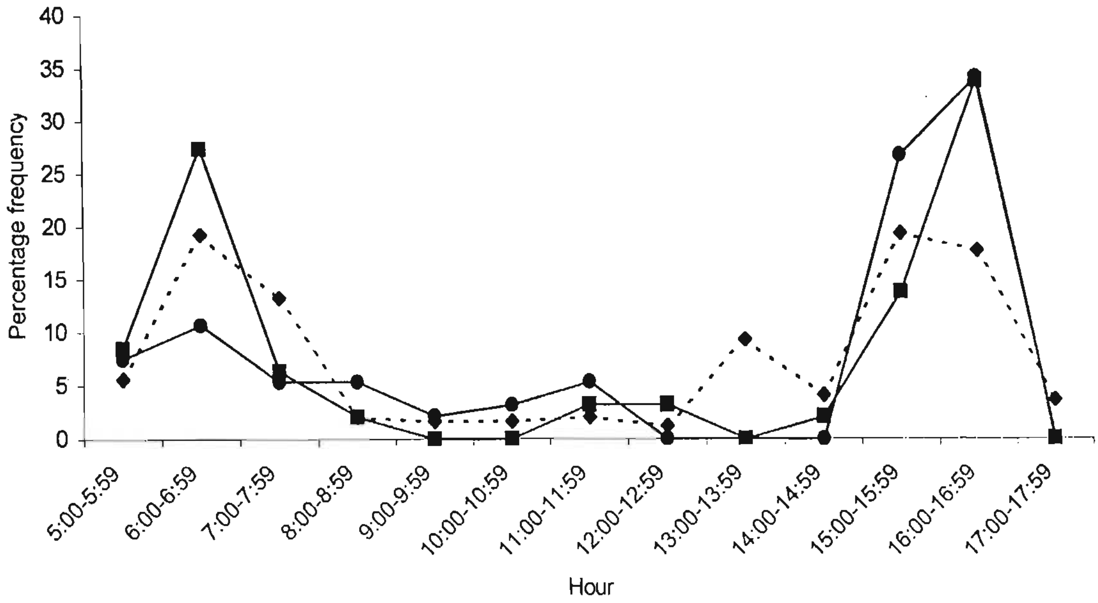

Figure 1. Percentage hourly frequency of Black-cheeked Lovebird foraging on millet and sorghum crops by month: ---♦--- = February 2000; ■ = March 2000; and ● = April 2000. (n = 439).

Crop growth stage preference of feeding lovebirds

Lovebirds mainly fed on unripe and ripening stages of millet and sorghum crops. Occasionally flowering plants were foraged, but all emerging inflorescences were ignored (table 2). Overall, there was a preference for ripening crops, where seeds were still soft and 'milky', although ripe seed heads (showing hardened 'dry' seed) are likely to be under-represented as harvested on ripening.

Table 2. Percentage of the various growth stages of millet and sorghum plants fed on by Black-cheeked Lovebirds.

Crop growth stage	Millet (Feb)		Sorghum (March)		Sorghum (April)	
	n	%	n	%	n	%
Emerging	0	0	0	0	0	0
Flowering	6	5.2	0	0	0	0
Unripe	43	37.1	42	60.9	66	85.7
Ripe	49	42.2	26	37.67	11	14.3
Dark (>75% seeds removed)	18	15.5	1	1.5	0	0
Finished (all seeds removed)	0	0	0	0	0	0
Total	116	100	69	100	77	100

Sex

Since Black-cheeked Lovebirds are sexually monomorphic, it was not possible to visually sex birds feeding on crops. However, concurrent observations in nesting areas showed females to be largely confined to the nest-cavity and immediate surrounds (based on the knowledge from captive studies that only female Black-cheeked Lovebirds incubate and build nests (Dilger 1960)). It can therefore be concluded that most lovebirds feeding on agricultural crops were male. Juveniles were first detected foraging in the fields on 10/04/00, late in the sorghum ripening season. Adult females may have flown to forage in fields up to two weeks prior to this as they were absent from nest cavities for longer periods from this date (chapter 7), substantiated by flock size increase at this time between millet and sorghum seeding.

Flock sizes

Foraging flock sizes were smaller when lovebirds fed on agricultural crops compared with non-agricultural food sources. In crops, mean foraging flock size was 6.7 (± 8.7, range = 1 - ± 60, n = 441); and on non-agricultural foodstuffs foraging flock size averaged 20.2 (± 33.5, range = 1 ± 300, n = 559). Figure 2 illustrates the mean Black-cheeked Lovebird foraging flock size by hour; flocks were significantly larger when feeding on non-agricultural food, during the morning and afternoon activity peak periods (two-sample t-test $P < 0.05$). Although non-significant when compared with non-agricultural feeding birds, flock size of crop foraging birds increased between 10:00 - 13:00h, i.e. outside peak foraging activity periods.

Flock sizes of lovebird and Lesser Masked Weavers *Ploceus intermedius* were larger than those of other avian species feeding on millet and sorghum crops. The mean flock sizes of the six avian species observed feeding in these crops are presented in table 3. Lovebird flock sizes were larger in sorghum fields (median = 5) than in millet fields (median = 4) (Mann-Whitney U-tests $U_{(279, 163)} = 0.02$, $P < 0.05$). No significant difference between lovebird and Masked Weaver flock sizes were found in millet ($U_{(279, 144)} = 0.08$) and sorghum fields ($U_{(163, 15)} = 0.67$). However, lovebird flock size was larger than those of other avian species apart from Masked Weavers. In millet fields lovebird flock size was significantly greater than for Southern Grey-headed Sparrows and White-browed Sparrow-weaver, $U_{(279, 19)} = 0$, $P < 0.001$; $U_{(279, 15)} = 0.001$, $P < 0.01$ respectively, with the mean lovebird flock size (5.69) over twice that of the Sparrow (2.53) and Sparrow-weavers (2.53). In sorghum fields flock size differences between lovebirds and Red-eyed Doves and Meyer's Parrots (median = 3 for both) were significant ($U_{(163, 23)} = 0.0009$, $P < 0.001$; $U_{(163, 9)} = 0.01$, $P < 0.05$) respectively.

Table 3. Mean (± S.D.) and range in flock size of avian species foraging on millet and sorghum crops, between February and April 2000.

Species	Crop	Mean ± SD	Range	n
Black-cheeked Lovebird *Agapornis nigrigenis*	millet	5.69 ± 5.32	1-50	279
Black-cheeked Lovebird	sorghum	8.57 ± 10.67	1-60	161
Lesser Masked Weaver *Ploceus intermedius*	millet	8.10 ± 11.29	1-50	144
Lesser Masked Weaver	sorghum	13.47 ± 15.41	1-50	15
Southern grey-headed Sparrow *Passer griseus*	millet	2.53 ± 3.5	1-16	19
White-browed Sparrow-weaver *Plocepasser mahali*	millet	2.53 ± 1.77	1-6	15
Red-eyed Dove *Streptopelia semitorquata*	sorghum	3.42 ± 1.98	1-8	24
Meyer's Parrot *Poicephalus meyeri*	sorghum	2.2 ± 1.10	1-3	5

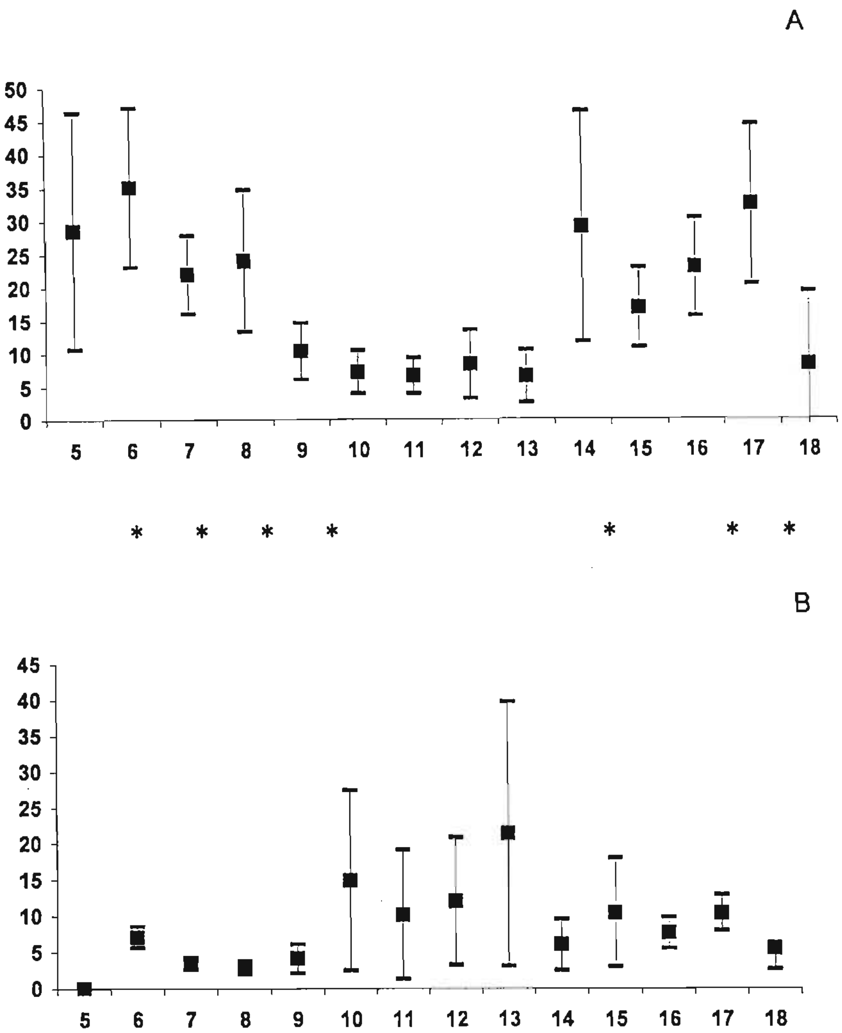

Figure 2. Mean lovebird foraging flock sizes with 95% confidence limits on (A) non-agricultural and (B) agricultural foodstuffs.

** indicates $P > 0.05$ using a two sample t-test*

Feeding during disturbance

Of 245 feeding observations in fields that incorporated crop protection strategies, Black-cheeked Lovebirds were deliberately disturbed on only 63 occasions (25.7%). Villagers protected their crops using a variety of methods including shouting, banging drums, cracking whips, throwing sticks, and the building of platforms from which streamers were run to field edges, and shaken, to scare feeding birds. In most millet and sorghum fields people built shelters and stayed in situ on guard from sunrise to sunset. Generally, active human disturbance in the fields deterred incoming lovebirds, although once feeding they would often remain in position or move to less disturbed areas, appearing less easy to scare than Lesser Masked Weavers. Human presence was insufficient to deter incoming birds that fed close to field shelters if the occupants were not actively engaged in deterrent activities.

Foraging behaviour in crop fields

Lovebirds generally flew quietly into fields softly contact-calling and perched directly on the crop seed-heads. Lesser Masked Weaver presence appeared to attract lovebirds to the same area. Lovebirds would often perch on seed-heads already occupied by a weaver, generally resulting in agonistic movements by the lovebird causing the displacement of the weaver. Occasionally the two species fed together without confrontation. Lovebird feeding did not always commence immediately; often a bird would examine the general locality before feeding or moving to another plant. They fed in silence, although incoming birds usually elicit contact calls from the lovebirds already feeding. Several small lovebird flocks could feed in the same field, about 30 m apart, with little interaction, these appeared to be more dispersed during the crop-ripening season than in any other season.

Lovebirds fed directly from millet and sorghum seed-heads, usually from a vertical position facing either up or down the crop stem with the tail positioned in towards the plant. The soft mesocarp was scooped out using the lower mandible, leaving some of the husk attached to the plant. Sometimes the birds used a foot to secure a sorghum branchlet against the main stem before feeding on the seeds. Lovebirds were observed drinking dew and rainwater from maize stalk leaf-sheath bases.

Up to five lovebirds were observed feeding on a single seed-head, although most birds foraged individually. Aggression was rare and usually limited to beak-thrusts and silent beak-spars.

When foraging ceased most lovebirds flew off in the direction of roost and nest areas. Concurrent nest and field watches found lovebirds arriving from the direction of the fields with full crops and millet/sorghum type debris attached to bills, to the nests During the day, some birds rested in wooded areas adjoining the agriculture fields, to preen, drink, forage on non-agricultural foods and sleep.

Synchronised field watches

Concurrent observations across three millet fields showed that lovebird foraging activity was not concentrated to any area at any one time. Some fields, particularly those close to Mopane woodlands (where the birds sometimes rested and sheltered from rain) were used to a greater extent than fields further away. .

Other species

Eight other avian species: Lesser Masked Weaver, Southern Grey-headed Sparrow, White-browed Sparrow-weaver, Red-eyed Dove, Meyer's Parrot, Red Bishop *Euplectes orix* and Yellow-eyed

Canary *Serinus mozambicus* also fed on agricultural crops. Grey-headed Parrots were also observed flying out of maize crops and follow-up inspections of the site indicated foraging activity. Greater Blue-eared Starlings *Lamprotornis chalybaeus* were observed ground feeding on shed seeds, while Grey Hornbills *Tockus nasutus* foraged on already harvested or opened maize cobs.

Feeding duration

Feeding rates per seedhead between February to April are summarised in table 4. Mean feeding duration on millet and sorghum for Black-cheeked Lovebirds and Lesser Masked Weavers are presented in figure 3. Feeding bout duration of lovebirds, Southern Grey-headed Sparrows and White-browed Sparrow-weavers on millet showed no significant differences (Mann-Whitney $U_{(115, 129)} = 0.7636$; $U_{(115, 17)} = 0.5938$; $U_{(115, 12)} = 0.5780$ respectively, all at $P > 0.05$). Lovebirds fed significantly longer on sorghum crops (median = 80 seconds than Lesser Masked Weavers (median = 42 seconds: $U_{(127, 14)} = 0.0136$, $P < 0.05$). Lovebird feeding bouts on millet in February (median = 43 seconds) were significantly shorter from those on sorghum during March (median = 57.5 seconds) and April (median = 84 seconds) ($U_{(115, 127)} = 0.0047$, $P < 0.05$). There was no significant difference between feeding durations on sorghum during March and April ($U_{(50, 77)} = 0.0642$, $P > 0.05$). In March, duration of feeding by lovebirds and Red-eyed Doves on sorghum were significantly different ($U_{(50, 13)} = 1462.5$, $p = 0.02$); although no difference was found during April ($U_{(77, 10)} = 0.7646$, $P > 0.05$), or between Meyer's Parrots and lovebirds ($U_{(127, 5)} = 0.9572$, $P > 0.05$).

Table 4. Feeding duration per seedhead (seconds) of the avian predators feeding on millet and sorghum crops.

Crop type	Crop predator	Month	Mean ± SD	N	Range
millet	Black-cheeked Lovebird	Feb	137.2 ± 244.47	115	1-1800
millet	Lesser Masked Weaver	Feb	102.85 ± 148.85	129	2-1034
millet	Southern Grey-headed Sparrow	Feb	84.59 ± 19.48	17	3-295
millet	White-browed Sparrow-weaver	Feb	91.08 ± 117.61	12	1-374
millet	Black-cheeked Lovebird	March	177.33 ± 189.73	3	47-395
millet	Masked Weaver	March	59.2 ± 64.96	5	7-168
millet	S. Grey-headed Sparrow	March	67 ± 21.21	2	52-82
millet	White-browed Sparrow-weaver	March	121.67 ± 126.62	3	25-265
sorghum	Black-cheeked Lovebird	March	127.16 ± 173.97	50	3-900
sorghum	Lesser Masked Weaver	March	30 ± 24.72	10	4-78
sorghum	Meyer's Parrot	March	183.4 ± 287.64	5	14-695
sorghum	Black-cheeked Lovebird	March	192.29 ± 238.29	77	2-1226
sorghum	Lesser Masked Weaver	March	78.75 ± 6.08	4	11-73
sorghum	Red-eyed Dove	March	166.1 ± 139.898	10	23-414

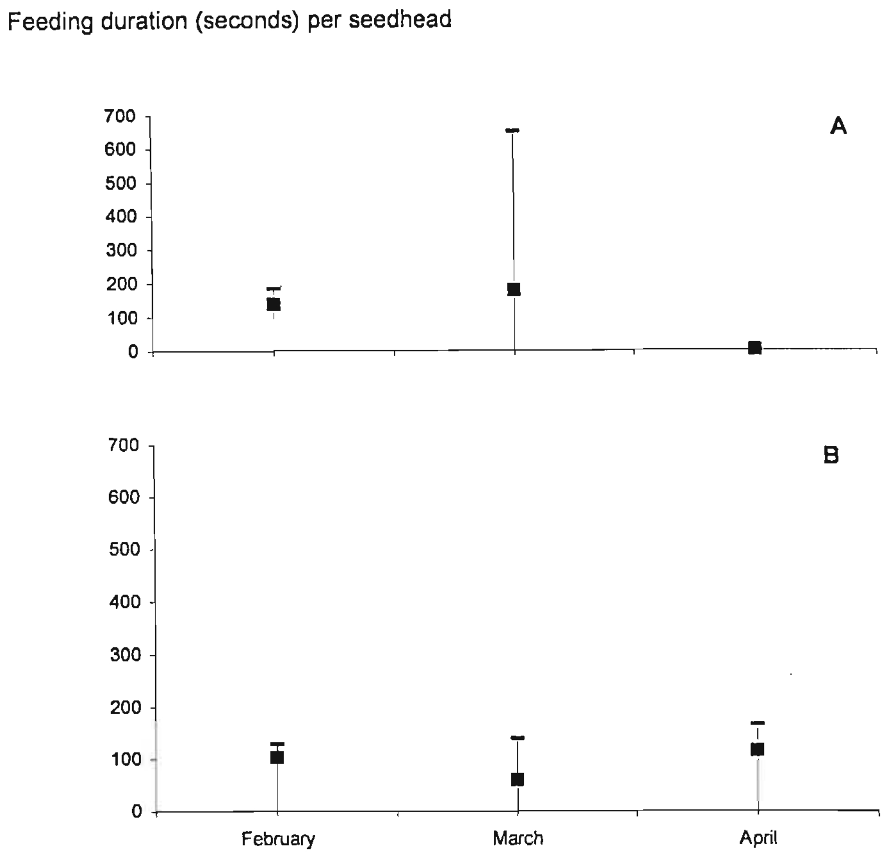

Figure 3
A. **Mean with 95% confidence limits of Black-cheeked Lovebird foraging duration on millet.**
B. **Mean with 95% confidence limits of Masked Weaver foraging duration on millet.**

Land use

In farming areas eight land use and crop types were identified, and availability assessed from line-transects (figure 4). Relatively, little millet or sorghum was cultivated compared with maize. Millet and sorghum crops occupied 5.27% (n = 55) of total land use, equivalent to 16% of the land under maize production (n = 493). Presence of lovebirds was confirmed at 0.621km intervals, of the 37.3km transect covered, although distribution was clumped, and generally correlated with millet, sorghum, or Mopane woodlands.

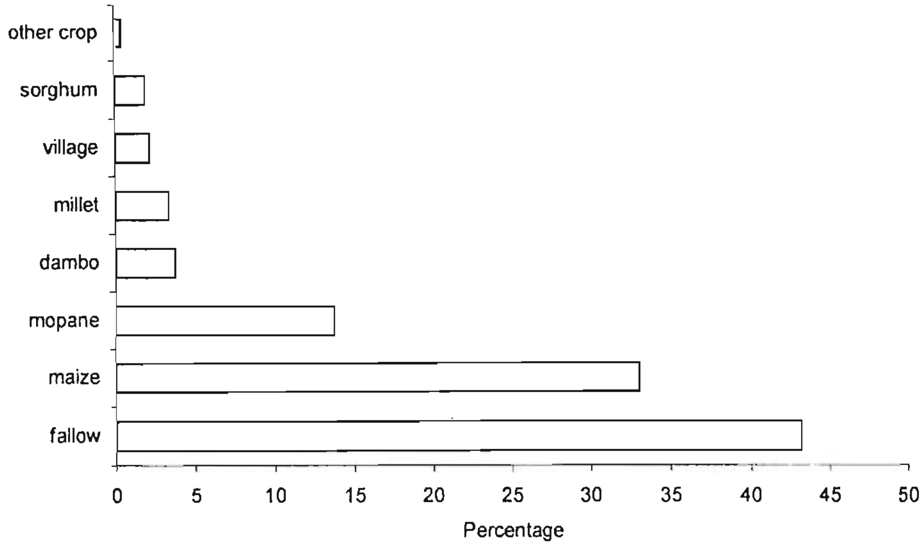

Figure 4. Percentage frequency of agricultural land use, indicating specific agricultural crop availability, from linear transects totalling 37 kms through human inhabited areas in the mid-Machile River region, March 2000.

Damage levels to millet crops

Overall, 28.4% of the millet crop showed some level of damage (table 5) at the end of the ripening season, with > 20% damage to 18.2% of seedheads. Damage to millet crops throughout the main ripening month, February, was lowest during the second week with 17% of seedheads showing some damage, and highest during week four, with 40.2% showing damage. Certain crop growth stages (unripe to ripe) were more susceptible to pest damage than others (emerging and flowering) (table 6), indicating that pest species preferred unripe to ripe crops for consumption compared with emerging and flowering growth stages.

Table 5 (a). Percentage damage to millet crops (all growth stages) from line-transect data during the main crop-ripening period.

% damage class	n	%
0	1778	71.6
1-19	252	10.1
20-39	64	2.6
40-59	72	2.9
60-79	56	2.3
> 80	260	10.5
Total	2482	100
> 19% damage total	452	18.3

Table 5 (b). Percentage damage to millet crops (all growth stages) from line-transect data during each week of the main ripening period.

February	Week 1		Week 2		Week 3		Week 4	
% damage class	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
0	416	83	472	86.4	446	64.5	444	59.8
1-19	19	3.8	50	9.2	100	14.5	83	11.2
20-39	2	0.4	11	2.0	16	2.3	35	4.7
40-59	11	2.2	9	1.6	12	1.7	40	5.4
60-79	7	1.4	2	0.4	18	2.6	29	3.9
> 80	46	9.2	2	0.4	100	14.4	112	15
total	501	100	546	100	692	100	743	100
total % with damage		17		13.6		35.6		40.2
>19% damage total		13.2		4.4		21.1		29

Table 6. Chi-squared contingency table demonstrating that crop pests have a significant preference for foraging on particular crop growth stages.

Week	Crop growth stage				
	emerging	**flowering**	**unripe-ripe**	**df**	**significance**
1	0	14	71	10	$P < 0.001$
2	3	11	60	10	$P < 0.001$
3	0	8	238	10	$P < 0.001$
4	0	3	296	10	$P < 0.001$

DISCUSSION

Contrary to expectations based on interview information from local farmers from a prior study (Dodman 1995, Dodman *et al.* 2000), Black-cheeked Lovebirds ate only millet and sorghum crops, and did not extend their foraging range during the crop-ripening period, which coincided with the lovebird breeding season. Lovebirds were also observed feeding on non-agricultural food supplies during the same season, suggesting a non-dependence on agricultural products for survival, contrary to Kilmer's (1994) predictions of lovebird dependence on agricultural crops for survival. Flock sizes did not peak during the crop-ripening season, and were likely comprised of mostly male birds during most of the ripening season, as females remained at nest sites, and juveniles fledged only in time for the end of the sorghum-ripening season in mid March. This study shows that total pest species' damage was < 30% to millet seed-heads, with 18% of seed heads suffering > 20% damage throughout the ripening season. Therefore, Black-cheeked Lovebirds, together with the other crop-feeding avian species may be considered a 'pest' species. Although the cut-off point for when a certain amount of damage becomes a serious pest problem is open to conjecture, the fact that the local farmers invest considerable time and effort in attempting to protect their millet and sorghum crops indicates that the birds are considered a serious threat to their harvest. Consequently, conservation programmes will need to take the local perception of the lovebird as a crop pest into account, and promote (continuance) of non-lethal crop protection strategies during the ripening season.

The success or failure of agricultural crops, harvest quality, and spatial and temporal patterns of crop raiding may be a consequence of variable seasonal rainfall patterns. Within the range of the Black-cheeked Lovebird rainfall patterns are unpredictable and highly localised (NPWS/JICA 1999). Therefore, results from this study, based on data collected at a single locality over one crop-ripening season, in this regard, offer little more than a snapshot, and as such, conservation management recommendations are made cautiously.

Black-cheeked Lovebirds rely on a natural habitat refuge of Mopane woodlands for roosting and nesting requirements and hence do not travel far into densely settled agricultural areas, resulting in very localised areas of crop predation.. With up to one third of the total lovebird population found largely within the boundaries of Kafue National Park and surrounding Game Management Areas (Dodman 1995, Dodman *et al.* 2000, chapter 3), it is likely that a third to half of the total population of Black-cheeked Lovebirds do not include agricultural crops in their diet. The common denominator between finding lovebirds feeding on agricultural crops outside the National Parks is likely to be the availability of dry season surface water and the presence of agricultural fields within a 10km radius of lovebird roost/nest sites in Mopane woodland (chapter 3). Although it is clear that lovebirds are not solely reliant on agricultural crops for their food requirements, including the section of their range which borders agricultural land, there is little doubt that the millet and sorghum crops represent discrete and super-rich food patches during the ripening season, and are visited by the birds daily. It is surprising that Black-cheeked Lovebirds did not feed on maize crops, as was indicated from interviews with local farmers (Dodman 1995), and observed for Fischer's Lovebird in Tanzania (Friedmann & Loveridge 1937) and for the hybrid population of feral lovebirds in Kenya (Thompson 1987). The success of the feral lovebirds at Lake Naivasha is thought to be largely attributable to the inclusion of maize in their diet, as the birds have established themselves in the more agricultural areas with little movement into natural bush (Thompson 1987).

The smaller flock sizes of Black-cheeked Lovebirds foraging in crops may be explained by a number of factors: for most of the crop-ripening season females remained at the nesting sites, foraging locally and being fed by the males. In croplands the foraging flocks dispersed, perhaps to avoid detection by predators (including crop-guarding farmers); and perhaps because the large foraging flocks found in non-agricultural areas had partially concentrated in those areas in post- and pre- roosting and drinking gatherings, which are behaviours confined to the non-breeding (dry) season.

Experimental models suggest that declines in annual rainfall across the southern African region will continue, and by the 2080's could average 5 - 18% less than the mean rainfall experienced between 1961 - 1990 (Hulme 1995, Hulme & Sheard 1999). Implications for agriculture production include reduced production, with the semi-arid regions suffering most. Impact assessment models indicate that climate change need not entail a widespread loss of agricultural suitability, although plant responses to increased temperatures and temperature extremes are unknown (Hulme 1995). The viability of maize would remain high, as reductions in rainfall would need to exceed 10% before subsequent moisture constraints on maize would outweigh the benefits of increased temperature and CO_2 concentrations (Hulme 1995). Since millet and sorghum are more drought resistant than maize, the decrease in water availability should not affect their survival in the foreseeable future.

For lovebirds, the further reduction in available surface water during the dry season, (chapters 10 & 12) together with increased anthropomorphic disturbance around pools, will likely be the more critical factor in determining the species' survival in agricultural areas, rather than any changes in cropping or crop-pathogen patterns.

Most psittacines are dietary opportunists, with most distributional opportunism restricted to the non-breeding season (Forshaw 1989). Unlike other avian pest species, most parrots are unable to rapidly increase numerically in response to abundant and ephemeral resources such as crops (Wiens & Johnston 1977), although their social organisation may facilitate detection and exploitation of such resources (Ward & Zahavi 1973). Breeding during crop-ripening limits the size of Black-cheeked Lovebird flocks visiting the fields, but the capacity of males to fill their crops with millet and sorghum which they feed to incubating females and nestlings means that the total population of lovebirds within foraging distance of the fields benefit from agriculture.

Conflicts between local farmers and Black-cheeked Lovebirds display all the common haracteristics outlined by Bucher (1992), namely: parrots are easy to detect; damage to crops ends to be exaggerated; damage is irregularly distributed in time and space; damage is commonly ssociated with agricultural frontiers and is usually related to poor agricultural practices. This oncurs with the general assumption that larger animals (in this case, the more conspicuous) ceive greater attention in terms of farmer's complaints and management response (Forshaw 989, Naughton-Treves 1998). A temporary raised platform was erected in every millet and rghum field from which farmers attempted to prevent incoming birds from landing as well as ghtening perching birds out of the crop. This guarding tactic indicated that the farmers perceived associated benefit, despite our findings that birds were only disturbed from feeding on 25.7% of casions when guards were present in the fields. Australian studies have shown that although aring tactics were ineffective in reducing parrot numbers in orchards, actual foraging time was uced (Halse 1986).

In common with some other previous studies assessing wildlife as crop pests (Graham *et al.* 1999, Hector 1989, Lim *et al.* 1993, Newmark *et al.* 1994) previous information concerning the agricultural pest status of the Black-cheeked Lovebird has relied on interviewing local farmers (Dodman 1995, Dodman *et al.* 2001, Kilmer 1994). Local attitudes towards the Black-cheeked Lovebird were gauged from interviews and paralleled those for Fischer's Lovebird in Tanzania (Zul *et al.* 1992, Moyer 1995). All local people interviewed identified the Black-cheeked Lovebird as a pest of millet and sorghum, with a number of individuals indicating that some form of control over lovebird numbers was desirable. These surveys have led to the formation of several assumptions, which this study has refuted. Black-cheeked Lovebirds did not feed on maize or sunflower (although Meyer's Parrots and Grey-headed Parrots fed on maize); nor were they present in flocks of greater sizes during crop-ripening; in fact flocks were smaller and more scattered over the fields than during any other season. There was no evidence to suggest that Black-cheeked Lovebirds extended their range during crop-ripening. Distinctive lighter colour morph birds, enabling the identification of individual birds, were found in the same locality during February to April 2000 (crop-ripening) as in May to December 1999. Also, as nesting sites were located at roost sites used throughout the year, it is unlikely that males would travel outside their normal range to find food during the breeding season. Feral hybrid lovebirds at Lake Naivasha also show a small home range, which Thompson (1987) suggests may be because the birds can find adequate foodstuffs in this highly agricultural region throughout the year.

Quantifying damage levels of crops is complicated by a range of factors including environmental variables which may affect plant establishment and subsequent yield, and varies in time and space (Bomford & Sinclair 2002). Also damage to a small part of the crop (by for example lovebirds) could subsequently lead to further losses due to factors such as secondary infection, like mould and fungal infection; and the difficulties in identifying which specific avian species caused the damage. In addition, the presence of lovebirds amongst crops may not equate with crop damage as they may be feeding on weed species.

Unfortunately it was not possible to identify the amount of damage done by lovebirds as a proportion of that inflicted by all birds. Overall, Lesser Masked Weavers showed larger flock sizes than lovebirds in both millet and sorghum crops, although the feeding duration of lovebirds per seedhead was longer on both millet and sorghum. Flock sizes of all other avian species were much smaller, indicating that the principal avian predators of millet and sorghum crops are likely Black-cheeked Lovebirds and Lesser Masked Weavers, although Meyer's Parrot had longer feeding durations than the lovebird's on sorghum crops and Red-eyed Doves fed for longer on Sorghum than Lesser Masked Weavers Although it was not possible within the scope of this study, the losses suffered in similar cropping regimes outside of the lovebird's range should be investigated.

The economic significance, in terms of gross income of Black-cheeked Lovebird crop damage is likely to be minimal since millet and sorghum are not grown commercially. However, this may not be the case with regard to the subsistence-level farmers, whose survival depends on consuming what they harvest, although neither millet nor sorghum represent a staple dietary source and are rather grown (based on information gathered in informal interviews) for dietary variation and beer-production.

Conservation

The survival of the Black-cheeked Lovebird is closely allied with local people, particularly in relation to water sources during the dry season. The perception of the species as a major crop pest attracts wide local support, and future conservators of the species will need to understand and be sympathetic to this perception. The long-term survival of the lovebird is at risk from low human tolerance for 'pest' species, particularly in the southern part of the lovebird's range which overlaps with agricultural areas. Potentially lethal eradication programmes as part of crop protection strategies may be introduced. Also, theoretically, lovebirds could be captured live as a crop protection tactic and sold off to aviculturalists, which could raise extra revenue for farmers in addition to potentially reducing damage to crops. However, given the lack of development and poverty of the region, and recent and ongoing wildlife population exterminations in Zambia, any trade, which by default attaches an economic value to wildlife removal should be strictly avoided. This is in addition to welfare concerns for captured birds, and the fact that capture during crop-ripening would interrupt the lovebird breeding season.

Historical records indicate that lovebirds have been caught in large numbers while feeding in millet fields. D. Gordon Lancaster recalled 16 000 Black-cheeked Lovebirds being caught in four weeks by liming trees in 'inyoti' fields during June-July 1928/9 (Chapter 1, Appendix I, Moreau 1948). The only record of live trade during the project came from one villager along the Sichifulo River who described how he caught lovebirds, by making nooses placed near sorghum seed-heads, during the crop-ripening season. In 1999 he caught at least five lovebirds which he transported to Livingstone, Zambia for sale. Nooses were found in one harvested field that were baited with seed, the farmer claimed to catch doves and lovebirds for consumption. Trade in live lovebirds was most active between 1920 - 1930, with sporadic reports through the 1960's and in 1994 (Dodman 1995). Capture for local consumption was found to be widespread but not targeted at specific species, and at current levels, not unsustainable with regard to the lovebird population (Dodman 1995, this study). If live trade were resumed it would be inadvisable to concentrate catching in crop-fields during the ripening season as far greater numbers of males would be caught and incubating females would be forced to abandon nests and/or young.

Successful conservation of species that are considered agricultural pests requires a balance between the preservation of the species and management of the damage they cause (Bomford & Sinclair 2002). Such a strategy implies three levels of action: determination that crop damage is sufficient to justify action; substitute with less susceptible crops; and as a last resort to consider population reduction, or compensation for damage programmes in the case of endangered or restricted range species (Dyer & Ward 1977). Idealistically the goal of management should be to raise general tolerance of wildlife among farmers, for example through local education projects highlighting the usefulness of lovebirds as weed-seed predators (Warburton 2001) and to improve non-lethal methods of crop defence. Other methods may be to grow decoy strips of crop species to deflect some of the damage (Naughton-Treves 1998, Warburton 1999), and provide supplementary food (Eckert 1990), although these may serve to attract more birds in the cropping area (Temby 1998). Other problems which are foreseen with schemes such as these are their long-term nature in terms of funding security and the practicalities of management. in such a relatively remote, (although highly localised) seasonally flooded region. The difficulties of managing such a programme would include securing land, organising and duly rewarding the workforce required, and ensuring that the crop was left available for the bird's use. Given the abysmal record of other compensation schemes in Africa, direct monetary compensation should be considered cautiously (Naughton-Treves 1998). For Black-cheeked Lovebirds conservation management should be prioritised towards maintaining and creating water resources, upholding the wild-caught ban and trade in the species, continuing environmental education with local schools promoting lovebird conservation and tolerance for the species feeding in fields, and monitoring populations through dry season water source counts (after Dodman 1995, Dodman *et al.* 2000).

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CHAPTER SIX

NEST-SITE CHARACTERISTICS OF THE BLACK-CHEEKED LOVEBIRD *Agapornis nigrigenis* IN ZAMBIA

ABSTRACT

Nest-site characteristics and nesting requirements of the Black-cheeked Lovebird were investigated in their natural habitat. Seventy-eight nests were found. Black-cheeked Lovebirds nested inside naturally formed cavities in live Mopane trees, in localities that were used for roosting during the non-breeding season. Fidelity to nest-sites is suspected. Although breeding behaviour was non-cooperative most nests were found in a loosely clumped distribution, likely an 'extension' of the lovebird's intrinsically social nature (phenotype). Nest-site characteristics including cavity dimensions, height from ground, distance to three nearest neighbours, cavity entrance orientation, and nest-shape are given. No nesting requirement appeared to be in limited supply, or affected the population's reproductive output.

INTRODUCTION

Athough lovebirds, genus *Agapornis*, are one of the most common and well-known groups of parrots in captivity, there have been no studies on their breeding or ecology in the wild. Knowledge of the reproductive biology of the *Agapornis* spp. is based on captive study studies (Moreau 1948, Dilger 1960 &1962, and numerable popular avicultural press articles) and anecdotal evidence (Moreau 1945 & 1947, Beesley 1972, Thompson 1987[a,b], 1989, Moyer 1995). The limitations of interpreting data from captive birds into ecological predictions for the species in their natural habitat were unknown.

Like most parrot species lovebirds are generally obligate secondary hole nesters, and exhibit many of the associated behavioural and ecological characteristics, including relatively large clutch size, long nestling period, and white egg colouration (Von Haartman 1957).

Studies of the taxonomy of the genus (Moreau 1948, Dilger 1958, 1960, Eberhard 1998, Racheli 1999) split the species into two groups on the basis of external morphology and behavioural characteristics: physically denoted by the presence or absence of white eye (periophthalmic) rings, with *A. roseicollis* as the intermediate. The four white eye-ring forms (*A. personata, fisheri, lilianae* and *nigrigenis* are sexually monomorphic and tend to live and nest in colonies; whilst the more 'primitive' plesiomorphic forms exhibit sexual dimorphism and live in pairs. Five of the lovebird species (white eye-ringed plus *A. roseicollis*) are the only psittacines, apart from Monk Parakeets (*Myiopsitta monachus*) that construct a nest, although lining the nest cavity and some cavity modification is widespread across members of *Psittacidae* (Forshaw 1989). The remaining *Agapornis* species exhibit the more typical parrot nesting traits: lining a tree cavity with nest material, whilst *A. pullaria* and possibly *A. swinderniana* excavate a burrow in arboreal ant nests (Forshaw 1989). Anecdotal records exist of some lovebirds, including *A. roseicollis*, and some feral lovebird populations, including hybrids, utilising crevices in cliffs, buildings and communal weaver nests (Forshaw 1989, Haugaard 1995, Moreau 1947).

The Black-cheeked Lovebird *Agapornis nigrigenis* is a small-sized parrot (13-14 cm long; 38.85g) (Maclean 1984, Warburton 2001, 2002) and classified as a Vulnerable species (Birdlife International 2000). The species is found within a highly localised range of approximately 2 500 km^2, in south-west Zambia. Black-cheeked Lovebirds are closely associated with woodland dominated by Mopane *Colophospermum mopane*, and forage and drink in adjoining habitats, such as riverine vegetation, agricultural fields, and grassland plain with vegetated termiteria. Daily access to water is critical. Population numbers appear to be considerably lower than in the early 20^{th} Century, estimated at 10 000 individuals (Dodman 1995, Dodman *et al.* 2000). The initial population decline is attributed to large-scale trapping for the cage bird trade, and their apparent non-recovery to a combination of factors, including natural desiccation of the area reducing the availability of surface water, increased human pressure including disturbance to the remaining water resources and the change in local agricultural cropping patterns.

The Black-cheeked Lovebird is a non-territorial, highly sociable species, with primarily sedentary habits. Their roosting and nesting locations are confined to Mopane woodland. Prior to this study there was only one nest record for *A. nigrigenis,* 8 m above ground level in a dead Mopane tree near Katombora, Zambia, found in November 1963 by Ashton, in Brooke (1967). The breeding season was recorded as November to December (Forshaw 1989, Maclean 1984) although breeding behaviour was not observed during fieldwork conducted during these months in 1998/1999 (chapter 7).

It was hypothesised that Black-cheeked Lovebirds would be cavity nesters, utilising the same locations for nesting as for roosting, on the basis of the bird's fidelity to the site during the rest of the year. Some form of coloniality was expected, and it was anticipated that the birds would retain their gregarious and highly sociable habits. Although nesting sites were not expected to be in limited supply, it was hypothesised that some other breeding season requirement may be in limited supply and affect the population's reproductive potential.

Knowledge of the nesting requirements for the Black-cheeked Lovebird are necessary to develop a long-term conservation strategy for the species. The aims of this aspect of the study were to locate and describe Black-cheeked Lovebird breeding sites, nest-site characteristics, and requirements. Breeding behaviours are described elsewhere (chapter 7).

METHODS AND MATERIALS

Study site

Zambia is a landlocked country in southern-central Africa. Black-cheeked Lovebirds are located in the driest region, within the Southern and Western Provinces, in a vast plain area, altitude 914 - 1 341 m, intersected by the floodplains and tributaries of the Zambezi and Kafue Rivers. The climate in the region is marked by two distinct seasons. A rainy season, usually from November to March, with a mean annual rainfall of 600 mm (NPWS/JICA 1999), and a dry season from April to November, with April being a transition month. July is the coldest month with a mean maximum temperature range of 22 - 28°C, and mean minimum 5 - 7°C; and October the hottest, with a mean maximum of 31 - 35°C, and mean minimum 15-18°C (NPWS/JICA 1999). Black-cheeked Lovebirds exist in two distinct but adjacent geographical ranges between 15° - 17°S and 24° - 26°E (Dodman 1995, Dodman *et al.* 2000). The northern population occurs along the Nanzhila River, largely confined to Kafue National Park and surrounding Game Management Areas (GMAs). The southern population is centred around the Machile and Sichifulo Rivers, with the Simatanga River to the north and Ngweze River in the south forming the limits of the species' range. The area is exposed to serious water shortages from June to December since all rivers in the region, with the exception of the Zambezi and Kafue Rivers, are ephemeral. The dominant vegetation within the range of the Black-cheeked Lovebird is Mopane woodland, which is associated with deposits left behind by an ancient lake that was drained by the downfaulting of the Zambezi trough (Bingham 1994) and forms a relatively isolated stand.

Methods

Observations were made over one breeding season covering four months (February - May 2000) of intensive fieldwork, using Swift 8x42 binoculars and a Kowa 10x telescope for observations. Locations were recorded using a 12XL Garmin GPS. Widespread flooding imposed limitations on observer mobility and only one area in the mid-Machile River region was found to be accessible. Once breeding areas were discovered, data collection was divided between all-day watches conducted from just before sunrise (lovebird emergence from roost/nest cavity) to sunset (lovebird entry into cavity) in three four-hour observer shifts; and opportunistic observations whilst searching the locality for active nests and measuring and checking on known nest trees. During each observation, number of birds, sex (if known from activity), time, location, behaviour and presence of other species was noted.

A tree cavity was recorded as a nest if lovebirds carried nest material into the cavity and/or were observed emerging from the cavity exhibiting breeding behaviour. The location was recorded and tree marked with biodegradable plastic tape, and named for observer recognition. Sixty-five trees were then climbed and the following data collected: GPS co-ordinates, species of tree, tree circumference at breast height (cm), height of cavity from ground (m), compass orientation of nest-hole, type of branch in which nest-cavity was located (dead, live, dead section of a live branch), cavity entrance dimensions (mm), cavity depth from lip of entrance to internal back wall (mm), nest length (mm) and nest shape (when visible), number of entrance holes, signs of occupation (chewing at entrance of nest, presence of adult lovebirds, number of chicks (when visible), and the distance to the three nearest known nests and nearest tree with a circumference >1m at breast height (i.e. judged as potentially capable of having a cavity suitable for lovebird nesting). As the study-site lacked any formal boundaries, to determine how lovebirds nest relative to one another, nearest neighbour distances were measured within a core area (17 500 m^2) of the nesting locality, where we were confident of locating all active nests. Within this area all (52) known nest locations were mapped by GPS (using compass bearings and measuring distances to known reference points), (figure 1). An envelope was used to reduce edge effect in the analysis of nearest-neighbour distances which followed Krebs (1989) using an index of aggregation (R) followed by testing for significant deviation from a random pattern (z). Thompson's Test was used to evaluate the null hypothesis of random spatial patterning to the second and third nearest nests (Krebs 1989). Nest-cavity orientations were tested for normality using a Kolmogorov Smirnov test.

RESULTS

Seventy-eight lovebird nests were found. Birds were observed copulating and collecting nest material when observations began on 2/2/00. (The previous field season had finished on 5/12/99 without making any specific breeding behaviour observations in the same locality). Data collection continued until 14/5/00 by which time fledging was complete.

Nesting regions

Black-cheeked Lovebirds were found nesting in a loose colonial pattern within Mopane woodland. Nesting activity was recorded at two localities, 3.12 km apart, known, from observations made during 1999, to be roosting areas outside the breeding season. These were used by a stable number of lovebirds from the first roosting site discovery in early June 1999 until the close of the 1999 field season in mid-December (chapter 9). A third known (although little studied) roosting area in the locality revealed no lovebird nesting sites.

Spacing of nests and nearest neighbour

To determine how lovebirds nest relative to one another, nearest neighbour distances were measured (n = 52) within a core area of 17 500 m^2 in one of the nesting localities (figure 1). For the nearest neighbour analyses it was assumed that the entire area was suitable for nesting. This seemed justified because the vegetation type was homogeneous with that of the area outside the demarcated core area. The index of aggregation R = 0.60 indicating a tendency towards an aggregated pattern away from randomness; z = > 1.96 (5.48) indicating distance to nearest nests were not randomly spaced (Krebs 1989). The distance to the second closest nest indicated a regular spatial pattern, a normal approximation of z = 4.61; although distance to third nearest nest indicated a tendency towards aggregation z = - 22.83 (Krebs 1989).

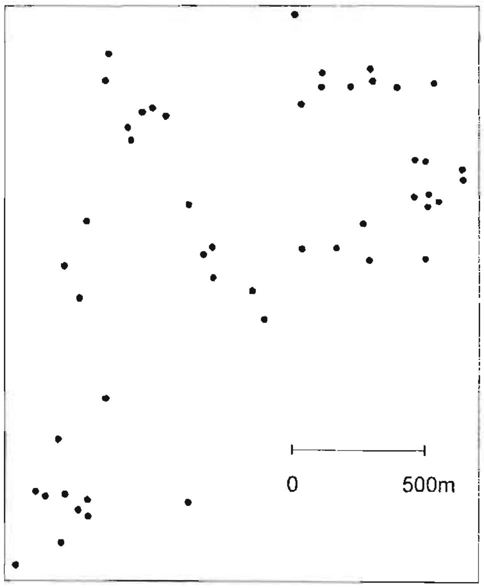

Figure 1. Location of nests (• = 1 nest) relative to each other in core nesting location.

Distances from nest trees to the nearest tree (circumference > 1 m) and three nearest nests were measured (table 1). Two-thirds (67.3%) of closest neighbouring nests were found between 2 – 8 m away. Distance to the nearest tree (CBH > 1 m) was typically within 3 – 8 m (74.5% n = 51)

Table 1. Distance from nest tree to nearest tree (CBH >1 m) and three nearest nests

Distances (m)	$\bar{x}$	S.E.	Range	n
Nearest tree	4.63	0.39	0.77 – 12.3	52
Nearest nest	6.53	0.5	1 - 16	52
2nd nearest nest	11.14	2.47	2 – 130	51
3rd nearest nest	11.64	0.88	3 – 31	50

Choice of nest trees and other cavity users

Tree species nest-site choice was highly specific. All nests were found in naturally formed cavities in Mopane trees, all but one nest (which was subsequently abandoned probably as a result of tree squirrel *Paraxerus cepapi* disturbance) were in live trees.

Twenty-five other cavity-nesting bird species were observed in the lovebird nesting locality (table 2), of which four were observed breeding concurrently with lovebirds.

Table 2. Other cavity-nesting bird species observed in the lovebird breeding locality

* denotes species known to breed during the same season as *A. nigrigenis*.

Grey-headed Parrot	*Poicephalus fuscicollis suahelicus*
Meyer's Parrot	*Poicephalus meyeri*
Giant Eagle Owl	*Bubo Lacteus*
Pearl-spotted Owl	*Glaucidium perlatum*
Scops Owl	*Otus senegalensis*
Barn Owl	*Tyto alba*
Woodland Kingfisher	*Halcyon senegalensis*
Striped Kingfisher	*Halycon chelicuti*
Lilac-breasted Roller	*Coracias caudate*
*Broad-billed Roller	*Eurystomus glaucurus*
African Hoopoe	*Upupa epops*
*Red-billed Woodhoopoe	*Phoeniculus purpureus*
Scimitar-billed Woodhoopoe	*Phoeniculus cyanomelas*
Ground Hornbill	*Bucorvus leadbeateri*
*Red-billed Hornbill	*Tockus erythrorhynchus*
Grey Hornbill	*Tockus nasutus*
Crested Barbet	*Trachyphonus vailantii*
Bearded Woodpecker	*Thripias namaquus*
Cardinal Woodpecker	*Dendropicos fuscescens*
Southern Black Tit	*Parus niger*
Arnot's Chat	*Thamnolaea arnoti*
*Long-tailed Starling	*Lamprotornis mevesii*
Burchell's Starling	*Lamprotornis australis*
Greater Blue-eared Starling	*Lamprotornis chalybaeus*
Southern Grey-headed Sparrow	*Passer griseus*

Re-use of nest sites

Inspection of some roost holes, which were not used as nests during the 2000 breeding season, revealed the presence of nesting material, suggesting that lovebirds either line roosting holes with material, or that they roost in cavities previously used for nesting (chapter 9). Difficulty of observation through small cavity entrances may have precluded observation of vegetative matter in some cavities. Tree squirrels were also observed depositing vegetative matter into cavities. Four (24%) of the 17 previously observed roosting cavities, were used as nesting cavities during the 2000 breeding season.

Number of nests per tree and cavity entrances

Only one lovebird nest was recorded in any one tree. Although not quantified, most trees contained more than one cavity probably suitable for lovebird nesting. One lovebird nest shared the same tree as an active Red-billed Woodhoopoe *Phoeniculus purpureus* cavity-nest. The hoopoe nest was at a more advanced stage, with chicks being fed during the time the female lovebird was still displaying typical incubation behaviour. During 37.5 hours of observation of this nest over three days no interspecific behaviour was recorded between lovebirds and hoopoes.

Three nest-trees were observed which had two (apparently separate) cavities into which nest material was deposited. In two of the trees, the second cavity was used as a roost by a single adult bird from the nesting pair during incubation and early brooding, then later, also by fledglings, whilst sibling-nestlings remained in the nest-cavity. Checking inside the third tree's roosting cavity revealed a half-constructed cup-shaped nest. Observation into the second nest cavity in that tree was not possible given the small size of the cavity entrance (see chapter 9).

Most nest cavities, 57% (n = 33) had a single entrance, 33% (n = 19) had two, and 10% (n = 6) three.

Cavity entrance orientations

No specific orientation was selected,(n = 64). 40.6% faced directly upwards, the remaining orientations illustrated in figure 2, were random (Kolmogorov Smirnov d = 0.123, $P < 0.05$).

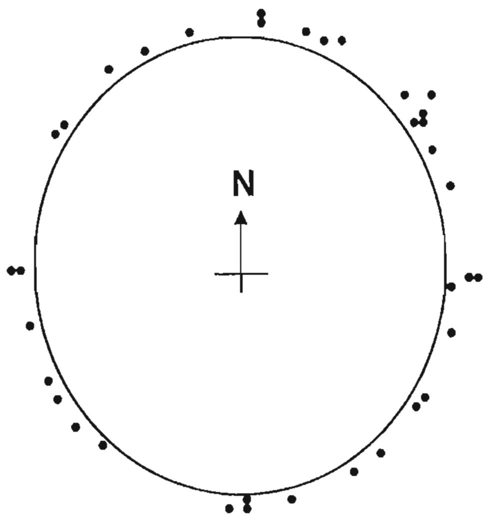

Figure 2. Nest-cavity entrance orientations (non-sky facing) relative to North, (• = 1 nest)

Nest tree and cavity dimensions

Table 3 summarises height of cavities from ground level, tree circumferences at breast height and cavity height, cavity dimensions and nest lengths.

Table 3. Nest site characteristics

Nest Characteristic	$\bar{x}$	S.E.	Range	n
Cavity height from ground (m)	10.44	0.21	7.11 – 13.73	60
Tree circumference at breast height (cm)	215	7.93	110 - 360	58
Cavity entrance height (mm)	97.51	8.34	40 – 405	65
Cavity entrance width (mm)	64.43	4.35	30 - 240	65
Tree circumference at cavity (mm)	631.37	19.46	80 - 1000	60
Cavity depth* (mm)	137.52	11.38	25 - 320	33
Nest length (mm)	417.27	47.75	220 - 830	11

* Measurement taken from the lip of cavity entrance to internal back wall.

Cavity condition

Most cavity entrances (65%) were found in live areas of a tree, 22% in dead sections of live branches and 13% in dead branches (n = 60).

Cavity modification and signs of occupation

Unless lovebirds were perched near to or looking out from cavity entrances, there were usually no external signs to indicate cavity use. Out of the 61 nest-cavity entrances inspected, 61% (n = 37) showed no external signs of occupation; 15% (n = 9) showed some chewing (adults and juveniles infrequently chewed at the entrance), 13% (n = 8) showed some faecal marking, 5% (n = 3) had protruding nest material, 3% (n = 2) had material and faeces, and one nest had chewing and faeces. The chewing did not develop into cavity modification as there were no significant changes to original cavity dimensions: the Mopane wood was too hard for lovebirds to manipulate.

Nest shape

Distance from cavity entrances to the top of nest structures ranged between 80 – 1600 mm, with a mean ± S.E. of 462.48 ± 56.87 mm (n = 33), and was occasionally integrated as part of the nest structure in the form of a woven tunnel. It was possible to measure the length of 10 nests, these ranged between 220 – 830 mm, mean ± S.E. of 417.27 ± 47.75.

Observations of nest shapes inside cavities were difficult to make and varied from an open-cup to a domed structure, others had half a roof structure. Nests with a full roof structure but no tunnels had a perfectly round entrance hole with a rim around the top surface, not necessarily in line with the cavity entrance. Open cups were also observed when chicks were hatched, so were presumed to be completed in the desired structure. At least one nest was suspected of having two chambers, with chicks occupying both. Material appeared intricately woven although given the relatively rough texture of the major substrate used (usually Mopane petioles) the appearance was not as neat as a weaver nest made of grass. Nests were superficially lined with feathers, leaves, bark and grass. Inspection of broods inside nests showed advanced-stage nestlings to be packed tightly together (see chapter 7).

DISCUSSION

Black-cheeked Lovebirds nested inside naturally formed cavities in live Mopane trees, in localities that were used for roosting during the non-breeding season. Although breeding behaviour was non-cooperative (chapter 7) most nests were found in a clumped distribution, this is likely an 'extension' of the lovebird's intrinsically social nature. No nesting requirement appeared to be in limited supply, or seemed to affect the population's reproductive output.

The primary functions of a nest are to provide a receptacle, ensure safety, and insulation for the eggs and developing young (Maclean 1990). Nest structure is closely related to habitat and species habits (Collias 1964), and Black-cheeked Lovebirds are no exception. Benefits of cavity nesting include shelter from external elements, energy conservation and greater protection from predators (Collias 1964, Du Plessis & Williams 1994).

Nest-site distribution

The colonial tendencies of the Black-cheeked Lovebird are uncommon in other bird species, including parrots (Eberhard *in press*). A colony is '*a breeding aggregation of birds characterised by many individuals nesting close to one another, generally feeding outside the nesting area, and organised by various types of social stimulation and elements of flock behaviour*' (Kharitonov & Siegel-Causey 1988). Colonial breeding tends to be found in stable habitats where environmental variables are predictable and life-long monogamy among colonial breeders is typical (Kharitonov & Siegel-Causey 1988), although there is no general conclusion concerning its evolutionary function (Rolland *et al.* 1998). For coloniality to evolve breeding pairs must be able to nest in close proximity; non-excavating species depend on pre-existing cavities which may limit nest-site choice (Eberhard *in press*). Black-cheeked Lovebirds have overcome these limitations by occupying Mopane trees which naturally form numerous cavities, and by constructing nests which provide the potential to modify otherwise unsuitable cavities into nest-sites. The natural abundance of cavities in Mopane (Palma & Pitman 1972, Roodt (not dated), Smith & Shah Smith 1999, Storrs 1995) means that unlike most secondary hole nesters, the Black-cheeked Lovebird is not dependant on primary hole creators or extreme maturation of individual trees. All nest-site cavities observed appeared not to be excavated by other species such as woodpeckers or barbets. Nest site acquisition and defence are therefore of less importance to the species than for those where sites are in limited supply. This lack of competition enables a greater degree of social contact, than if nest-sites were in limited supply and subject to territorial defence. Although no observations suggest that lovebirds are co-operative breeders, maintaining close social contact with other flock-members throughout the breeding season appears to be important to lovebirds.

Few studies exist pertaining to the reproductive stimuli of parrots. Captive studies of Budgerigar's *Melopsittacus undulatus* indicate that a combination of nest-box availability, vocal stimulation from males, darkness and the position of perching outside the nest box all have some influence on male and female gonad development (Ficken *et al* 1960, Brockway 1962). A study on captive Rosy (Peach)-faced Lovebirds *Agapornis roseicollis* showed that preparation of nest material is mediated at least partially by oestrogen (Orcutt 1967). The coloniality of Black-cheeked Lovebirds is likely to act as a socio-sexual stimulant with the sight of one female performing nesting activity stimulating others to copy, as for Budgerigars (Brockway 1962). Other sexual stimulants are discussed in chapter 7.

However, Black-cheeked Lovebirds did not nest as close to each other as the cavity availability combined with nest-building modifications in the Mopane woodland would have allowed. Suggesting reasons for this is problematic. From the nesting pattern observed it appears that the lovebirds need the social stimulation of others close by, but not as immediate neighbours, perhaps as an anti-predation measure. Similar to the observation of a Black-cheeked Lovebird nest tree being concurrently used by another cavity nester, a Red-billed Woodhoopoe, Lilian's Lovebird have been recorded using the same Mopane tree as a Greater Scimitarbill Woodhoopoe *Rhinopomastus cyanomelas* (Fothergill 1984).

The close association of the species with Mopane is probably a function of cavity availability, and to a lesser extent on the associated abundance of annual grasses which form the lovebird's staple diet (chapter 4).

Nest-site fidelity

Parrots show a strong fidelity to nesting sites, and are conservative in the areas selected, using only a small fraction of the available habitat for breeding (Gnam 1988, Robinet & Salas 1999, Saunders 1982, Snyder *et al.* 1987). At Lake Naivasha, Kenya, feral hybrid lovebirds (*A. personata* x A. *fisheri*) permanently occupy the same various tree cavities throughout the year (Thompson 1987). Although anomalous to most parrot nesting habits, studies of Monk Parakeets *Myiopsitta monachus* (Eberhard 1996) found unbroken use of the same nest-site throughout the year for roosting and breeding. The Monk Parakeet showed a low nest-site fidelity, with up to 47% of the population changing nests between years, which was correlated with parasitic infestation in the compound nests (del Hoyo *et al.* 1997). It remains unknown whether Black-cheeked Lovebirds re-use the same nests or locality in subsequent breeding seasons, although given their annual fidelity to feeding, roosting and drinking areas (chapters 4, 9, 10) it seems likely. Observations during early April 1999 found lovebird activity at the same locality in which nesting was observed in February 2000 although at the time it was not identified as a breeding (or roost) site. In retrospect the activity level, time of observation and number of birds observed suggests the lovebirds seen in April 1999 were likely to have been fledglings, suggesting breeding site fidelity. Black-cheeked Lovebirds showed no difference in habitat preference for feeding and roosting activities throughout the breeding season compared with the rest of the year.

Function of nest-building in cavities

Two hypotheses are suggested to explain parrot nest building behaviour: either that it evolved from the habit of lining the cavity with material or through nest adoption (Eberhard 1998). Following the evolutionary trend in speciation within the genetic tree for the *Agapornis* genus from the 'primitive' to 'advanced' white eye-ringed lovebird species (Eberhard 1998, chapter 2), it can be seen that nest-building has also evolved, from the building of a domed nest by the more 'advanced' white eye-ringed lovebird species derived from the habit of simply lining the nest cavity, which is the habit of the non white eye-ringed species (Eberhard 1998). The construction of a nest within a cavity appears to modify cavities that might otherwise have proved unsuitable for nesting (Eberhard 1998), this facilitates colonial breeding. There are suggestions that nest-building by the white eye-ringed lovebirds and *A. roseicollis,* co-evolved with their colonial tendencies and is also hypothesised to be largely habitat related (Eberhard 1998). In Tanzania, Fischer's Lovebirds *A. fischeri* breed communally in Baobab and Palm trees, in this habitat more than one pair may nest in the same tree, but, in *Acacia/Commiphora* woodland habitat nest sites are more dispersed (Moyer

1995). In Mopane woodland nest-building likely enables the lovebirds to exploit cavities in closer proximity to other lovebird nests than would otherwise be feasible, rather than being fundamental to cavity nesting. This is indicated by the number of other hole-nesting but non-nest building avian species found in the same habitat. The lovebirds were the only colonial cavity breeder observed.

Nest shape

Nest shape of *A. nigrigenis* was first described by Philips (1907, 1908), the first to breed the species in captivity. It was described as, 'quite substantial', cup-shaped to begin with and eventually completed as an enclosed structure with a small entrance slit at the back. Dilger (1960, 1962) studied the captive nesting habits of the *Agapornis* species in detail. He describes the nests of the periophthalmic species as an elaborate structure constructed from interwoven and carefully positioned nesting material, consisting of an enclosed chamber at the end of a tunnel from the cavity entrance. The entire nest can be removed from the nesting cavity (box) without losing shape (Dilger 1960), which concurs with anecdotal evidence from most aviculturalists (*pers. comm.* Povlsen, Lamke, Künzel, Potgieter) although contradicts Moreau (1947).

Captive Black-cheeked Lovebirds build a variety of nest shapes, including intra-colony with uniform sized nest boxes. Some aviculturists report nests with two chambers, the back chamber used as the brood chamber and the front by the male for roosting (*pers. comm.* Lamke, Künzel, Potgieter, Drew), which concurs with a couple of our observations. Few aviculturists reported universal nest shapes within their lovebird colonies (*pers. comm.* Scopes; D.v.d.W.Hofmeyer), with a single record of a woven entrance tunnel (*pers. comm.* Potgieter).

Studies of captive Masked Lovebirds *A. personata* indicate that nest shape is variable: where space in the nest box was limited the domed roof of the nest may be omitted, or if the box opening was too large material might be piled up against it to reduce the size (Eberhard 1998), or perhaps to increase darkness. The suggestion that nest-shape is adaptive to cavity specifications further suggests that the lovebirds build nests as a way of modifying the tree cavity for their own purposes, and that if the cavity is well insulated, and/or sufficiently dark the lovebirds do not build a roof over the nest. Lovebirds primarily modify cavities through building a nest, which decreases the internal dimensions of the cavity. This allows use of space which would otherwise have been unsuitable for nesting, the nest structure is built to provide a base, sides and sometimes an upper surface. However, observations by captive breeders of Black-cheeked Lovebirds suggest that variable nest-shape occurs within colonies that have uniformly sized nest boxes and similar access to nesting materials. Also that individual pairs may build different nest-shapes in the same sized nest boxes between season (*pers. comm.* D.v.d.W. Hofmeyer), which suggests that variation in nest shape may be an inherent trait of the species, and independent of nest-building experience and cavity dimensions.

Captive studies could quantify lovebird nest-building modification as an adaptation to variables such as cavity/nest-box shape, size, number of entrance holes, amount of infiltrating light etc; and also test the differences in nest-shape between experienced and inexperienced breeding birds. Experiments involving Village Weaverbirds *Textor cucullatus* showed that young birds raised without access to nest materials required considerable practice before a complex nest structure could be built (Collias & Collias 1964). It is hypothesised that nest shape varies as a result of two factors: the females' nest-building experience, with the less experienced birds constructing the more simple cup-shaped nest; and internal cavity dimensions, with more bulky enclosed nests being built inside the larger cavities where there is more space.

In the *Acacia* dominated habitat of Lake Naivasha, resident feral hybrid (*A. personata* x *fisheri)* lovebirds conduct substantial modification of nesting cavities (Thompson 1987), suggesting the *Acacia* wood is more pliable to manipulation by lovebirds than Mopane, and/or competition for nesting cavities was more pronounced. The Lake Naivasha hybrid population were also observed to burrow down and nest in the central core of dead branches (Thompson 1987). Many Mopane trees are hollow as a result of heartwood removal by fungi and insects, this is probably beneficial to the tree as it gains nutritional benefits and becomes less susceptible to felling (Smith & Shah-Smith 1999). The chewing behaviour observed in *A. nigrigenis* is likely a displacement activity or conducted as part of bill maintenance. Other parrot studies have indicated that some species are able to modify nest cavity size, primarily though chewing away internal sides. Both Hispaniolian Amazon Parrots *Amazona ventralis* and Puerto Rican Parrots *A. vittata* have been recorded as modifying the internal dimensions and cavity entrance dimensions through chewing (Snyder *et al.* 1987). Cape Parrots *Poicephalus robustus* and Grey-headed Parrots *P. fuscicollis suahelicus* are capable of the same (*pers. comm.* Symes).

Nest site selection and availability

Height of trees was not measured, although records from literature for the 'tall' physiognomic form of Mopane, which lovebirds used for nesting, are between 13 - 24 m (Bolza & Keating 1972). Compared with other hole-nesting bird species observed breeding concurrently (table 2), the lovebird's cavities were much higher from ground level. This suggests that the Black-cheeked Lovebirds were at least partially selecting their nest cavities on the basis of height from ground. There is a wide range in the mean height of nest cavities from other studies of parrots (Lanning & Shiflett 1983; Marsden & Jones 1997; Nelson & Morris 1994; Snyder *et al.* 1987). Although height in the tree species containing nest-cavities varies, making inter-species comparison difficult, there appears to be a general preference for higher nest-sites. Monk Parakeets have also been observed to nest high above ground level where there is a choice (Navarro *et al.* 1992). However, studies of the feral hybrid population at Lake Naivasha revealed no obvious preference for any particular cavity type or height (Thompson[a,b] 1987), and Moreau (1948) described the white eye-ringed species as indiscriminate cavity nesters. It is hypothesised that where there is an abundance of available cavities, such as in Mopane habitat, the associated lovebird species (*A. nigrigenis* and *A. lilianae*) have the opportunity to be more discriminating in their choice of nest-site cavity, for example, when compared with those species associated with other less cavity-bearing habitats, such as the *Acacia* woodland around Lake Naivasha, where lovebirds appear indiscriminate in their cavity choice. Records include *A. fischeri, A. personata* and *A. roseicollis* nesting in cliffs, communal weaver nests and under the base of Palm fronds (Forshaw 1989), this diversity of nest-sites compared with those recorded for *A. nigrigenis* and *A.lilianae* may be indicative of a relative scarcity of suitable tree cavities for these other lovebird species.

No specific orientation of cavity entrance was selected. Randomness can either be explained as a lack of preference or lack of choice. Non-random nest-site orientations have been reported for a number of hole-nesting species of birds, including parrots (Rodriguez-Vidal 1959, Symes & Perrin *in press*), although the values of specific aspects have not been clarified for most species, beyond speculation of temperature regulation benefits (Snyder *et al.* 1987).

As a tentative supposition, the lovebirds could make nest-site selection on the basis of which cavity offers protection from the rain rather than wind and direct temperature effects, especially since the eggs are laid within the comparative insulation of a nest within a cavity, and the rains were at the height of their fall during the incubation period for the majority of lovebirds. Smaller cavity entrances may offer better protection from the elements, reduce light infiltration and may discourage nest-hole predators; construction of a woven tunnel-like structure as part of the nest may serve the same function.

Height of the cavity above ground, distance to nearest lovebird neighbour and possibly cavity entrance dimensions were probably the principal nest-site characteristics selected by the lovebirds. Orientation and number of entrance holes appeared less important and were probably a function of less discriminate selection processes.

Unlike many other parrot species, Black-cheeked Lovebirds do not have a limited supply of nesting cavities that could potentially limit breeding output. Although it was not possible to identify if there were any non-breeding lovebird adults, it is unlikely that this would be related to the scarcity of nest-sites as with some other parrot species, for example the Puerto Rican Parrot (Snyder *et al.* 1987), Great Green Macaw *Ara ambigua* (Reintjes *et al.* 1997, López-Lanús 1999), Red-tailed Amazon *Amazona brasiliensis* (Lalime-Bauer 1999), Cape Parrot (Wirminghaus *et al.* 2001), and Grey-headed Parrot (Symes & Perrin *in press*).

Given the relative abundance of available cavities within the Mopane woodland habitat, the localised nature of lovebird breeding distribution is not likely to be a function of limited cavity availability. The occurrence of many apparently unoccupied holes does not necessarily imply an overabundance, as some cavities may be inhabited by microfauna including an overload of parasites making the hole unsuitable for avian habitation (Brawn & Baldo 1988).

If nest-site distribution is not a function of cavity availability there is need to invoke further additional factors to explain the localised restriction of nesting activity, such as the species' socio-biology.

End note

Extrapolating the nest-site density data recorded from the mid-Machile region in this study should be made with caution, given that data are available from only a single breeding season and from one locality known to contain the highest density of *A. nigrigenis* (chapter 3). The collection of breeding data from other areas of the species' range would meet with considerable practical challenges given that much of the range during the breeding season is flooded. Breeding data from other lovebird species, in particular *A. lilianae* that are also associated with Mopane habitat, and *A. roseicollis* a more widespread species associated with thornveld habitat (less cavity abundant), would be useful to compare for the presence of coloniality, and other nest-site characteristics.

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CHAPTER SEVEN

BREEDING BIOLOGY OF THE BLACK-CHEEKED LOVEBIRD, *Agapornis nigrigenis* IN ZAMBIA.

"Black-cheeked Lovebirds are adding constantly to their already numerous progeny"

Lee Crandall, New York Zoological Society Bulletin 1914.

ABSTRACT

The breeding biology of Black-cheeked Lovebirds in their natural habitat and captivity was investigated as part of a wider study on the ecology of the species. The study obtained basic reproductive data and elucidated factors affecting reproductive success in order to assist with the development of a conservation management plan for this Vulnerable species. Prior to this study little was known about the biology of this parrot or other members of the genus (Collar 1998, Forshaw 1989, del Hoyo *et al.* 1997, Juniper & Parr 1998). This study is the first collection of breeding data for the species in the wild and first detailed field study within the genus. Breeding occurred from mid- to late January to early May, coinciding with annual maximum rainfall and the early dry season, with only a single clutch raised by most pairs per breeding cycle. Nesting chronology is correlated with mean rainfall and major food source availability. Behavioural data on nest building and location, defence and predation are presented. In addition, courtship, copulation, parental care and juvenile behaviours are reported. Breeding biology, including clutch size, laying interval and hatching success of captive birds is discussed.

INTRODUCTION

The Black-cheeked Lovebird *Agapornis nigrigenis* is near endemic to Zambia. The species is locally common with a clumped distribution within a highly localised core range of 2 500 km² of Mopane *Colphospermum mopane* woodland (Dodman 1995, Dodman *et al.* 2000). Although some of the nine lovebird species within the genus *Agapornis* are among the most common parrots in captivity there have been no prior studies on their breeding biology or ecology in the wild. Current knowledge is based on captive studies (Moreau 1948, Dilger 1960, 1962, and numerous popular avicultural press articles) and anecdotal observations in natural habitat (Beesley 1972, Moreau 1945, 1947, Moyer 1995, Thompson 1987[a,b], Thompson & Karanja 1989). The limitations of interpreting data from captive birds to form ecological predictions for the species in its natural habitat were unknown.

Studies of the taxonomy of members of the genus (Moreau 1948, Dilger 1958, 1960) placed the constituent species into two groups on the basis of external morphology and behavioural characteristics: physically denoted by the presence or absence of white eye (periophthalmic) rings, with *A. roseicollis* as an intermediate. The four white eye-ring forms (*A. personata, A. fisheri, A. lilianae* and *A. nigrigenis*) do not show sexual dimorphism and tend to live and nest in colonies; whilst the more plesiomorphic forms exhibit sexual dimorphism and nest as pairs.

The Black-cheeked Lovebird is a non-territorial, highly sociable species, with primarily sedentary habits (chapter 3). The roosting and nesting locations are confined to Mopane woodland. Prior to this study there was only one nest record for *A. nigrigenis,* 8 m above ground level in a dead Mopane tree near Katombora, Zambia, found in November 1963 by Ashton (in Brooke 1967). No behavioural observations were made. The breeding season was recorded as November to December (Forshaw 1989, Maclean 1984) although fieldwork conducted by the author during these months in 1998/1999 did not observe breeding behaviour during these months. The first records of the species breeding in captivity come from R. Phillipps in 1907 who was among the first aviculturists to receive the birds in Europe (Phillipps 1907/8).

The lovebird breeding season extends from mid-January until April and coincides with the rainy and agricultural crop-ripening season. Widespread flooding imposed limitations on observer mobility at this time. Access to only one area in the mid-Machile River region where lovebirds had been observed roosting, feeding and drinking from May to December during 1999, was known. In fact the mid-Machile River region is home to the largest known density of Black-cheeked Lovebirds and was identified by Dodman (1995). Therefore, the large numbers of lovebirds found nesting in this locality may not be completely representative of the population dynamics as a whole.

The aim of this paper is to provide baseline reproductive data and to elucidate the factors affecting the reproductive success of this species in order to prepare a conservation management plan for this Vulnerable species.

METHODS AND MATERIALS

Study site

Zambia is a landlocked country in southern-central Africa. Black-cheeked Lovebirds inhabit the driest region of Zambia, a vast plain, altitude 914-1 341 m, intersected by the floodplains and tributaries of the Zambezi and Kafue Rivers within the Southern and Western Provinces. The lovebird's range is marked by two distinct seasons; a rainy season, usually from November to March, with a mean annual rainfall of 600 mm (NPWS/JICA 1999), and a long dry season from April to November, with April being a transition month. July, the coldest month, has a mean maximum temperature range of 22 - 28°C, and mean minimum of 5 - 7°C; while October is the hottest month, with a mean maximum of 31 - 35°C, and mean minimum 15 - 18°C (NPWS/JICA 1999). Black-cheeked Lovebirds exist in two distinct but adjacent geographical ranges between 15° - 17°S and 24° - 26°E (Dodman 1995, Dodman *et al.* 2000). The northern population occurs along the Nanzhila River, largely confined to Kafue National Park and surrounding Game Management Areas. The southern population is centred around the Machile and Sichifulo Rivers, with the Simatanga River to the north and Ngweze River in the south forming the limits of the species' range. The lovebird's range is exposed to serious water shortages from June to December as are all rivers in the region, with the exception of the Zambezi and Kafue Rivers, which are ephemeral. The dominant vegetation within the Black-cheeked Lovebird range is Mopane *C. mopane* woodland. Data were collected from across the lovebird's range.

Methods

Information about the breeding biology of Black-cheeked Lovebirds in captivity was obtained from aviculturists who responded to appeals in popular literature (Warburton 1999[a,b], Warburton 2000[a,b]) and internet newsgroups: (APC-LIST@UMDD.UMD.EDU, ParrotAdmin@parrotdata.com, Sabirdnet@lists.nu.ac.za).

In the wild, one breeding season was studied during four months (February-May 2000) of intensive fieldwork as part of a wider ecological study spanning 22 months. Locations were recorded using a 12XL Garmin GPS. Once breeding areas were discovered data collection was divided between all-day watches, operating on a four-hourly rotating observation schedule, conducted from just before sunrise (lovebird emergence from roost/nest cavity) to sunset (lovebird entry into cavity); and opportunistic observations whilst searching the locality for active nests or measuring and checking on known nest trees. In total, 545 hours were spent observing breeding behaviours at two nesting localities: 14 all day watches (totalling 169 observer hours), plus 376 hours in opportunistic observations. All observations were made 15 – 30 m from nest trees using Swift 8x42 binoculars and a Kowa 10x telescope. The activity and location of all lovebirds in the focal nest tree was recorded, including time of day and behaviours, the presence of other species was noted, along with observations of lovebirds within the immediate vicinity. For all day observations lovebird active hours were recorded starting from the first lovebird activity at the focal nest to the last before nocturnal roosting.

A tree cavity was recorded as a nest-site if lovebirds carried nest material into the cavity and/or were observed emerging from the cavity exhibiting breeding behaviour. The location was recorded (GPS) and tree marked with the biodegradable plastic tape, and uniquely identified for observer recognition. Most nest trees were then climbed and measurements taken (chapter 6).

Black-cheeked Lovebirds are sexually monomorphic and do not provide distinguishing characters except in sexually-related behaviours. Therefore, sexes were only assumed if the focal individual(s) were performing behavioural traits and the sex could be identified using knowledge gained from captive behavioural studies with birds of known sex (Moreau 1948, Dilger 1960).

Breeding behaviours and associated activities were quantified by observing the occurrence and timing of behaviours throughout the nesting period. Time budget estimates were placed into five time periods (figure 1). The time periods were associated with: nest-finding, copulation and twigging (nest material collection); incubation; hatching and brooding; nestlings look-out and fledge; post-fledging. These stages are correlated with certain environmental factors including rainfall, and the agricultural crop-ripening season (figure 1). In calculating the proportion of time that males and females were together, or alone, data collection followed Eberhard (1998). It was assumed that the pair were together only if birds were observed to leave and arrive together from the nest site. The female was considered to be alone only if she was being observed and the male was absent. Individuals were considered to be in the 'locality' only if they were within 20 m of the nesting tree.

Unless otherwise specified, mean values ± standard errors, minimum and maximum range values, and number of observations (n) are reported.

No negative effect was detected due to human presence when visiting nests, and observations did not affect the breeding of birds in this study. Care was taken to ensure both adults were absent from the cavity and locality of the nest tree before chicks were removed for sampling, and the cavity entrance was always blocked whilst the chicks were removed to prevent adult entry. On occasions adults returned to the scene before processing and data collection had finished. At these times they showed signs of distress. However, adults always resumed their parental duties within 18 min of our leaving the nest tree. Seven chicks were ringed with Zambian Ornithological Society (ZOS) stainless steel overlap rings, but, rings were removed five days later after follow-up observations noted slight inflammation of the tarsus on two birds close to the ring. Recommendations against ringing pre-fledged chicks, and removing chicks more than once from nest cavities are presented elsewhere (Warburton 2001).

RESULTS

Seventy-eight Black-cheeked Lovebird nesting trees in two localities were identified between February and April 2000. Fifty-nine were climbed for cavity inspection, and the nest inside 16 of the cavities were viewed, of which 13 contained chicks and one contained eggs.

Nesting chronology

Figure 1 illustrates Black-cheeked Lovebird nesting chronology and its synchronisation with mean rainfall and major food source availability. Breeding activities commenced at the end of January with nest- finding and building behaviours and copulations coinciding with the peak annual rainfall period. Incubation spanned February into March, coinciding with still heavy rains and the ripening of the millet crops and wild grass seeds. Hatching and nestling ran across March to mid-April, coinciding with a gradual drop in rainfall and the ripening of the sorghum crops. By the time of the first fledging rainfall has dropped, although not ceased, and the sorghum is into late ripening and harvesting. By the time most juveniles have left the nest in late April and early May the rains have almost ceased, agricultural crops have been harvested although wild grasses are still seeding.

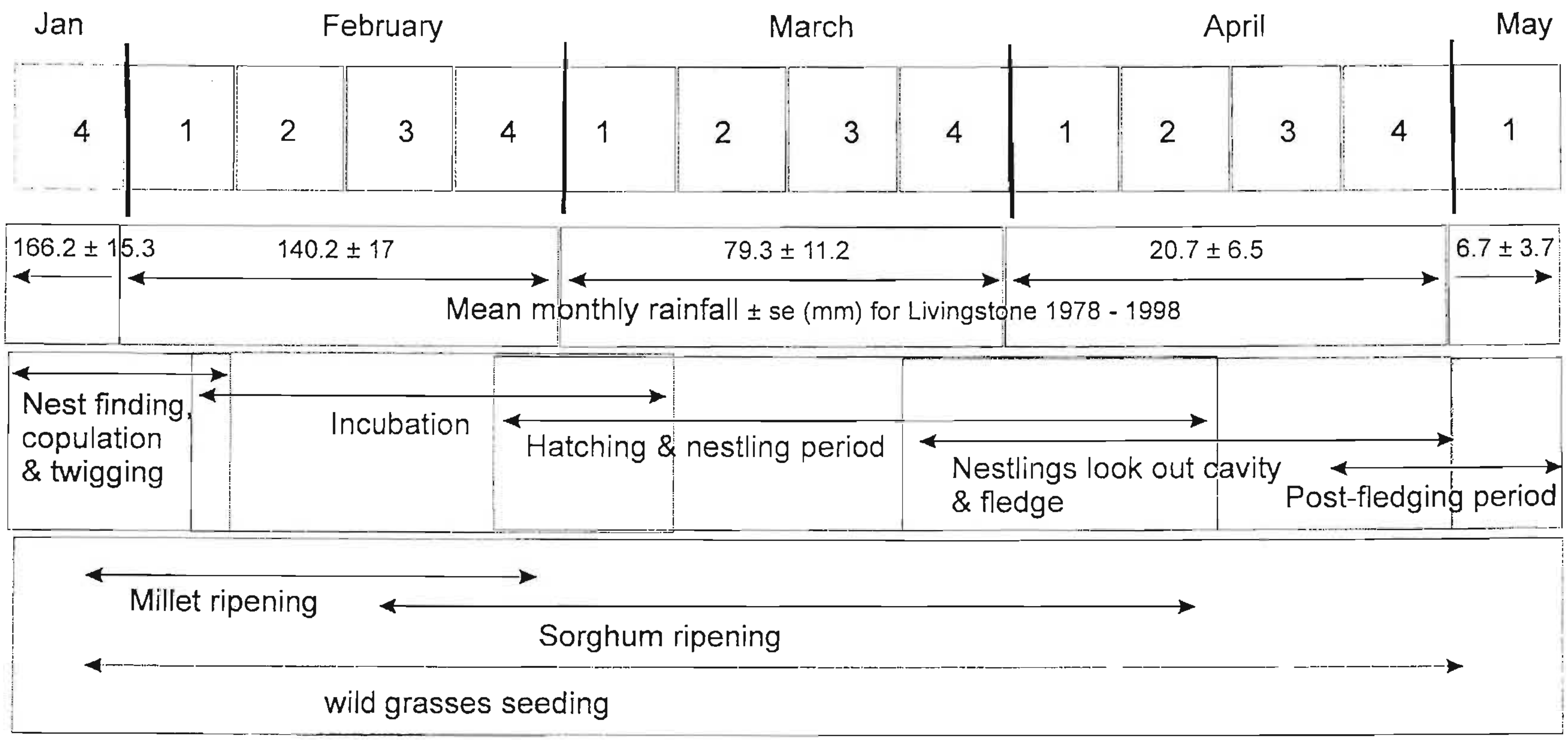


Figure 1. Chronology of Black-cheeked Lovebird breeding activities with monthly rainfall and agricultural crop and grass seed production.

Breeding season and nest-finding behaviours

Breeding occurred from mid-January until early May. Nest-site locations and tree characteristics are described elsewhere (chapter 6). Lovebirds showed no change in habitat preference during the breeding season, the same foraging and roosting habitats were used throughout the year (chapters 3, 4, and 9)

Lovebirds occasionally investigated tree cavities outside the breeding season increasing in activity in November and December; mean flock size for this activity was 3 ± 0.44 birds, (range 1 – 4, n = 10). Usually one bird would repeatedly put its head and shoulders into the cavity, whilst other flock members 'rattle' called. Usually the investigating bird would then briefly enter the cavity, whilst another flock member perched at the entrance. Captive studies suggest similar behaviour, and that it is the female lovebird who tends to investigate the nest-cavity, whilst her mate remains in attendance 'with an interest in her' (Dilger 1960).

Nest-building behaviour

Nest-building behaviour was observed immediately when fieldwork commenced (2 February 2000) and continued throughout the breeding season until observations stopped (27 April 2000) at which time breeding behaviour had ceased. Similar behaviour was not observed during any other month of the year, although it is very likely to have occurred during late January when no fieldwork was conducted, but was not recorded during late December observations. Most (95% n = 119) of the nesting material collected was Mopane twigs, in addition to twigs from Baobab trees *Adansonia digitata*, *Acacia* and *Albizia* spp. and blades of grass. Most twigs (93%, n = 119) were stripped of their leaves and leaf stalks once detached from the tree at the point of collection, and were usually about half as long as the lovebird in length although occasionally they were up to three times their body length. Immediately following collection the twig was sometimes manipulated using the bill and foot to bend the twig stem around the main branchlet stem, where it was held in place by the foot and snipped off using the bill. One end of the twig was then chewed rapidly until it had a frayed appearance before being transported into the nest cavity in the bill. The female made 65% (n = 120) of the material collecting trips alone, although the male would always follow her if he was in at the nest tree at the time of her departure. The majority (81.5% n = 103) of the material collection trips lasted between 1 and 3 min from the time the female left the nest tree to her return into the cavity with the material (table 1). Re-entry into the cavity with material was always very rapid, with the male remaining outside. There was little difference in material collection durations, with single female birds averaging 2.2 ± 0.2 min (<1 – 9, n = 68); and with males in attendance 2.4 ± 0.2 min (<1 – 7, n = 47). Overall females spent 17.7 ± 4.1 min a day, (range 1 – 31 min, n = 48) collecting nesting material throughout the breeding season, making and average of eight separate trips a day, (range = 1 – 16, n = 48). Nest-shape and dimensions are discussed elsewhere (chapter 6).

Females collected nest material throughout the breeding period, including the late nestling stage. The number of collection trips made per day varied, averaging 3.14 and ranging between 1 – 16 (n

= 6 all-day nest watches, between 9/2/00 – 11/04/00). Collection of nest material occurred more often during the pre-laying and early incubation period and mid-late nestling period, with least activity in early March, coinciding with the early hatching period. Nest material was occasionally removed from the cavity during the late nestling period.

Table 1. Duration of nest material collection trips: total, by female alone, by female accompanied by male.

Trip length (min)	% of total no. of trips per time period	n	% of trips per time period: female alone	n	% of trips per time period: accompanied by male	n
<1	5.5	6	66.7	4	33.3	6
1	31.5	34	67.7	23	32.3	11
2	31.5	34	61.8	21	30.2	13
3	18.5	20	60	12	40	8
4	5.5	6	50	3	50	3
5	1.9	2	50	1	50	1
6	1.9	2	0	0	100	2
7	1.9	2	50	1	50	1
8	0.9	1	100	1	0	0
9	0.9	1	100	1	0	0

Courtship behaviours and copulation

Courtship behaviours were observed from December through April. Although many typical pair-bond maintenance behaviours were exhibited daily throughout the year such as allopreening and perching in bodily contact, mutual feeding was rarely observed outside the breeding season (single observations in May, June and August, and two observations in November). Courtship behaviours involved allopreening between the sexes, particularly of the head (nape and cheek areas), and regurgitation of food, usually by the male in response to female begging (lowering body posture, sometimes flapping wings, and calling softly).

Copulation was usually preceded by a series of ritualistic behaviours (plate 1) by the male bird, that would come in to perch near a nest cavity entrance, or a perching female, calling. He would then scratch his head, followed by pacing and turning around on the perch several times (described as 'switch-sidling' by Dilger (1960)), making soft low-pitched calls (described as '*kuck, kuck*' or '*cook, cook*' by Philipps (1907-08), and termed 'squeak-twittering' by Dilger (1960)), before stopping to scratch again (displacement activity), shake his tail and 'head-bob' with regurgitation-like actions. We termed this set of behaviours the 'mating jig'. The 'jig' would normally attract the female encouraging her to come out of the nest cavity, move towards the male, where she might accept regurgitated food, (alternatively she might reject him with a bill-lunge, or depart the scene), after which she might allow the male to mount her. The female communicates her willingness to mate by lowering her body posture towards the perch. The male mounts the female by stepping onto her back, and lowering his tail to one side of her raised tail, making cloacal contact with a thrusting action which is rhythmically repeated, with the male changing his approach to the other side of the female's tail regularly and rapidly (plate 1). On occasions the female would extend her wing on the opposite side to the male to maintain balance. Duration of copulation attempts averaged 57.04 ± 13.16 seconds (range 1 – 441 seconds, n = 50). Following copulation the female usually departed to collect nesting material with the male following her (plate 1).

Most, (67.3%, n = 49) copulations were observed away from the nesting tree, although the majority, 80%, occurred in a Mopane tree, (often during a nest-material collection foray), the remainder in either an *Acacia* or *Albizia* spp. Copulations were observed during most diurnal hours from 06:00h until 18:00h, except during 13:00-13:59h, and 16:00-17:00h Some, 24%, of copulations were observed between 09:00-09:59h, when the male bird returned to the cavity from the first foraging event of the day. Couplings were observed throughout the breeding season, including when eggs and chicks were in the nest.

Clutch size, laying intervals, incubation and hatching success

Black-cheeked Lovebird eggs are pure white, rounded to slightly elliptical, detailed dimensions are given in table 2.

Table 2. A review of egg dimensions from captive Black-cheeked Lovebirds.

$\bar{x}$ length ± s.e.	length range	$\bar{x}$ width ± s.e.	width range	n	Reference
22.2 ± 0.3	20.4 – 24.2	16.6 ± 0.1	16.04 –17.4	14	Warburton (this study)*
21.7	19.6 – 24.9	16.8	15 - 18	33	Maclean 1988, Fry *et al.* 1988
n.d.	19.4 – 24.8	n.d.	15 – 17.9	n.d.	Winterbottom 1971
20.4 ± 0.4	19.4 – 21.1	16.45 ± 0.8	15 – 18.8	4	Brooke 1967**
n.d.	20 – 23.6	n.d.	15.7 – 17.7	20	Schönwetter 1964

n.d. no data supplied.

* birds owned by the School of Botany & Zoology, University of Natal, Pietermaritzburg

** from J.C. Carlisle's Egg Register; considered unreliable source by James (1970) and Rowan (1983).

Gathering precise information from wild birds on incubation period, clutch size, laying intervals, hatching success and age at fledging was not practical given the difficulties of observing the wild birds through small cavity entrances, which in some cases were further obscured from view by the nest structure. However, two broods one of six and one of seven chicks, respectively, (where we could be sure of viewing all the chicks in the nest and subsequently monitor) were successfully raised.

Captive breeding

In captivity, 2 - 8 eggs (4 ± 0.07, n = 226) are laid during any month of the year (data from: J. Boomker, D.v.d. Hofemeyer, U. Künzel, K. Lamke, B. Povlsen, G. Scopes, S. Waters, *pers. comm.*). Eggs are generally laid within one day of each other (1 ± 0.03, n = 337), although laying intervals range between 0 days (exceptions included 2 eggs being laid on the same day, n = 4) and up to 6 days apart, (n = 1). Eggs are then incubated by the female as they are laid, for between 19 - 33 days (22 ± 0.13, n = 344). 70% of eggs laid hatched successfully (n = 226 clutches, 1002 eggs laid, 699 hatched). Fledging occurred between 30 – 42 days of age (Dilger 1960, B. Povlsen & G. Scopes *pers. comm.*) with parents feeding fledglings for at least a further two weeks (G. Morgan & G. Scopes *pers. comm.*, this study).

Most pairs raised a single brood, but it is possible that some birds raised more than one. Lack of individual identification precluded a definite answer, but, observation of 'late' nests containing eggs and newly-hatched young in mid-March may have been second clutches, or re-starts following failure with the first brood.

Parental care

During incubation and the early nestling stages, the female Black-cheeked Lovebird spent most of her time inside the nest cavity, only appearing to look out of the cavity entrance, exiting to be fed by the male (which also likely occurred inside the cavity as well), and to collect nest material. Most females showed an obvious brood patch. The male's role during this period was to provision the female with food and copulation.

Three 12 hour+ nest watches were made in mid-February on two nests known to contain eggs. Females inside the nest cavity were assumed to be incubating. The average time spent incubating between sunrise amd sunset, was 11:08 hours (range 10:13–11:65) which constitutes 90.2% of lovebird active hours.

On average, the female spent between 20 – 97 min looking out, or resting, at the cavity entrance for durations of 2.53 ± 0.33 min, (range < 1 – 22 min, between 11 – 31 times per day, n = 118). She was almost always silent, and rarely responded to passing lovebirds or her incoming mate who invariably approached the nest-site calling. In addition to briefly leaving the nest-tree for nest-material collection, the female also made between 1 – 3 short trips of 4.33 ± 1.28 min, (range 1 – 10 min, n = 6) a day to drink, forage or socialise.

In contrast, the male was largely absent from the nest-site during incubation, making an average of 10 visits to the nest each day (range = 9 - 12), in total spending 66 min (10%) of the active day period, perching in the vicinity of the cavity, for an average 6.39 ± 1.50 min on each occasion, (range < 1 – 37 min, n = 31). On most visits he fed the female. The male spent even less time inside the nest cavity, a total of 5.76 ± 1.48 min, (range 1 – 24 min, n = 17), making on average 6 visits inside per day (range 3 – 8). The male usually 'appeared reluctant' to enter the cavity and never did so during incubation without the female already being present inside, the primary function was probably to regurgitate food to her (bill debris was normally observed on his emergence from the cavity) and to shelter from rain.

Mutual feeding was normally solicited by her, who assumed a begging posture (crouched with neck extended back over the shoulders and head pointing upwards) and fluffed plumage. Often the male made 'head-bobbing' motions before linking bills with the female and regurgitating.

Cavity defence and social interactions

Nest defence appeared limited to the nest-cavity entrance, and was performed by male birds. Occasionally, male lovebirds were observed preventing other lovebirds' access into the nest-cavity using bill-thrusts and aerial attacks to displace the unwelcome birds. These observations (n = 3) were made when flocks of 5 – 7 lovebirds perched in an active nest tree and appeared to want to access the cavity. The female showed no defensive activity and proceeded to collect and deliver nest-material whilst her partner defended the cavity entrance. On two occasions the male only made defensive attacks when the cavity entrance was threatened, and ignored other lovebirds perching in the nest tree when they showed no interest in entering the nest. One interaction lasted 40 min, with a second 'invasion' attempt repeated 20 min later. The male was always successful in preventing other lovebirds entering the nest cavity. Offending lovebirds appeared highly animated making almost constant 'rattle' and shriek calls. Other observations were made (n = 5) during all day and opportunistic nest-watches, of lovebirds in flocks of 3 – 6, coming to nest-trees and looking repeatedly inside the nest cavity (but not entering) in both the absence and presence of the breeding pair or female only. 'Visits' lasted up to 17 min; again the visiting lovebirds appeared agitated. At the time of these observations cavities were known to contain chicks. No defence was attempted. This behaviour was interpreted as other lovebirds, possibly other breeding birds from the locality, checking for suitable nest sites or for the presence of chicks.

Occasionally, Southern Grey-headed Sparrows *Passer griseus*, Red-billed Hornbills *Tockus erythrorhynchus* and Crested Barbets *Trachyphonus vaillantii*, and Tree Squirrels *Paraxerus cepapi* looked into nest cavities, making no attempt to enter, they met with no antagonistic reaction from the lovebirds.

Nestling behaviour and parental care

Observations of chicks inside nests showed various stages of development within broods (plate 2). Space inside the nest appeared highly limited and nestlings were packed tightly together. During cavity inspections they showed no defensive behaviour. Nestlings were first observed looking out of a nest-cavity entrance on 22 March 2000. During an all day watch at this nest, the chicks looked out eight times for between < 1 – 5 min, usually during the absence of adult birds. They appeared very inquisitive and pecked at insects at the cavity entrance, sometimes stretching and flapping wings, and climbing into the surrounding canopy. On their first appearance, chicks were still largely covered in down, although facially mature, the wings were still in pin, with the back and breast areas largely covered in down. Occasionally, chicks facially preened each other or an incoming parent at the cavity entrance. Once all the chicks were covered in down the female left the cavity for longer periods on foraging trips returning to feed chicks and sometimes to remain in the nest for some time. The male also fed nestlings. Chicks were fed both inside the cavity and from the entrance; once fledged, chicks were also fed in the nest tree and beyond. Chicks solicited feeding by lowering their body posture, in particular the head and neck, typically accompanied with soft calls and wing-whirring actions. All day watches showed adults servicing their nests, containing six and seven chicks, on nine and 11 occasions respectively. On average feeding visits lasted 7.2 ± 1.19 min, (range 2 – 25 min, n = 20) and intervals without any adults in attendance lasted 63.70 ± 9.15 min (range 29 – 119 min, n = 13). Sometimes the adult birds would leave the nest together and return separately or leave the nest singly and return together. Once fed by an adult, the fledgling would sometimes feed a sibling, and on one occasion the second recipient fed a third. Parents returning separately to the nest were sometimes observed to feed the same fledgling/nestling within 10 min of each other. Near fledged chicks were observed defecating out of the cavity entrance, although in general nest hygiene was poor and nests were encrusted with faecal matter and deceased chick(s).

Fledging

Most chicks that emerged from the cavity entrance were fully developed and almost identical to the adults, except for a more orange-coloured bill which might have a dark patch near the cere or fine dark veining (Warburton 2002) (plate 2). Occasionally, some individuals emerged still showing visible patches of down on the back and lesser wing coverts. First flights were short and obviously inexperienced, crashing through branches and landing precariously, sometimes leaving the fledgling hanging upside down. Fledged siblings appeared to remain together and often grouped with peers from neighbouring nests and spent their time making short flights, chewing on twigs and leaves, and calling with a distinctive juvenile call, which was softer than an adult contact call. Unfledged siblings observed these behaviours from cavity entrances. Adults returning to these gatherings appeared to identify offspring on their approach into the immediate locality (the use of visual or vocal cues was not explored). Adults continued to feed fledged chicks away from the nest tree (exact duration unknown but greater than 14 days) by regurgitation. Details on roosting of adults and fledged juveniles during the breeding season are presented elsewhere (chapter 9).

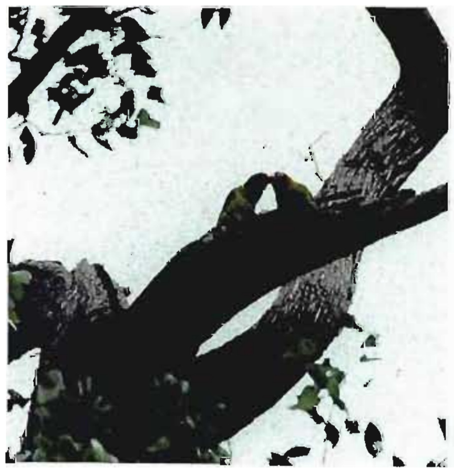
Plate 1.

Courtship behaviours (pictures 1 – 4), copulation (picture 5) and nest material collection (picture 6).

1. Male scratches, female looks out the nest cavity.

2. Male paces as female observes.

3. Male scratches again and female emerges from cavity.



4. Male regurgitates food for her.

5. Copulation.

6. Female collects nest material.

Plate 2.

Chick development (pictures 1 – 4), a complete clutch (picture 5) and a Mozambique Spitting Cobra entering a nest cavity (picture 6).

1.

2.

3.

4.

5.

6.

Disease, predation and nesting success

A third (30.8%) of all visually accessible nests containing chicks held a dead nestling, and one contained two (n = 13). A fifth nest smelt of a corpse, but a small cavity entrance prevented inspection.

One nestling from a brood of seven, where six blood samples were taken, tested positive for Psittacine Beak and Feather Disease Virus (PBFDV). Three other chicks, each from different nests in the same breeding locality tested negative (Warburton & Perrin 2002, chapter 8).

Predation by snakes was observed twice (plate 2). In late March an unidentified species of snake, but likely a Mozambique Spitting Cobra *Naja mossambica,* fed on a nestling that had emerged from the nest cavity the previous afternoon; the fledgling had climbed through the nest tree branches and was apparently unable to find its way back to the nest cavity. The chick was partially feathered and unable to fly. After feeding, the snake entered a cavity situated below the nest cavity, and the remaining chicks (2+) continued to be fed by the adults and apparently fledged successfully. On another occasion a Mozambique Spitting Cobra (identified from photographs and shed skin by L. Arnott and S. Bourquin, University of Natal) was observed entering a nest containing an incubating female (4 March 2002). The female escaped through a second cavity entrance and the snake remained in the cavity for at least three of the subsequent weeks (coinciding with the period of maximum rainfall/flooding) and presumably consumed the lovebird eggs. The adults returned to the nest tree later the same day and subsequent day to the snake's invasion and were observed to look into the cavity. During other cavity inspections, as part of the larger nest-site survey (chapter 6), two were found to contain snakes where lovebirds had previously been observed nesting.

One adult male lovebird was found fatally injured (a flesh wound tearing the crop wall). The injury appeared typical of a raptor. The injured bird was found on the ground in a nesting area calling to other adult lovebirds perched in the mid-canopy layer above the injured bird that responded with screech-alarm calls. An attempt was made to assist the injured bird, which fed on the *Echinochloa colona* grass seeds offered, but it did not survive.

Human predation in agricultural areas occurred on a very small scale, and was non target-species specific. Nooses were laid on the ground and at seed-head level in sorghum and millet fields . Most lovebirds caught by this method were for local consumption with only one report of 10 birds being taken to Livingstone for live sale (chapter 5).

DISCUSSION

Breeding stimulation

The breeding seasons of most avian species are timed to coincide with a peak of some resource (Moyer 1995). Breeding by Black-cheeked Lovebirds is highly synchronised. As the species' distribution is limited to a small area the species can only exploit the more localised patterns of climatic and primary production. No variation in breeding season, throughout the highly localised range of the Black-cheeked Lovebird, is expected as is observed in the case of Fischer's Lovebird whose core range of suitable habitat is much larger and covers *c.*51 200 km^2 and experiences considerable local variation in timing, distribution and quantity of rainfall (Moyer 1995). The foremost stimulation for the Black-cheeked Lovebird (and likely the other white eye-ringed species) breeding is likely to be the onset of the rainy season, increasing surface water availability and inducing the grasses to sprout and set seed, maximising food availability for the nestling period. Rainfall has been shown to be a stimulus for initiating breeding in arid-zone birds (Lloyd 1999). In Budgerigars *Melopsittacus undulatus* rainfall and temperature are thought to act as indirect controls on their movements and breeding by affecting the production of food (Wyndham 1983). The breeding seasons of *A. personata* and *A. fischeri* in Tanzania (Moreau 1945) and *A. roseicollis* in Namibia (Simmons 1997) and *A. lilianae* in Zimbabwe (Fothergill 1984) coincide with the timing of maximum food availability immediately following the period of maximum surface water. This correlates with the Black-cheeked Lovebird populations observed in this study (figure 1). However, hybrid birds (*A. fischeri* x *A. personata*) at Lake Naivasha, Kenya, are capable of breeding during any month of the year. This is attributed to the bird's staple diet of maize, which is grown throughout the year under irrigation (Thompson 1987[a,b]). In captivity, all lovebird species are capable of breeding by four months of age, and continuous breeding throughout the year. In the wild Black-cheeked Lovebirds are likely to be capable of breeding at 10 months old and hence form pairs and breed in the first rainy season following their own hatching. Most pairs produce a single clutch each breeding cycle. This implies that the natural breeding season is timed to coincide with an abundance of grass seed and water required by breeding lovebirds. The increase in surface water availability across the species' entire range during the breeding season means that lovebirds do not have to 'commute' far to a water resource and can conserve time and energy for breeding behaviours (see chapter 10). From experiments with captive Lovebirds (all species except *A. swinderniana* whose behaviour remains unknown) it appears that breeding/sexual stimulation is independent of day length (Dilger 1960). Males come into breeding condition before females, and it is likely that their courtship activities (proffering food and the 'mating jig' ritual) provide a stimulus to the females' propensity to exhibit sexual behaviour (Dilger 1960). The observations of wild Black-cheeked Lovebirds in this study follow the same behaviours made of captive birds by Dilger (1960). Dilger's interpretation follows that male sexual behaviour remains strong throughout nest-building, egg-laying and into incubation; whilst females appear to have periods of shorter term arousal, during which they may permit copulation, this appears dependent upon the persistence of the male's sexual behaviours, and also upon environmental conditions such as the availability of nest-sites and collection of nest material. The male lovebird's behaviour during this time has been described as a conflict, termed 'FaM', where 'F' refers to flee, 'a' to attack and 'M' to mate (after Morris 1956 in Dilger 1960), when he exhibits considerable tendencies to flee and mate, and little tendency to attack; whereas the females conflict is expressed as 'fAm' as she exhibits little tendency to flee or behave sexually, and considerable tendency to attack. Dilger (1960) interprets the behaviours exhibited during the male's 'mating jig' as exemplifying these conflicts, for example the 'switch-sidling' (pacing and turning actions) which appears to be the result of wanting to approach the female and wanting to flee.

Based on studies of captive lovebirds, Dilger (1960) suggested that no copulations under 150 seconds in length seem to result in sperm emission. Hence, only 20% (n = 10) of all copulations observed in this study may have been successful, those over 150 seconds had a mean duration of 226 ± 24.5 seconds (median = 214, range 179 – 441 seconds).

Pair formation

Little is known from captive studies of pair formation in lovebirds, although it is generally accepted that lovebirds form pair bonds as juveniles (Dilger 1960). Captive pairs have been reported to be socially monogamous, but duration of pair bonds is unknown, although assumed to last until the death of one partner (Dilger 1960, 1962). In addition to the formation of pairs, lovebirds also form well-knit flocks, within which they interact with other members on an intimate daily basis, performing behaviours such as allo-preening, perching with bodily contact, feeding, drinking and roosting etc. (Dilger 1960). This may explain why the males chased some lovebirds away from cavity entrances at nest-sites (see cavity defence and social interactions section in results above) but not others when they went to inspect the nest cavity.

Predation

Although potential predators, consisting certain species of snake and raptor, were commonly present in all habitats used by lovebirds across their range, their impact, given the low number of observations of interaction (see above: results), is considered small. Predation by snakes on other psittacine species is known, including the Red-tailed Amazon *Amazona brasiliensis* (Lalime 1997, Martuscelli 1997), Monk Parakeet *Mysiopsitta monachus* (Navarro *et al.* 1992) and Green-rumped Parrotlet *Forpus passerinus* (Stoleson & Beissinger 2001), although few species have birds as their main prey (Muchinsky 1987) and little literature exists of bird predation by snakes (Sorace *et al.* 2000). Our sightings of Mozambique Spitting Cobras ascending trees are unusual (*pers. comm.* Arnott), although at the time of observation most of the ground surface was seasonally flooded, the snakes were likely looking for a dry retreat, in addition to food and a place to shed their skin.

Attacks (or at least assailment) by raptors on parrots are also recorded, even large-bodied species like Great Green Macaws *Ara ambigua* (Lόpez-Lanús 1999), Blue-throated Macaws *A. glaucogularis* (Boussekey 1997 *et al.* 1997), Red-fronted Macaws *A. rubrogenys* (Pitter & Christiansen 1995), Red-tailed Amazons (Bertagnolio 1981, Martuscelli 1997), Puerto Rican Parrots *Amazona vittata* (Lindsey *et al.* 1994) and Galahs *Cacatua roseicapilla* (Rowley 1983), but in some cases motives maybe more territorial than predatory (Lόpez-Lanús 1999).

Double-clutching

In captivity lovebirds are capable of continuous breeding, overlapping cycles of egg-laying while continuing to feed semi-dependent fledglings from the previous brood. In the wild Black-cheeked Lovebirds egg-laying peaked in February, and most birds appeared to raise a single brood. However, atypical observations of late copulations, nest-building behaviours, and a nest containing eggs and newly hatched young in mid-March may indicate that some birds raise more than one brood in a season unless the clutches were replacements for lost broods. This has also been suggested for Fischer's Lovebird based on information from bird-trappers (Moyer 1995).

Nest-building

Removal of nest material by the adult female during the nestling period likely serves to increase the area available to the growing brood inside the cavity (inspection showed space to be extremely limited as nestlings approached fledging). This behaviour has been suggested to be a function of improving nest hygiene (Dilger 1960). However, material removal does not appear to aid hygiene, as the bottom of the nest area is covered in faecal and other waste material including deceased chicks, and the removed nest material probably originates from the sides of the nest.

Agonistic behaviour

Little agonistic behaviour was recorded at the nest-site, which suggests a breeding territory limited to the nest itself, which is typical behaviour of other parrot species, for example Cape Parrots *Poicephalus robustus* (Wirminghaus *et al.* 2001) and Grey-headed Parrots *Poicephalus fuscicollis suahelicus* (Symes & Perrin *in press*). A captive study (Dilger 1960, 1962) showed nest cavity defence behaviour is well developed in the Grey-headed Lovebird *A. cana*, little developed in *A. taranta*, suspected in *A. pullaria*, and non-existent in *A. roseicollis* and the four white eye-ringed forms. However, the findings of this study differ, and show that Black-cheeked Lovebirds do defend the cavity entrance to their nest-site from other lovebirds (see results above). Agonistic behaviour has been observed in female White-tailed Black Cockatoos *Calyptorhynchus funereus latirostris* during the pre-incubation cavity preparation stage, and suggests this behaviour may limit availability of hollows to other conspecifics (Saunders 1974, 1982).

Implications for conservation

The most likely threats associated with breeding appear to be that of disease, principally PBFDV, (at least potentially as this primarily affects nestlings) (chapter 8); predation by snakes; and (some of) the crop defence strategies of local farmers (chapter 5). Potential threats include habitat destruction which would limit nest sites and foraging opportunities, and resumption of illegal trade. However, currently the principal threats to the species' survival are non-breeding season specific and combine habitat desiccation across the species' highly localised range, causing range contraction, together with an increased human population and thus demand and pressure on remaining surface water supplies during the dry season (chapters 10, 12).

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CHAPTER EIGHT

EVIDENCE OF PSITTACINE BEAK AND FEATHER DISEASE IN WILD BLACK-CHEEKED LOVEBIRDS IN ZAMBIA

Warburton, L. & Perrin, M.R. 2002. Evidence of psittacine beak and feather disease in wild Black-cheeked Lovebirds in Zambia. *Papageien*. **5**:166-169. *(Published in German).*

SUMMARY

One wild Black-cheeked Lovebird *Agapornis nigrigenis* nestling tested positive for Psittacine Beak and Feather Disease Virus (PBFDV). The chick was one of a brood of seven of which six were sampled, with PBFDV not being detected in the other five. Also, the virus was not detected in three other chicks, each from a different nest in the same breeding locality. Other observations suggest PBFDV is present in the wild population. Implications for research and conservation are discussed.

Keywords: Black-cheeked Lovebird, *Agapornis nigrigenis,* Psittacine Beak and Feather Disease, Conservation, Zambia.

INTRODUCTION

The Black-cheeked Lovebird *Agapornis nigrigenis* is a Vulnerable species (Birdlife International 2000), found in a highly localised range of 2, 500 km² in south-west Zambia (Dodman 1995, Dodman *et al.* 2000). The species is classified as CITES Appendix II, although trade in wild birds has been banned under Zambian law since 1930. The geographical range in a remote area, has little rural development and no evidence of present or historical bird-keeping, although a large number of the lovebirds were caught for trade during the 1920's. In captivity, the Black-cheeked Lovebird is uncommon, being confined to specialist breeders, mainly in South Africa. A research project to study the ecology of the lovebirds in the wild, based at the University of Natal, was initiated in 1998. As part of the Zambia Bird Atlas Project a pilot study indicated the lovebirds are divided into two subpopulations (Dodman 1995, Dodman *et al.* 2000).

PSITTACINE BEAK AND FEATHER DISEASE VIRUS

Until recently little was known about Psittacine Beak and Feather Disease, including detail of its transmission, symptoms, and the natural development of immunity. PBFDV is endemic in Australia, but has spread to North America, Europe and Asia (Ritchie and Carter 1995) and Africa. Recent evidence suggests wild populations of the highly Endangered Cape Parrot *Poicephalus robustus* are infected in South Africa (Wirminghaus *et al.* 1999 & *pers.comm.* Downs 2001). For captive parrots the disease is usually considered fatal. In general Lovebirds are thought to be susceptible to the disease (Kock *et al.* 1993). The Grey-headed Parrot *Poicephalus fuscicollis suahelicus* and Meyer's Parrot *P. meyeri* also occur throughout the range of the Black-cheeked Lovebird, but their disease status is unknown.

The virus (family Circoviridae) was first described in several species of Australian cockatoos in the 1970s (Ritchie and Carter 1995), although a much earlier report of possible PBFDV was described in a wild population of Red-rumped Parrots *Psephotus haematonotus* (Ashby 1907 www.vet.murdoch.edu.au). Each of the Coviridae viruses appear to be host-specific, with distinct protein and nucleic acid characteristics, and as such, cross-infection with other bird families is unlikely and unrecorded (Ritchie and Carter 1995). In Australia infected wild populations comprise more than 14 species belonging to 12 families (Ritchie and Carter 1995, www.vet.murdoch.edu.au). It has since been diagnosed in many other captive psittacine species, probably spreading via the international bird trade (Ritchie and Carter 1995). A universal PCR assay which consistently detects the virus has been recently developed (Ypelaar *et al.* 1999). Symptoms of PBFDV include the abnormal growth of feathers, loss of down feathers, abnormal beak and nail growth, and in the late stages, paralysis. Some aviculturists report the growth of yellow feathers on infected Black-cheeked Lovebirds (Scopes *pers. comm.* 2001). Clinical symptoms are common in captive lovebirds and young Sulphur-crested Cockatoos (Ritchie and Carter 1995). In Australia the acute form of the disease is common in wild-caught cockatoo nestlings and fledglings, with a prevalence of 90%, although most cases of naturally acquired acute PBFDV are not fatal (Raidal and Cross 1995). Secondary diseases, including bacterial, fungal and other viral infection may result (York *et al.* 2000). The virus also causes acute hepatitis (Raidal and Cross 1995 and www.vet.murdoch.edu.au). Most infected birds are < two years, although adult birds are susceptible, particularly when stressed (York *et al.* 2000). Some infected birds show no symptoms, including the lovebird chick, but are infectious carriers to other birds. Certain captive Black-cheeked Lovebird colonies in the UK have tested positive for PBFDV, the birds are reported to survive for two years, breeding normally and without showing clinical symptoms (Scopes *pers. comm.* 2001). Viral transmission appears possible both vertically via the egg (Penning 2000) and horizontally (Ritchie and Carter 1995). During experimental work, parrot chicks have been infected with the virus through oral, intracloacal, subcutaneous, intramuscular and intranasal routes (Ritchie and Carter 1995). There is also evidence to suggest transmission is possible by inspiration of airborne viral particles or ingestion of virus-contaminated materials (Ritchie and Carter 1995). Feather dust is likely a major source of virus transmission, which together with faeces and crop contents is environmentally persistent (Ritchie and Carter 1995).

Some infected birds are known to recover from the virus. A positive result from a bird with feather abnormalities strongly suggests the bird has an active infection. A positive result from a bird with no feather problems means that either the bird is a carrier or has been recently exposed to the virus, which may result in an immune response eliminating the infection (www.wetark.co.uk). A few infected individuals, from a number of species including lovebirds, are known to have recovered from suspected PBFDV virus-induced feather abnormalities (Ritchie and Carter 1995). Most virus exposed individuals appear to develop some immunological response (Ritchie and Carter 1995). A vaccine has been developed by the University of Sydney, Australia, which appears effective in stimulating immunity in negative-testing birds (Raidal *et al.* 1993, www.vet.murdoch.edu.au).

BLACK-CHEEKED LOVEBIRD STUDY

The Black-cheeked Lovebird's core range is located 15° - 17°S and 24° - 26°E in Zambia. The northern population occurs along the Nanzhila River in areas of suitable habitat, largely confined to Kafue National Park and surrounding Game Management Areas (GMAs). The southern population is centred around the Sichifulo and Machile Rivers, with the Simatanga River to the north and Ngweze River in the south forming the limits of the species' range. Blood samples were collected in March and April 2000 from the mid Machile River area during the breeding season, although observations were made throughout the species range from May 1998 to December 1999.

As part of the breeding biology study, 18 chicks were briefly removed from five nests for body measurement, photographic record and blood sampling. Blood was taken from nine chicks from four nests. Samples were collected from six individuals from a brood of seven (the seventh chick was judged as being to young to take a sample from). A further three nests were sampled with blood taken from only one chick per nest.

Blood was collected by pricking the radial artery with a fine dental needle, collecting the blood in a capillary tube, which was then transferred and stored in a solution of EDTA. Samples were kept un-refrigerated for three weeks, and tested for the first time 20 weeks later. The presence of PBFDV genomic DNA was confirmed by molecular analysis (D.York *pers.comm.* 2001). Briefly, total genomic DNA was extracted from approximately 5 ul of whole blood and a conserved region of the PBFDV genome targeted and amplified. The amplified product was digested with a sequence specific restriction endonuclease prior to analysis by agarose gel electrophoresis and ethidium bromide staining. The presence of a specific sized product confirmed the presence of PBFDV. Appropriate assay controls were included to ensure the sensitivity and specificity of the assay. The sample retested as positive twice in the same laboratory. Other pathogens screened for were Avian polyoma virus and Chlamydia psittaci. Gender testing was also conducted.

RESULTS

One blood sample from a nestling in a brood of seven tested positive to PBFDV, the virus was not detected in the other samples from the nest-mates. Only the positive chick was male, six female and two unsexed samples. The positive bird was aged proximately from a photograph as 28 days old (Scopes *pers. comm.* 2001). The chicks from this nest were removed twice for growth rate measurements. Blood was sampled on the first removal on 26/03/00 from the five oldest chicks, and from the second youngest chick upon the second removal on 1/04/00. The seventh youngest chick was too young to sample. On the second removal the eldest chick was found dead inside the nest cavity, with no apparent cause of death. This bird tested clear to PBFDV, was feather perfect, and ready to fledge. No evidence of other pathogens screened for were found. In addition, three other samples were taken from chicks, each from a different nest in the same breeding locality as the positive bird; PBFDV was not detected in these samples.

Seventy-eight Black-cheeked Lovebird nesting trees, in two localities, were identified between February to April 2000. Fifty-nine were climbed for cavity inspection. It was possible to view to the nest in 16 of the cavities. Thirteen contained chicks and one contained eggs. In the 13 nests containing chicks, four were found to contain dead nestlings (one nest had two). A fifth smelt of a corpse, but a small cavity entrance size prevented our inspection. So 30.76% (n = 13) of nests that were accessible contained at least one dead nestling. If the fifth nest also contained a dead nestling the percentage of frequency of occurrence increases to 38.46%. One of the dead nestlings had a damaged cranium, which was probably predator induced or infanticide, the second dead chick in that nest was heavily decomposed with a crushed bill. One of the corpses was identified as being 'in pin', and another near-fledged, the ages of the remaining deceased could not be determined. All five nests with dead nestlings, including the suspected fifth site, also contained live siblings.

During nineteen months of field observation throughout the species' range, five observations were made of adult birds that showed unusual feather loss or poor condition that could be attributed to PBFDV. Symptoms included feather loss to head, chest and back regions, and one bird showed a very pale, almost white, bill at the basal end. A few colour mutations were observed, but are not believed to be disease related. Other conditions that may cause these symptoms include Polyoma virus, Chlamydiosis, psychogenic and dietary factors (Penning 2000).

Lovebirds with symptoms of PBFDV were observed in both sub-populations, although blood samples were only collected from one breeding site in the south.

OTHER RESEARCH

Research in Zimbabwe on captive PBFDV infected Black-cheeked Lovebirds and Lilian's Lovebirds *Agapornis lilianae* showed 100% mortality in captivity (Kock *et al.*1993). All had excellent body condition at the time of death, although an elevation in respiratory rate was noted (Kock *et al.*1993). Rosy-faced Lovebird *A. roseicollis* and Fischer's Lovebird *A. fischeri*, which were in close contact with the birds that died, were only transiently affected or uninfected (Kock *et al.* 1993). Black-cheeked Lovebirds and Lilian's Lovebirds are considered con-specific species by some authors

(Fry *et al.* 1988, Eberhard 1998), although their ranges do not overlap their ecological requirements appear similar, and in Zambia their populations are separated by approximately 160km of unsuitable miombo and basalt gorge habitat (Benson and Irwin 1967). Rosy-faced Lovebirds are native to northern Angola, through much of Namibia into the Kalahari area of South Africa, and Fisher's Lovebird is a near endemic to Tanzania. The apparent resistance of the geographically remote lovebird species from the Black-cheeked Lovebirds and Lilian's Lovebirds suggests that species are more susceptible to different strains of the virus depending on their geographic origins (Kock *et al.* 1993), although only one strain of PBFDV has so far been identified, and comparison of the virus found in different species showed similar morphological and antigenical traits and comparable induced microscopic changes (Ritchie and Carter 1995). However, Fischer's, Lilians, Rosy-faced and Masked Lovebirds *A. personata* are listed by Ritchie and Carter (1995) as susceptible to the PBFDV virus, although clinical and pathological symptoms varies between species. DNA probe testing indicated that Old World Psittaciformes are most likely to be infected (Ritchie and Carter 1995). When a selection of lovebirds, Eclectus *Eclectus roratus*, Grey *Psittacus erithacus* and cockatoo parrots (presumably captive) were tested with a DNA probe, lovebirds tested positive in 30% of cases, scoring almost three times as high as the *Eclectus* parrots in 'second place' (Ritchie and Carter 1995).

IMPLICATIONS FOR CONSERVATION

In terms of the conservation of the Black-cheeked Lovebird the outlook is a bleak one. This scenario is similar for the Cape Parrot, and perhaps other African psittacine species. With no known treatment, conservationists can only hope that naturally acquired PBFDV is rarely fatal, and that natural immunity develops. 'Clean' captive populations must be encouraged to breed to maintain a pure blood-stock. Monitoring of wild populations in the long-term must be initiated, and there can be no catching of wild birds for avicultural markets. Future research should concentrate on understanding the transmission and epidemiology of the virus – why did one chick out of six tested in a brood test positive?, how long can infected birds survive?, what are the stresses which cause manifestation of PBFDV?, can anything be done to alleviate such stresses in the wild situation?, what are the mortality rates in the wild?. If a vaccine is developed is it possible to treat wild birds?. The highly sociable nature of Black-cheeked Lovebirds, typical of most psittacines, would appear to favour the spread of PBFDV, through direct contact or virus contamination of water and foraging areas, although some research suggests that horizontal transmission between adult Galahs *Eolophus roseicapillus* is not highly infectious (Raidall & Cross 1993). However, although infected populations of certain Australian parrots apparently continue to thrive, the outlook is unlikely to be so positive for the already endangered and localised populations of Black-cheeked Lovebirds, particularly since they face additional threats to survival.

Input from avian veterinarians and birdkeepers is warmly invited.

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CHAPTER NINE

ROOSTING REQUIREMENTS AND BEHAVIOURS OF THE BLACK-CHEEKED LOVEBIRD *Agapornis nigrigenis* IN ZAMBIA

ABSTRACT

Roost-site characteristics and roosting requirements of the Black-cheeked Lovebird were investigated in their natural habitat. Thirty-five roosting cavities were identified in four locations. Black-cheeked Lovebirds roosted inside naturally formed cavities in live Mopane trees, in localities that were also used for nesting during the breeding season. Roost site location remained stable throughout the observation-period of 11 months, and long-term fidelity to these sites is suspected. Roost cavities were found in a loosely clumped distribution, with mean roosting flock size of two birds per cavity with eight to 26 lovebirds roosting in the same locality. Overall roosting habits appear an extension of the lovebird's intrinsically social nature. On average lovebirds entered cavities 8.5 min before sunset and vacated 6.7 min either side of sunrise. Roost-site characteristics including cavity dimensions, height from ground, tree circumference, distance to two nearest neighbours and nearest tree. Results of internal inspections are given. Roosting behaviours in the non-breeding and breeding season are described. No roosting requirement appeared to be in limited supply; implications for the species' conservation are discussed.

INTRODUCTION

Social roosting is widespread among psittacids (Forshaw 1989, Juniper & Parr 1998) that generally show an increase in flock sizes as sunset approaches; this has been used as an indicator of communal roosting (e.g. Chapman *et al.* 1989, Gnam & Burchested 1991, Gilardi & Munn 1998, Johnson & Gilardi 1996, Serle 1965, Snyder *et al.* 1987). Where information exists, African parrot species are no exception (e.g. Button 1953, Serle 1965, Tarboton 1976, Fothergill 1984, Bhatia *et al.* 1992, Dodman 1995, Moyer 1995). Roosting activity patterns are generally homogeneous, roost-sites being vacated before or at sunrise, then birds regrouping at the same site either side of sunset (del Hoyo *et al.* 1997).

The roosting behaviour of Black-cheeked Lovebirds was first described by Dodman (1995) who recorded the birds entering cavities in mature Mopane *Colophospermum mopane* trees, in flocks of 2 - 12 birds, with one or more other trees being occupied in close proximity to each other. Lilian's Lovebirds *Agapornis lilianae* also use natural holes in Mopane trees (Button 1953, Fothergill 1984, *pers. obs.* L. Warburton), including trees (thought to be Mopane) with submerged bases after the flooding of Kariba dam (*pers. obs.* B. Howells).

The Black-cheeked Lovebird *Agapornis nigrigenis* has the most restricted distribution, of any African psittacine species, with a core range of approximately 2 500 km^2 (Dodman 1995, Dodman *et al.* 2000). The Black-cheeked Lovebird is a small parrot, 13 - 14 cm long; 38.85 g (Maclean 1988, Warburton 2001, 2002). Primarily found in Mopane *Colophospermum mopane* woodland, but moves into adjoining habitats, such as riverine vegetation and agricultural areas to forage and drink. The species was extensively trapped soon after it's first description in 1906 (Sclater 1906) through the 1920's, until a national trade ban was implemented on wild-caught birds in 1930, although trade appeared to continue until the 1970's (Dodman 1995). The only documented historical record, from Dr Gordon Lancaster in 1929, records 16 000 Black-cheeked Lovebirds being trapped from one area over a four week period (Moreau 1948, chapter 2, Appendix I). Currently the total population is estimated to be between 8 000 – 10 000 individuals (Dodman 1995, Dodman *et al.* 2000), and is classified as Vulnerable (Birdlife 2000).

The aim of this paper is to provide baseline roosting data, as part of a wider ecological study on the Black-cheeked Lovebird, and to evaluate the resources needed for roosting in order to prepare a conservation management plan for this Vulnerable species.

METHODS AND MATERIALS

Study site

Zambia is a landlocked country in southern-central Africa. Black-cheeked Lovebirds inhabit the driest region of Zambia, a vast plain, altitude 914-1 341 m, intersected by the floodplains and tributaries of the Zambezi and Kafue Rivers within the Southern and Western Provinces. The lovebird's range is marked by two distinct seasons; a rainy season, usually from November to March, with a mean annual rainfall of 600 mm (NPWS/JICA 1999), and a long dry season from April to November, with April being a transition month. July, the coldest month, has a mean maximum temperature range of 22 - 28°C, and mean minimum of 5 - 7°C; while October is the hottest month, with a mean maximum of 31 - 35°C, and mean minimum 15 - 18°C (NPWS/JICA 1999). Black-cheeked Lovebirds exist in two distinct but adjacent geographical ranges between 15° - 17°S and 24° - 26°E (Dodman 1995, Dodman *et al.* 2000). The northern population occurs along the Nanzhila River, largely confined to Kafue National Park and surrounding Game Management Areas. The southern population is centred around the Machile and Sichifulo Rivers, with the Simatanga River to the north and Ngweze River in the south forming the limits of the species' range. The lovebird's range is exposed to serious water shortages from June to December as are all rivers in the region, with the exception of the Zambezi and Kafue Rivers, are ephemeral. The dominant vegetation within the Black-cheeked Lovebird range is Mopane woodland. Data were collected from across the lovebird's range.

Methods

Roosting sites were located by following the direction of travel of lovebirds departing from water sources in the late afternoon, combined with opportunistic watches in areas of suitable habitat, local people were also interviewed to gain their knowledge. Difficulties included following the lovebirds due to their swiftness in flight above canopy height in woodland habitat and the roadless nature of the terrain. Presence of some other wildlife species also created difficulties for observers on foot during non-daylight hours. Once roost-sites were found, locations were recorded using a 12XL Garmin GPS and observations made using Swift 8x42 binoculars and a Kowa 10x telescope. A tree cavity was recorded as a roost if a lovebird spent a night's duration inside; trees were marked with biodegradable plastic tape. Observations were divided between known roost cavities, to record use over time, and searches for new cavities and sites; this largely involved following birds departing from pre-roost gatherings and afternoon drinking sites. Each time a lovebird was observed entering or leaving a tree cavity, time, flock size and behaviours were recorded. Roost-tree characters were documented and the following measurements taken: GPS co-ordinates, species of tree, presence/absence of understorey, tree circumference at breast height (cm), height of cavity from ground (m), compass orientation of nest-hole, branch characteristics in which nest-cavity was located (dead, live, dead section of a live branch), cavity entrance width (cm), and the distance to the two nearest known roosts and nearest tree with a circumference >1 m (i.e. potentially capable of having a cavity suitable for lovebird roosting). Time of sunset and sunrise was also recorded during each roost-site visit using the GPS. Unless otherwise specified, mean values ± standard errors, minimum and maximum range values, and number of observations (n) are reported. Anova and Scheffé's tests were used to test for differences between flock sizes between breeding and non-breeding seasons, between months and entrance and emergence times from and into roosting cavities around the times of sunset and sunrise.

RESULTS

Roost locations

Thirty-five roosting cavities were located in four locations. Data from roost-sites was collected during each month except May and January over 11 months. All roost-sites were situated in the middle of Mopane woodlands. Mean distance to the nearest water source utilised by lovebirds (during the dry season) was 4.9 ± 1.34 km, ranging between 1.94 – 7.85 km (n = 4). Mean distance to human habitation was 6.51 ± 1.39 km, ranging between 2.52 – 8.85 km (n = 4). Locations were used throughout the year, and at least two of the three roost sites accessed during the breeding season were utilised, including at least 7 (20%) of the same cavities used for roosting during the non-breeding season. The same cavities were not always strictly used on a nightly basis, and there was some variation in flock sizes, usually the result of 'disputes' between birds entering cavities. However, repeated use of specific cavities by the same flock size remained more or less constant throughout the non-breeding season.

Roost tree characteristics

All roosts were located inside naturally formed cavities in mature Mopane trees. Most (85%, n = 22) had a single entrance, the remainder had two. The majority (71%, n = 22) of cavity entrances were located in live branches, the remainder in a dead section of a living branch.

Roost tree characteristics and distances to the nearest tree and two roost trees are summarised in table 1. Mean distance between roost trees was 25.65 ± 6.39 m (n = 21), which was greater than the mean distance to the nearest tree 6.07 ± 0.75 (n = 19). The overall pattern was for roosting trees to be loosely clumped into localities, similar to nest-sites (chapter 6)

Table 1. Roost tree characteristics

Nest Characteristic	$\bar{x}$	S.E.	Range	n
Cavity height from ground (m)	8.25	0.36	6.1 - 15	26
Tree circumference at breast height (cm)	163.88	8.38	111 - 298	25
Cavity entrance width (cm)	9.67	1.20	6 - 12	6
Distance to nearest tree (m)	6.07	0.75	1.33 – 12.09	19
Distance to nearest roost tree (m)	25.65	6.39	3.55 – 127.7	21
Distance to second nearest roost tree (m)	33.19	5.16	11.55 – 47.45	8

Roosting flock size

Flock sizes of roosting birds were recorded throughout the study period (table 2), and differed significantly between the breeding (February to April) and non-breeding season (May to December) (Anova $F_{(1)} = 22.5$ $P < 0.05$) (figure 1). A post-hoc Scheffé test showed significant differences between certain months (February and April, May and August; March and April, May and August). Flock size was smallest during the mid-breeding season (February - March) with most birds roosting singly (not including chicks within nests), and peaked in April during the main fledging period with a mean of three birds. During the remainder of the year, mean roosting flocks were constant at two birds, but ranged from one to seven. However, the number of lovebirds roosting in the locality, typically 8 - 26 individuals, held constant throughout the year except during the immediate post-fledging period when new recruitment increased the number of individuals.

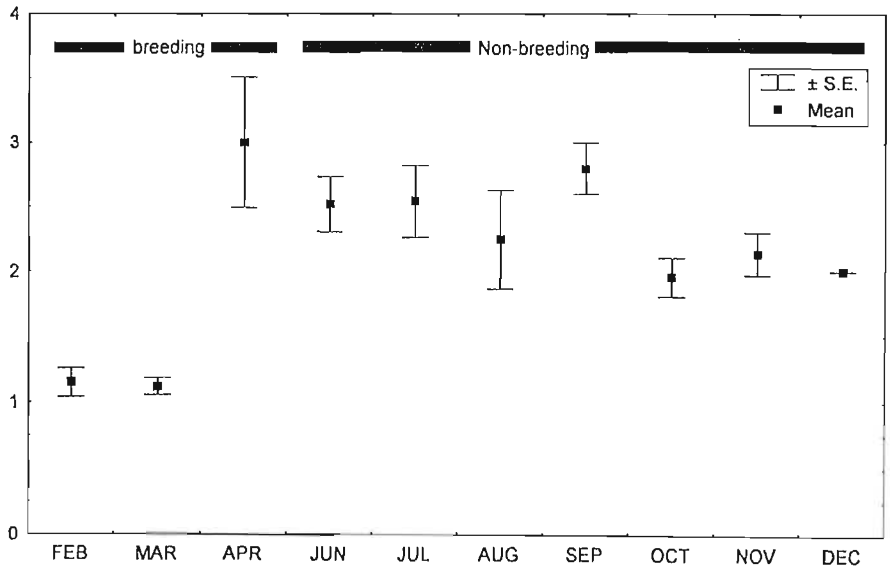

Figure 1. Mean ± S.E. roosting flock sizes between breeding and non-breeding seasons.

Table 2. . Mean ± S.E. of roosting flock sizes observed at four different localities, in 35 different trees.

Month	x̄ flock size	S.E.	Range	n
Overall	2.16	0.83	1 - 7	212
January	No data			
February	1.15	0.11	1 - 3	20
March	1.12	0.07	1 - 2	25
April	3	0.51	1 – 7	12
May	No data			
June	2.52	0.22	1 - 6	46
July	2.77	0.30	2 - 5	13
August	2.25	1.53	1 - 6	16
September	2.8	0.2	1 - 4	25
October	1.96	0.15	1 - 4	23
November	2.14	0.17	1 - 4	22
December	2	0	2	10

Roosting times in relation to sunset and sunrise

Day-length was longest during November to March, mean 13:09 ± 2:08h and shortest during June to August, mean 12:21 ± 13.7h (figure 2)

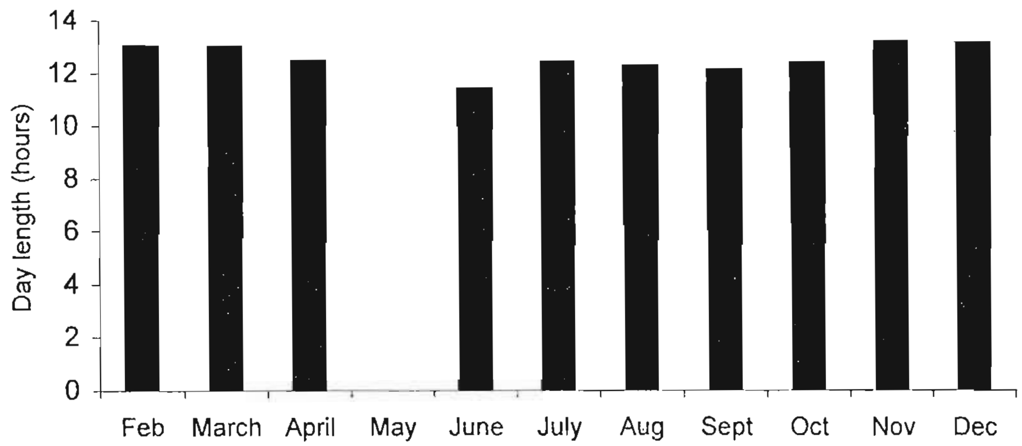

Figure 2. Day length throughout the year at lovebird roost-sites (No data for May or January).

Overall, lovebird entrance and exit times from roost cavities differed significantly between February to December (Anova $F_{(9,1)}$ = 2.52, *P* <0.05. Emergence times around sunrise were not significantly different between months (Anova $F_{(9,)}$ = 1.77 *P* > 0.05, a post-hoc Scheffé test showed the birds left the cavity at the same time throughout the year. In comparison, the time birds entered cavities around sunset differed significantly between months (Anova $F_{(9)}$ = 2.60, *P* < 0.05).

On average, lovebirds entered cavities to roost 8.5 ± 1.74 minutes before sunset (n = 127), and left 6:7 ± 0.8 either side of sunrise (n = 144). Figure 3 illustrates the trend in cavity entry and exit times between February and December. During February and March birds roosted earlier than sunset, and later than sunset during December. Emergence from cavities in the morning was latest during July, August and November, and earliest during April.

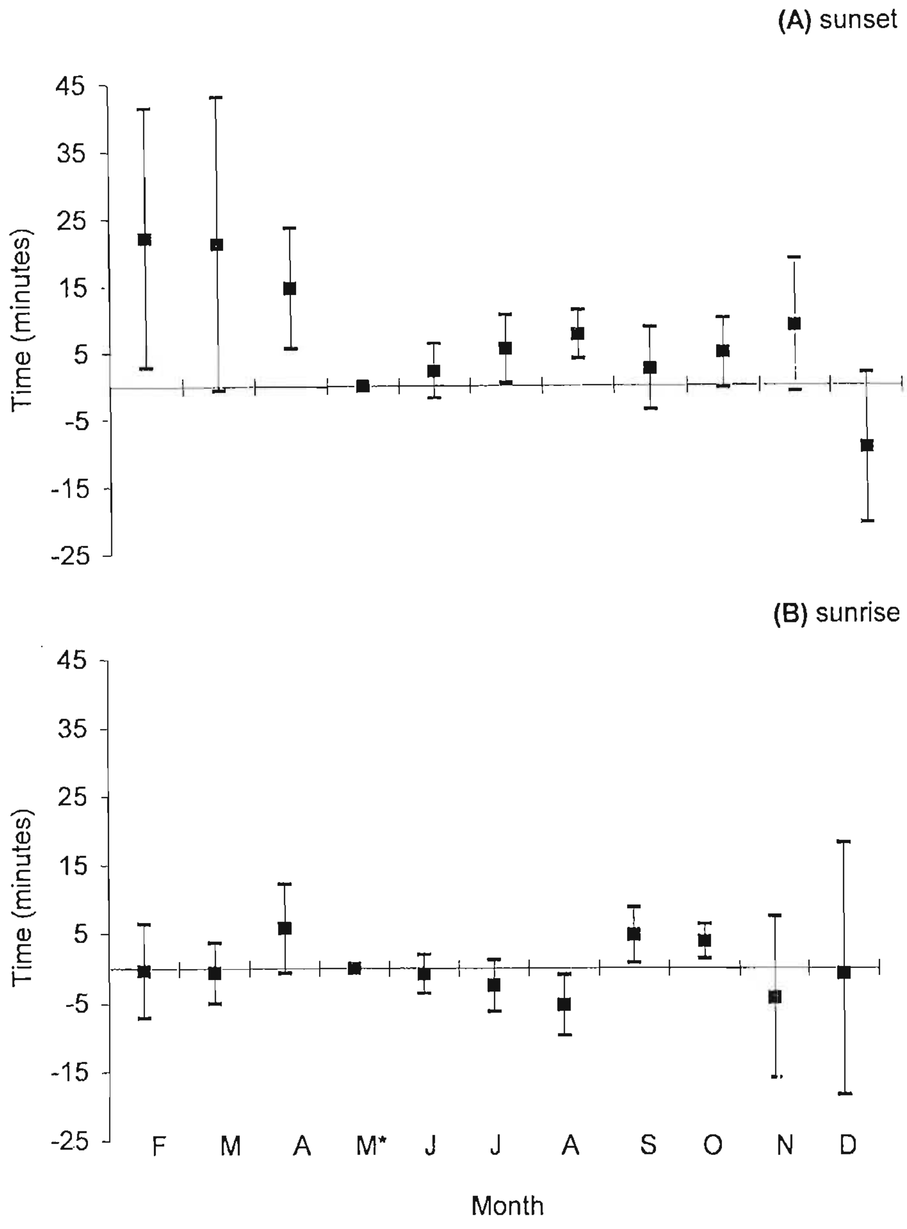

Figure 3. Mean time ± 95% confidence limits in minutes around (A) sunset and (B) sunrise that lovebird's entered and exited roosting cavities throughout the year (n = 271, at 35 roosting cavities in 4 locations). Time of sunset and sunrise is represented at zero minutes. Negative values = after sunset/sunrise, positive values = before sunset/sunrise.
**** no data for May or January.***

Cavity entry and emergence times of flocks

In general, lovebirds entered and emerged from roosting individually rather than as a group. The mean time between successive birds entering cavities was 7 minutes 18 seconds ± 0.83 (n = 9), and for emerging birds 5 minutes and 7 seconds ± 0.95 (n = 21).

Roosting behaviours

A. Non-breeding season

Lovebirds flew back to the roosting locality after drinking, usually 10 - 20 minutes before sunset. From, often, large gatherings at the water source, flocks dispersed directly towards roost sites in smaller groups, flying rapidly above canopy height, vocalising. At the roost site, birds perched and preened together on the same tree (assembly point), typically a dead tree or the tallest with exposed upper branches. The 'assembly point' tree was used by lovebirds as a pre- and post-roost gathering point on a twice daily basis throughout the year. Typical flock size ranged from 8 - 26 individuals. As the sun set, the flock would rise initially calling loudly, with birds breaking off into pairs or small groups to fly below canopy height, usually in silence, to the roosting cavities. Individuals then landed near the cavity and perched in silence before entering the cavity. Entrance was usually head-first. Occasionally disputes between birds gathering outside cavities would result in further movements. Once inside the cavity birds were silent and rarely reappeared.

Around sunrise, emergence from roosting cavities was typically rapid, with birds calling as they left to gather at the assembly point tree. Behaviours typically included preening, sun-basking and calling, before the entire flock flew directly towards a water source where they gathered with other lovebird flocks from the region, before drinking.

Some ground-level feeding also occurred at roost-sites, typically within 50 m of the assembly trees, just prior or post roosting times. This generally took place where seeds of the grass species *Echinochloa colona* were found, or in dried out elephant tracks where windblown seeds had gathered (chapter 4). Lovebirds flew from the assembly tree to ground level to feed. Feeding during any time of the day in the roosting locality increased towards the end of the dry season (from September) through the breeding season (lovebirds nested at the same sites as roosting occurred during the non-breeding season (chapters 6 & 7). Outside of these months lovebirds were rarely found in the roosting areas except for during the early morning and late afternoon.

B. Breeding season roosting behaviours

Throughout the incubation, brooding and the main chick-rearing season females roosted in the nest. Males were observed to roost either in the nest or in a near-by cavity. As the breeding season progressed both parent birds roosted away from the nest, presumably due to lack of space inside the nesting cavity, leaving the nest-cavity at last light and returning at sunrise. Two observations were made of the adults roosting in a separate cavity from the nest, but in the same tree, although most roost sites were in separate, although close-by trees. Later in the season fledged juveniles from the nest also roosted in a nearby cavity whilst sibling nestlings remained in the nest. Females carried nesting material into these roosting cavities during the nest-building period. Observation inside one roosting cavity revealed a half-constructed cup-shaped nest. Observation into another nest cavity in the same tree was not possible given the small size of the cavity entrance.

Internal cavity inspections

Although lovebirds were never observed to transport nesting material outside the breeding season, inspection of roost holes not used as nests during the 2000 breeding season, revealed the presence of nesting material, which suggests that lovebirds either line roosting holes with material, or that they roost in cavities previously used for nesting Nest-type material was also found inside second cavities in some nesting trees where adult lovebirds and fledged chicks were observed to roost.

Daytime roosting

Lovebirds rested at feeding and drinking sites during the day, retreating as a flock to the shade of the mid-aboreal canopy, or in shrubs, typically *Balanites aegyptiaca*. Birds roosted for up to 40 minutes at a time, either with their heads turned around onto their backs, or resting on the chest. Birds rested at any time of day, most typically following and preceding the main feeding and drinking peaks in the early morning and late afternoon (chapters 4 & 10).

Other avian cavity roosting and breeding species

Twenty-five other cavity-utilising avian species were recorded at lovebird roost sites (table 3).

Table 3. Other cavity roosting/nesting bird species observed in the locality of Black-cheeked Lovebird roosting areas.

Grey-headed Parrot	*Poicephalus fuscicollis suahelicus*
Meyer's Parrot	*Poicephalus meyeri*
Giant Eagle Owl	*Bubo lacteus*
Pearl-spotted Owl	*Glaucidium perlatum*
Scops Owl	*Otus senegalensis*
Barn Owl	*Tyto alba*
Woodland Kingfisher	*Halcyon senegalensis*
Striped Kingfisher	*Halycon chelicuti*
Lilac-breasted Roller	*Coracias caudate*
Broad-billed Roller	*Eurystomus glaucurus*
African Hoopoe	*Upupa epops*
Red-billed Woodhoopoe	*Phoeniculus purpureus*
Scimitar-billed Woodhoopoe	*Phoeniculus cyanomelas*
Ground Hornbill	*Bucorvus leadbeateri*
Red-billed Hornbill	*Tockus erythrorhynchus*
Grey Hornbill	*Tockus nasutus*
Crested Barbet	*Trachyphonus vaillanti*
Bearded Woodpecker	*Thripias namaquus*
Cardinal Woodpecker	*Dendropicos fuscescens*
Southern Black Tit	*Parus niger*
Arnot's Chat	*Thamnolaea arnoti*
Long-tailed Starling	*Lamprotornis mevesii*
Burchell's Starling	*Lamprotornis australis*
Greater Blue-eared Starling	*Lamprotornis chalybaeus*
Southern Grey-headed Sparrow	*Passer griseus*

DISCUSSION

In general the roosting habits of Black-cheeked Lovebirds are comparable to those of most parrot species where roosting habits are known. Parrots typically travel some distance daily to roost communally at traditional sites (del Hoyo *et al.* 1997). The roosting behaviours of the Black-cheeked Lovebird follow this typical activity pattern. Roost sites are vacated soon after sunrise, followed by a social gathering, before flying to communal drinking and feeding sites for the day. This is repeated around sunset, with birds regrouping at the roost locality before roosting for the duration of the night. Roosting position of Black-cheeked Lovebirds is typical, at least in the daytime, as most parrots roost with their heads turned back over a shoulder with the bill and head buried in the ruffled feathers of the scapular and back (del Hoyo *et al.* 1997). Roosting position inside the cavity is unknown. Lilian's Lovebirds *Agapornis lilianae* are recorded as perching with their heads up clinging to the sides of the cavity (Fothergill 1984). At least two species, the Black-winged Lovebird *A. taranta* and Red-headed Lovebirds *A. pullaria* roost hanging upside down (del Hoyo *et al.* 1997).

However, few other parrot species roost communally in tree-cavities. Other locations utilised by other communal parrots include tree canopies, cliffs, arboreal termitaria, and man-made structures including buildings and roadside culverts (del Hoyo *et al.* 1997, Juniper & Parr 1998). The primary benefits associated with cavity roosting are shelter from external elements, energy conservation and greater protection from predators (Collias 1964, Du Plessis & Williams 1994), nest-site defence (Snyder *et al.* 1987), information exchange (Ward & Zahavi 1973) and/or avoidance of con-specific competition for resources (Chapman *et al.* 1989). In captivity, Black-cheeked Lovebirds and Lilian's Lovebirds are susceptible to cold temperatures (Hayward 1979), indicating that one of the principal benefits of cavity roosting are thermoregulatory. As Black-cheeked Lovebirds are highly social in every aspect of their daily behaviour pattern, two additional functions of communal roosting are likely: pair-bond and flock-bond maintenance. Since Black-cheeked Lovebirds were observed to feed and drink in the same localities throughout the year, information exchange is an unlikely primary function of the communal roost in these populations. Predator avoidance is also unlikely, as snakes (the major predator) are able to enter roost/nest-cavities (chapter 7).

Flock sizes and cohesion

Overall, flock size of roosting Black-cheeked Lovebirds, averaging two birds, and ranging between single birds to flocks of seven, were smaller than expected. Earlier reports recorded flock sizes of up to 12 birds (in addition to pairs) (Dodman 1995). Observations of Lilian's Lovebirds, (an allopatric species to the Black-cheeked, associated with similar Mopane woodland habitat) at Sengwa River, near Lake Kariba, recorded up to 25 birds in one cavity, with a mean flock size of 7 ± 2 birds, ranging between 3 to 25 (n = 10) (Fothergill 1984). Although, only pairs (of Lilian's Lovebirds) were recorded roosting together (n = 6) in Sapi Safari Area, Zimbabwe during September 1999 (*pers. obs.* L. Warburton). Few data exist for roosting flock sizes of other lovebird species, although one Tanzanian bird trapper claimed to have removed 450 Fischer's Lovebird from a single roost in one night (Bhatia 1992).

It is very likely that roosting locality flock members associated with each other to feed and drink on a daily basis, and formed sub-units within the larger-flocks, which gathered at drinking and some feeding sites throughout the year. This is surmised on the basis that flocks left roost-site social gatherings (post emerging from the roost-cavities) to drink in the morning and left the drinking sites together to feed; the pattern was reversed in the late afternoons (chapter 4).

Roosting and lovebird conservation

The roosting habits of Black-cheeked Lovebirds currently give 'no cause for alarm' in terms of the species conservation. Cavities are abundant (chapter 6), and apart from some localised small-scale charcoal production and land clearance for agriculture Mopane woodland is presently not threatened (chapter 11). Local knowledge, gathered from *ad hoc* interviews revealed scant information on lovebird roosting habits. Only one man reported a lovebird 'village', and appeared only to have taken note as he had previously been interviewed for this study for his knowledge on where lovebirds go at night. No one else knew that lovebirds entered tree cavities, although the general direction of movement as birds came in from roosting sites to water sources in the morning and vice-versa in the evening was generally recognised by most people as being a constant daily feature. There is little doubt that if trade in the species was resumed demand would be eagerly met by local trappers, who would likely source roosting sites. From Fothergill's (1984) report of blocking the cavity entrance holes of Lilian's Lovebird roosting cavities after dark and then cutting apertures into the branches to reach the birds (in this case for research), it would appear that roost-sites could provide a way to catch live birds with little effort. Given the extremely localised range of the species, and low population, maintenance of the trade ban in wild-caught birds is highly recommended.

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CHAPTER TEN

DRINKING HABITS OF THE BLACK-CHEEKED LOVEBIRD *Agapornis nigrigenis* IN ZAMBIA

"This species is always observed in small flocks, and seldom far away from water, to which it resorts at least once a day, and is consequently not a bad guide to thirsty traveller; though if he be inexperienced it would hardly avail him much, as it frequently happens that the drinking places resorted to by this and other water-loving birds are but of small compass and strangely situated"

A.G. Butler. The Rosy-Faced Lovebird in Foreign Birds for Cage & Aviary (II). 1911. London

ABSTRACT

Over the last 45 years (1950 – 1997) the annual rainfall in the habitat of the Black-cheeked Lovebird has decreased resulting in range reduction of an already highly localised species and increasing dependence on artificial water supplies. In this study, the water requirements and drinking behaviours of Black-cheeked Lovebirds in their natural habitat were investigated. Seasonal variations in these behaviours were examined and implications of water requirements for the conservation of the species are discussed. During the dry season Black-cheeked Lovebirds usually drank at the same water point, once in the early morning and again later in the afternoon. Little drinking activity was observed during the middle of the day. Flock sizes of drinking birds ranged from individuals to groups of 175. Birds from one locale drank at the same waterhole. Black-cheeked Lovebirds were highly cautious drinkers that did not drink when the water resource was actively disturbed by humans or livestock.

INTRODUCTION

Daily water requirements of animals are met by three sources: free water from collections of standing surface water including rain and dew; preformed water contained in food; and metabolic water, produced by the oxidation of organic compounds containing hydrogen (Robbins 1993). Measurement of free water intake often underestimates total water requirements by ignoring preformed and metabolic water sources (Robbins 1993). Water intake rates increase with ingestion of a 'drier' diet as well as environmental conditions (Calder 1981), so free-ranging animals have the opportunity to habituate and adapt to stressful environments. Hence physiological studies on captive animals (e.g. Budgerigar *Melopsittacus undulatus* Cade & Dybas 1962) add little value to our understanding of the ecological requirements in natural situations (Robbins 1993). Parrots in the wild need to consume greater amounts of food, with lower nutrient quality, than sedentary birds in captivity (Klasing 1998). Also, parrots in general are specialist feeders of dry foods, particularly seeds, holding little preformed water but considerable metabolic water. Most parrots are obligate daily drinkers and thus highly dependent on sources of free-standing water.

Parrot species, particularly those whose diet comprise mainly cone, herb and grass seeds that are low in preformed water are all recognised as being highly dependent on free water (Fisher *et al.* 1972, del Hoyo *et al.* 1997). Although little is known about the ecological requirements of lovebirds in the wild, it is apparent from anecdotal records that the white eye-ringed species and the Rosy-faced Lovebird *A. roseicollis* tend to concentrate around water sources (Moreau 1945 & 1948, Button 1953, Forshaw 1989, Moyer 1995, Fry *et al.* 1998).

In this study the drinking habits of wild Black-cheeked Lovebird *Agapornis nigrigenis* were investigated. It is a small parrot (13 -14 cm long; 39g (Maclean 1988, Warburton 2001[a], Warburton 2002), and has the most restricted distribution of any African psittacine species, with a core range of approximately 2,500km^2 (Dodman 1995, Dodman *et al.* 2000). It is primarily found in Mopane *Colophospermum mopane* woodland, but moves into adjoining habitats, such as riverine vegetation and agricultural areas to forage and drink. Since grains dominate the Black-cheeked Lovebird's diet (chapter 4), it is likely that the species is highly dependent on water for its survival. Support for this comes from Dodman 1995 and Dodman *et al.* 2000) who recorded Black-cheeked Lovebird population densities along river catchments at the height of the 1994 dry season. He found lovebird concentrations were greatest in the mid-Machile and mid-Sichifulo River catchments areas close to Mopane woodland, containing permanent water sources. Regions, even those within the core range with suitable habitat, like the Bovu and Sinde catchments, without surface water, contained no lovebirds

The apparent non-recovery of the species is thought to be correlated with the decrease in availability of free water (Dodman 1995, Dodman *et al.* 2000). Birds were trapped extensively from 1908, until a Zambian trade ban was implemented on wild-caught birds in 1930, although trade appeared to continue until the 1960's (Dodman 1995). Currently the total population is estimated at 10,000 individuals (Dodman 1995, Dodman *et al.* 2000), and the species is classified as Vulnerable (Birdlife 2000).

The aim of this section of the study was to elucidate the drinking habits of the Black-cheeked Lovebird in the species' natural range throughout the year. The drinking behaviours were documented over a 22 month observation period. It was necessary to determine the drinking behaviours and requirements of the Black-cheeked Lovebirds and elucidate from these the implications for the conservation of the species. This study is a base-line study on the ecology of the Black-cheeked Lovebird. The outcomes of the study raise detailed and specific questions, such as, what are the changes of lovebird abundance in relation to the spatial distribution of water?, which will need to be addressed by future research.

METHODS AND MATERIALS

Study site

Zambia is a landlocked country in southern-central Africa. Black-cheeked Lovebirds inhabit the driest region of Zambia, a vast plain area, altitude 914 - 1,341m, intersected by the floodplains and tributaries of the Zambezi and Kafue Rivers within the Southern and Western Provinces. The Lovebird's range is marked by two distinct seasons. A rainy season, usually from November to March, with a mean annual rainfall of 600mm (NPWS/JICA 1999), and a long dry season from April to November, with April being a transition month. The coldest month, July, has a mean maximum temperature range of 22 - 28°C, and mean minimum of 5 - 7°C; while October is the hottest month, with a mean maximum of 31 - 35°C, and mean minimum 15 - 18°C (NPWS/JICA 1999). Black-cheeked Lovebirds exist in two distinct but adjacent geographical ranges between 15° - 17°S and 24° - 26°E (Dodman 1995, Dodman *et al.* 2000). The northern population occurs along the Nanzhila River, largely confined to Kafue National Park and surrounding Game Management Areas. The southern population is centred around the Machile and Sichifulo Rivers, with the Simatanga River to the north and Ngweze River in the south forming the limits of the species's range. Few artificial (i.e. man-made) water sources were available to the northern sub-population; in contrast to the southern sub-population whose range encompasses subsistence agricultural areas where local people make small dams in river beds, dig wells and shallow pools along otherwise dry river courses and on occasions fill troughs for cattle to drink from. The lovebird's range suffers serious water shortages from June to December as all rivers in the region, with the exception of the Zambezi and Kafue Rivers, are ephemeral (*pers. obs.* L. Warburton). The only other naturally occurring water source is scattered shallow pools, few of which last through the dry season (*pers. obs.* L. Warburton). The distribution of surface water is irregular, and scarce, with their distribution and quality depending primarily on the previous rainy season.

The dominant vegetation within the range of the Black-cheeked Lovebird is Mopane *Colophospermum mopane* woodland.

Methods

Rainfall data for the period between 1950 to 1995 from two meteorological stations in south-west Zambia (Choma and Livingstone) were collected from the Meteorological Department in Livingstone, and analysed using linear regression, (following Dodman 1995 & Dodman *et al.* 2000 who used data from Sesheke, Mulobezi, Machile and Livingstone stations).

Black-cheeked Lovebird drinking activity was studied during 22 months (May - December 1998; April - December 1999; February - May 2000) of intensive fieldwork in south-west Zambia using Swift 8x42 binoculars and a Kowa 10x telescope. Locations were recorded using a Garmin 12XL GPS.

Drinking sites were located by following lovebirds and other birds early in the morning (after roost-site departure) and in late afternoon, with opportunistic watches at areas with suitable surface water, and by interviewing local inhabitants. When lovebirds drank, the time, flock size, behaviour, presence of other species, number of sips (where possible), and pool location and type were recorded.

The Black-cheeked Lovebirds used a variety of water sources categorised as the following major types: 'mopane pools': natural depressions within the Mopane woodland habitat where water collected, but usually dried up by mid-July; 'river pools': pools found within river courses or drainage channels; 'plain pools': pools found within a grassland plain habitat (usually adjoining Mopane woodland) and not part of a river drainage system; and finally 'artificial' pools which included all water sources which were available to lovebirds due to human intervention.
Kruskal Wallis tests were used to test for significant differences in flock sizes between morning and afternoon drinking activities. Given the irregularity of the surface water distribution, both spatially and temporally, it was impossible to devise an index of resource availability. Unless otherwise specified, mean values ± standard errors, minimum and maximum range values, and number of observations (n) are reported.

RESULTS

Rainfall analysis

Between 1950 and 1995, annual rainfall (recorded for the Livingstone and Choma areas) decreased (figure 1). Overall, mean annual rainfall from 1950 to 1970 was 740 ± 23mm, but since the 70's (to 1995) it has declined to a mean of 676 ± 30.4mm. From a simple regression analysis (figure 5) it can be seen that rainfall has declined at a rate of just over 5mm a year. The major consequence of this for lovebirds is a reduction in available surface water sites to drink from during the dry season, and a drop in underground water table levels, which means local people have to dig deeper wells which are inaccessible to lovebird use.

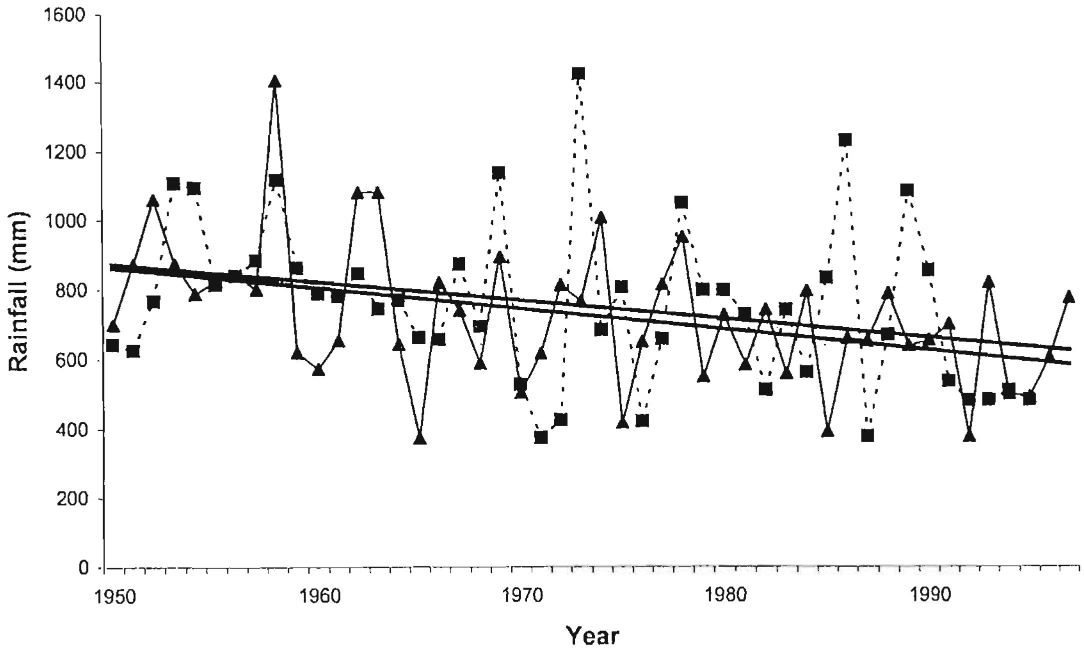

Figure 1. Total annual rainfall recorded at Choma (square symbol) and Livingstone (triangular symbol) meteorological stations in south-west Zambia between 1950 - 1997. Solid lines are represented by y = - 5.9289 x + 868.91, with regression coefficient (r^2) = 0.1706 for Livingstone and y = - 5.2859 x + 878.15, with regression coefficient (r^2) = 0.0902 for Choma

Black-cheeked Lovebirds were observed drinking from water pools on 807 occasions. Most observations were made during the dry season. During the rains lovebirds drank from whatever water was available, usually as individuals with none of the pre- and post- drinking social rituals. After rainstorms the birds were observed drinking from water collected on foliage and in depressions along tree branches, in addition to puddles and temporary water pans.

Within the Black-cheeked Lovebird's northern range limits there was little human activity, thus all pools were formed naturally along water-courses or were natural depressions in both Mopane woodland and grassland plains. In the south, however, the lovebirds were more dependent on man-maintained or man-made water resources, particularly during the dry season. Lovebirds drank from wells dug in riverbeds, water-filled wooden canoes (livestock troughs) (plate 1), small dams and wider depressions dug in sandy riverbeds. Where lovebirds used wells and troughs there was no other surface water available. However, the birds did not use any water sources subject to human or livestock disturbance at peak drinking times, wells with a steep access, or pools without a perching position within 20m of the water's edge.

Mean distance from roosts to nearest water sources utilised by lovebirds (during the dry season) was 4.9 ± 1.34 km, ranging between 1.94 – 7.85 km (n = 4).

Frequency of drinking

A summary of Black-cheeked Lovebird flocks' daily drinking behaviour, based on six dawn-to-dusk pool watches is shown in figure 2. Although most birds drank during two daily peaks of activity, one a few of hours after sunrise and another before sunset, some birds were observed drinking throughout the day. It is, however, very likely that most lovebirds drank twice daily, as demonstrated by natural colour-morphed birds, one yellow and three light green birds that were observed drinking at the same pools twice daily on frequent occasions over a twelve month period.

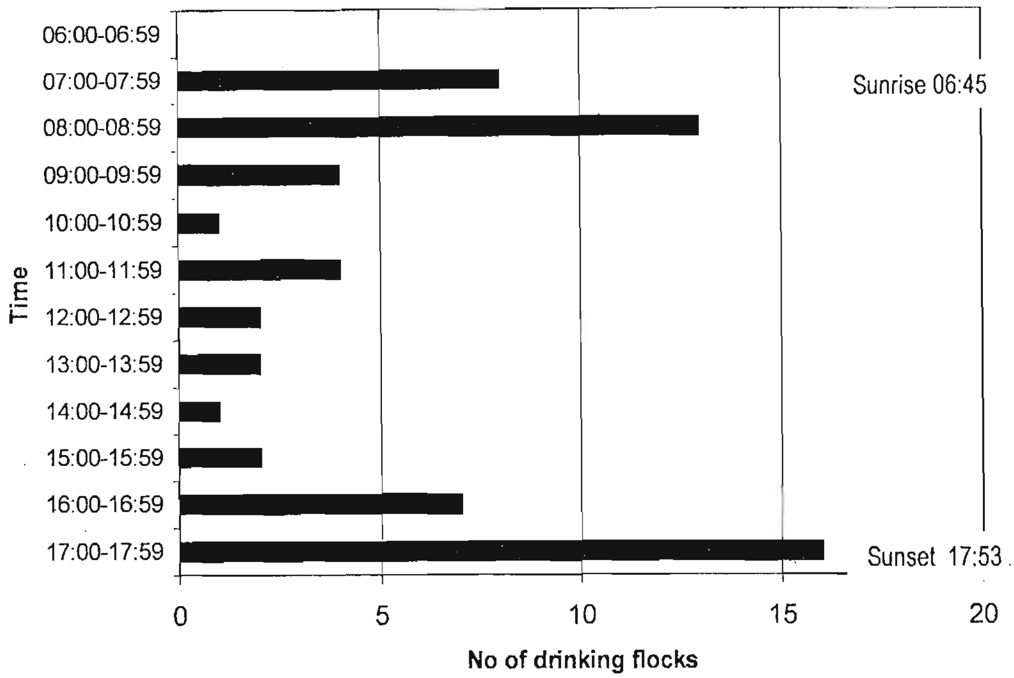

Figure 2. Number of Black-cheeked Lovebird drinking flocks observed per hour during 6 all-day pool-watches.

Total number of birds drinking

Numbers of Black-cheeked Lovebirds drinking at each water pool varied spatially, likely reflecting local lovebird abundance and distance to the next drinking site. Generally, all lovebirds from a 'local' area drank at the same water source, even if it was not the most centralised pool between the various roost sites; this was ascertained by surveying all the water sources in the locality for lovebird activity, and observing the flight-paths of birds leaving and returning to roosts.

During the mid-to-late dry season the more isolated water sources appeared to attract birds from a greater surrounding area. The largest number of lovebirds observed drinking at a single water hole was 800 birds at Mabiya Pools in south Kafue National Park, and the mid-Machile River region where approximately 300+ and 250+ drank at separate pools along the same river course 1.3 km apart. Other pools, across the species range attracted far fewer lovebirds (mean number = 24 ±

3.2, range = 1 – 120, n = 74 observations of 24 different pools) at the height of the dry season reflecting localised lovebird abundance.

Flock size

Most flocks (77%) of Black-cheeked Lovebirds observed drinking consisted of 1 – 10 birds, although a few comprised up to 175 birds. Overall 90% of flocks comprised 1 – 20 individuals. A single bird was the most commonly observed drinking flock size, although the overall mean was 9.97 ± 0.6 (n = 807) (figure 3).

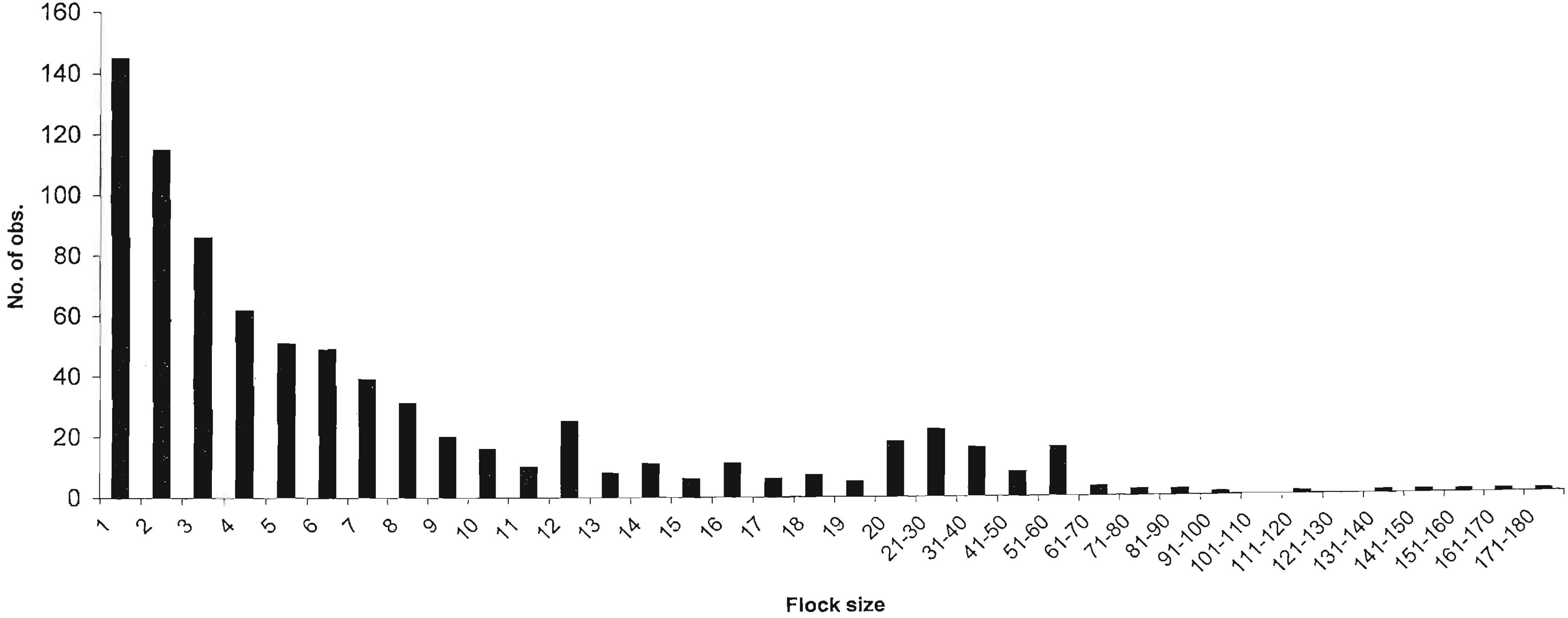

Figure 3. Frequency distribution of flock sizes of drinking lovebirds observed, (n = 807, mean = 10 ± 0.6, range = 1 to 174).

Flock sizes were significantly different between morning and afternoon drinking sessions (Kruskal Wallis H = 26.71, n = 651, 295, P = < 0.001). Overall, the larger flocks were observed drinking in the early morning between 06:00h – 08:59h (mean = 13.5 ± 0.9, range = 1 – 175, n = 457), with smallest flocks observed during the middle of the day between 09:00h – 16:59h (mean = 3.4 ± 0.3, range = 1 – 44, n = 194). There was a second, late afternoon peak between 17:00h – 18:59h (mean = 8 ± 1.2, range 1 – 160, n = 156), (figure 4).

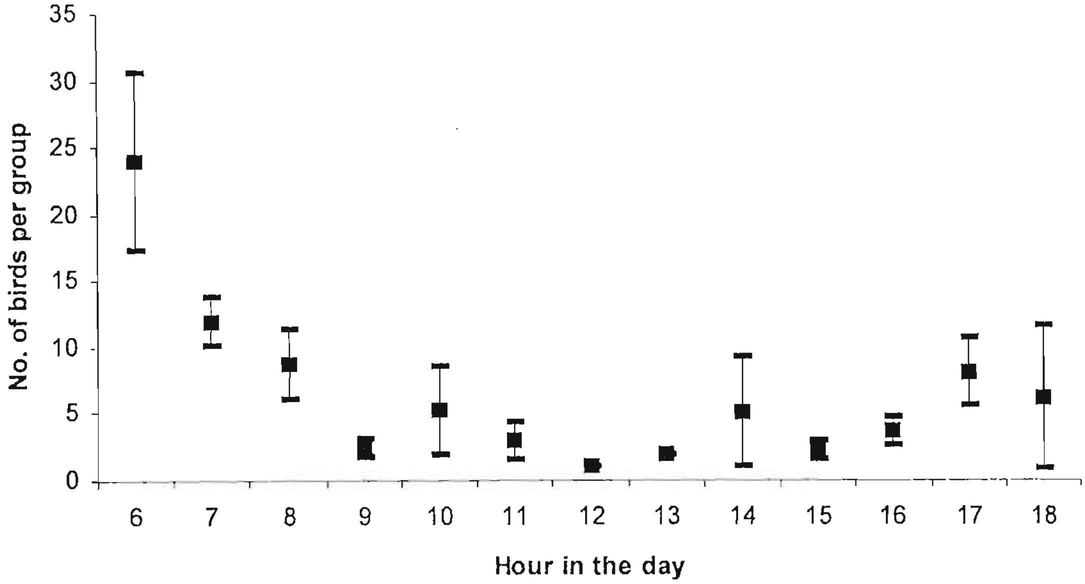

Figure 4. Mean flock size ± 95% confidence limits of drinking Black-cheeked Lovebirds by hour between February to December, 1998 - 2000 (n = 807).

Behaviours associated with drinking

Black-cheeked Lovebirds were cautious drinkers, particularly timid in the presence of non-avian (human, livestock and game) disturbance. Lovebirds generally approached a water source directly from the roost sites in the morning, or from feeding sites in the afternoon. They arrived in small flocks, typically contact-calling on their approach, then usually perched on the tallest tree or shrub within 15 m of the water. Time spent perched (typically in silence, except when answering the calls of approaching or passing lovebirds) depended on lovebird numbers in the locality and time of day. At isolated water sources, and/or when large flocks (> 80) gathered, early arrivals perched for up to 100 minutes, waiting for all the birds to gather before drinking. Perched birds preened, allo-preened, sun-bathed and rested (plate 1). When bird gatherings were smaller, or during non-peak periods, the birds perched on tall trees for only a few minutes, prior to flying down to a lower perch (typically a bush or small *Acacia* spp.) closer to the water's edge. From the lower perch they flew down to the water, landing just inside the water's edge so their feet were submerged (plate 1). Small flocks nearly always drank in silence, in contrast to the larger gatherings that dropped to the water in noisy waves. Between drinking bouts, birds perched again either on the lower bush or in the original tall tree. After drinking, lovebirds departed in small groups (most likely with the same flock members they arrived with), dispersing to either feeding sites in the morning or roosting sites in the evening.

Plate 1.

Drinking sites of Black-cheeked Lovebirds (pictures 1 & 2), pre-drinking gathering (picture 3), drinking lovebirds (pictures 4 & 5), lovebird caught in a snare at a water pool (picture 6).

1. Nanzhila River, Kafue National Park.

2. Chelenge Pool, Kafue National Park

3.

4.

5.

6. Lovebird caught in a snare, Sichifulo River.

Like most birds, Black-cheeked Lovebirds ingested water by dipping their bills into the water, scooping or 'sipping' briefly, then raising their heads and tilting them slightly backwards, allowing water to run down their throats. The mean number of sips taken between April to November was 4.8 (± 0.2, range of 1 – 16 , n = 201). The temporal pattern (figure 5) shows a general increase in water intake per drinking bout towards the late dry season.

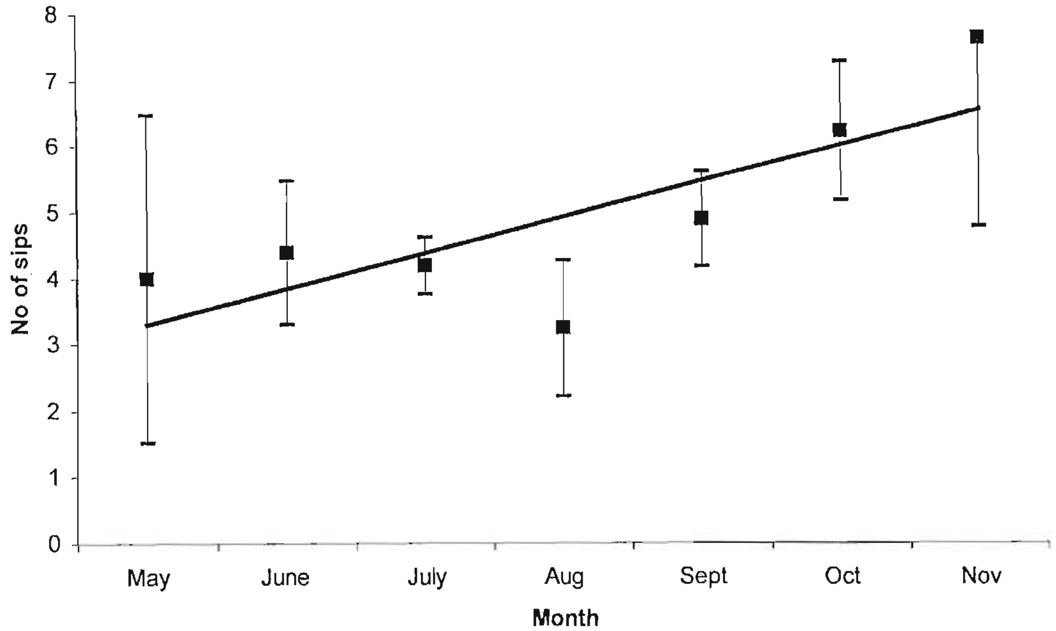

Figure 5. Mean number of sips ± 95% confidence limits taken by drinking Black-cheeked Lovebirds between May to November, 1998-2000. The solid line is represented by $y = -0.5404x + 2.7614$, with regression coefficient (r^2) = 0.6117.

Occasionally, the Black-cheeked Lovebirds changed their drinking sites, a shift usually associated with a pool drying out. Although most birds adjusted immediately to the change, a few appeared 'disorientated' returning to the old water source contact-calling and perching for short periods. The 'confusion', however, only lasted over a few days, after which birds arrived twice daily at the new drinking site.

Black-cheeked Lovebirds also bathed in the water, albeit infrequently. Bathing entailed lowering their chests into the water accompanied with vigorous wing flapping, followed by perching in the sun with drooped wings, fluffed body feathers, and rigorous preening.

Associated species

Black-cheeked Lovebirds typically drank in single species flocks, although they were observed drinking with 23 other species for 35% of the observations (n = 806) (table 1).

Table 1. Percentage occurrence of species within mixed drinking flocks observed with Black-cheeked Lovebirds.

Species		%	N
Common name	**Scientific name**		
S. Grey-headed Sparrow	*Passer diffusus*	24.2	103
S. Long-tailed Starling	*Lamprotornis mevesii*	23	98
Cape Turtle Dove	*Streptopelia capicola*	12.7	54
Red-billed Quelea	*Quelea quelea*	7.3	31
Meyer's Parrot	*Poicephalus meyeri*	5.2	22
Swainson's Francolin	*Francolinus swainsonii*	5.2	22
Lesser Masked Weaver	*Ploceus velatus*	4.7	20
Greater Blue-eared Starling	*Lamprotornis chalybaeus*	4.5	19
Laughing Dove	*Streptopelia senegalensis*	4	117
Red-eyed Dove	*Streptopelia semitorquata*	2.1	9
Yellow-eyed Canary	*Serinus mozambicus*	1.4	6
Green Woodhoopoe	*Phoeniculus purpureus*	0.9	4
Blacksmith Lapwing	*Vanellus armatus*	0.9	4
Blue Waxbill	*Uraeginthus angolensis*	0.7	3
Red-billed Oxpecker	*Buphagus erythrorhynchus*	0.7	3
Dark-capped Bulbul	*Pycnonotus barbatus*	0.5	2
Helmeted Guineafowl	*Numida meleagris*	0.5	2
Red-billed Buffalo Weaver	*Bubalornis niger*	0.2	1
Fork-tailed Drongo	*Dicrurus adsimilis*	0.2	1
Go-away-bird	*Corythaixoides concolor*	0.2	1
White-browed Sparrow Weaver	*Plocepasser mahali*	0.2	1
Green-spotted Dove	*Turtur chalcospilos*	0.2	1
Red-billed Firefinch	*Lagonostica senegala*	0.2	1

The majority of mixed flocks comprised either one (53%) or two (33%) other species with Southern Grey-headed Sparrows *Passer griseus* and Long-tailed Starlings *Lamprotornis mevesii* as the most commonly associated species. 115 avian species were recorded at Black-cheeked Lovebird utilised water sources (table 2).

Table 2. Other avian species observed at water sources used by Black-cheeked Lovebirds across the species' range. Nomenclature follows Maclean (1988).

Pink-backed Pelican	*Pelecanus rufescens*	Laughing Dove	*Streptopelia sengalensis*
Little Egret	*Egretta garzetta*	Cape Turtle Dove	*Streptopelia capicola*
Yellow-billed Egret	*Egretta intermedia*	Red-eyed Dove	*Streptopelia semitorquata*
Great-white Egret	*Egretta alba*	Emerald-spotted Wood Dove	*Turtur chalcospilos*
Grey Heron	*Ardea cinerea*	Namaqua Dove	*Oena capensis*
Goliath Heron	*Ardea goliath*	Green Pigeon	*Treron australis*
Hamerkop	*Scopus umbretta*	Grey-headed Parrot	*Poicephalus fuscicollis suahelicus*
Yellow-billed Stork	*Mycteria ibis*	Meyer's Parrot	*Poicephalus meyeri*
Woolly-necked Stork	*Ciconia episcopus*	Grey Lourie	*Corythaixoides concolor*
Saddle-billed Stork	*Ephippiorhynchus senegalensis*	Senegal Coucal	*Centropus senegalensis*
Marabou Stork	*Leptoptilos crumeniferus*	Pearl-spotted Owlett	*Glaucidium perlatum*
Hadada	*Bostrychia hagedash*	African Palm Swift	*Cypsiurus parvus*
African Spoonbill	*Platalea alba*	Red-faced Mousebird	*Urocolius indicus*
White-faced Whistling Duck	*Dendrocygna viduata*	Malachite Kingfisher	*Alcedo cristata*
Egyptian Goose	*Alopochen aegyptiacus*	Pygmy Kingfisher	*Ceyx pictus*
Spur-winged Goose	*Plectropterus gambensis*	Brown-headed Kingfisher	*Halcyon albiventris*
Knob-billed Duck	*Sarkidiornis melanotos*	Giant Kingfisher	*Megaceryle maxima*
African Pygmy Goose	*Nettapus auritus*	Pied Kingfisher	*Ceryle rudis*
Red-billed Teal	*Anas erythrorhyncha*	Little Bee-eater	*Merops pusillus*
Hottentot Teal	*Anas hottentota*	Lilac-breasted Roller	*Coracias caudate*
Black-shouldered Kite	*Elanus caeruleus*	Broad-billed Roller	*Eurystomus glaucurus*
Black Kite	*Milvus migrans migrans*	Red-billed Wood Hoopoe	*Phoeniculus purpureus*
Yellow-billed Kite	*Milvus aegyptius*	Red-billed Hornbill	*Tockus erythorhynchus*
African Fish Eagle	*Haliaeetus vocifer*	African Grey Hornbill	*Tockus nasutus*
Hooded Vulture	*Necrosyrtes monachus*	Trumpeter Hornbill	*Bycanistes bucinator*
White-backed Vulture	*Gyps africanus*	Crested Barbet	*Trachyphonus vaillanti*
Lappet-faced Vulture	*Torgos tracheliotus*	Lesser Honeyguide	*Indicator minor*
White-headed Vulture	*Trigonoceps occipitalis*	Cardinal Woodpecker	*Dendropicos fuscescens*
Brown-snake Eagle	*Circaetus cinereus*	Bearded Woodpecker	*Thripias namaquus*
Bateleur	*Terathopius ecaudatus*	Grey-rumped Swallow	*Pseudhirundo griseopyga*
Dark Chanting Goshawk	*Melierax metabates*	Mosque Swallow	*Hirundo senegalensis*
Ovambo Sparrowhawk	*Accipiter ovampensis*	Dark-capped Bulbul	*Pycnonotus nigricans*
African Goshawk	*Accipiter tachiro*	White-browed Robin-chat	*Cossypha heuglini*
Shikra	*Accipter badius*	White-browed Scrub Robin	*Erythropygia leucophrys*
Lizard Buzzard	*Kaupifalco monogrammicus*	Yellow-breasted Apalis	*Apalis flavida*
Tawny Eagle	*Aquila rapax*	Spotted Flycatcher	*Muscicapa striata*
Long-crested Eagle	*Lophaetus occipitalis*	Arrow-marked Babbler	*Turdoides jardineii*
Martial Eagle	*Polemaetus bellicosus*	White-bellied Sunbird	*Nectarinia talatala*
Dickinson's Kestrel	*Falco dickinsoni*	Amethyst Sunbird	*Nectarinia amethystine*
Lanner Falcon	*Falco biarmicus*	Black-crowned Tchagra	*Tchagra senegala*
Swainson's Francolin	*Francolinus swainsonii*	Tropical Boubou	*Laniarius aethiopicus*
Helmeted Guineafowl	*Numida meleagris*	Orange-breasted Bushshrike	*Malaconotus sulphureopectus*
Wattled Crane	*Grus carunculatus*	Fork-tailed Drongo	*Dicrurus adsimilis*
African Jacana	*Actophilornis africanus*	Greater Blue-eared Starling	*Lamprotornis chalybaeus*
Black-winged Lapwing	*Himantopus himantopus*	Southern Long-tailed Starling	*Lamprotornis mevesii*
Three-banded Lapwing	*Charadrius tricollaris*	Wattled Starling	*Creatophora cinerea*
African Wattled Lapwing	*Vanellus senegallus*	Yellow-billed Oxpecker	*Buphagus africanus*
Blacksmith Lapwing	*Vanellus armatus*	Red-billed Oxpecker	*Buphagus erythrorhynchus*
Crowned Lapwing	*Vanellus coronatus*	Southern Grey-headed Sparrow	*Passer diffusus*
Greenshank	*Tringa nebularia*	Red-billed Buffalo Weaver	*Bubalornis niger*
Wood Sandpiper	*Tringa glareola*	White-browed Sparrow-weaver	*Plocepasser mahali*
Common Sandpiper	*Actitis hypoleucos*	Southern Masked Weaver	*Ploceus velatus*
Yellow-throated Sandgrouse	*Pterocles gutturalis*	Village Weaver	*Ploceus cucullatus*
Red-billed Quelea	*Quelea quelea*	Common Waxbill	*Estrilda astrild*
Melba Finch	*Pytilia melba*	Blue Waxbill	*Uraeginthus angolensis*
Red-billed Firefinch	*Lagonosticta senegala*	Village Indigobird	*Vidua chalybeata*
Jameson's Firefinch	*Lagonosticta rhodopareia*	Yellow-fronted Canary	*Serinus mozambicus*

Natural predation at water sources

Attacks (or at least assailment) by raptors (Shikra *Accipter badius*, Fish Eagle *Haliaeetus vocifer*, Lanner Falcon *Falco biarmicus* and Goshawk *Accipiter* spp.) on Black-cheeked Lovebirds were observed on four occasions at water sources. Additionally, evidence of plucking (typical raptor behaviour prior to feeding on flesh) of a lovebird was found at Mabiya Pools, Kafue National Park.

DISCUSSION

The need to drink

A close correlation exists between the diet and drinking habits of desert-adapted birds (Fisher *et al.* 1972). Since dry seeds contain little water, usually 8 - 12% by weight (Fischer *et al.* 1972), granivorous birds tend to be particularly dependent on surface water throughout the year. As the primary diet of the Black-cheeked Lovebird comprises Jungle Rice *Echinicholoa colona*, seeds with only a 9.5% moist milled percentage (see table 4, chapter 4), it seems likely that daily access to surface water is critical for the Black-cheeked Lovebird's survival. However, an Australian study (Macmillen & Baudinette 1993) showed that grass and herb seeds have higher carbohydrate and metabolic water production (MWP) yields, than seeds of shrubs. This implies that small (< 100 g) granivorous parrots, (like the lovebirds in this study), that prefer and/or are dependent on grass seeds, have better water regulation capacities than the larger bodied parrots (e.g. Meyer's and Grey-headed Parrots) (Macmillen & Baudinette 1993).

Daily drinking patterns

The drinking pattern of Black-cheeked Lovebirds displayed features common to those of other parrot species. Daily bimodal drinking bouts are typical of Bourke's Parrot *Neophema bourkii*, Mulga Parrot *Psephotus varius*, Port Lincoln Parrot *Barnardius zonarius*, Galah *Eolophus roseicapillus* and Pink Cockatoo *Cacatua leadbeateri*; while drinking, although to a lesser extent, between the peak periods is also exhibited by Cockatiels *Nymphicus hollandicus* and Little Corellas *C. sanguinea* (Fisher *et al.* 1972) and Fisher's Lovebird *A. fischeri* (Moyer 1995). Avoidance of high daytime temperatures and intense solar radiation by drinking in the early and late hours, and mainly resting in the shade during the mid-day hours, likely assist the Black-cheeked Lovebird's temperature regulation. The intra-drinking bouts may reflect a physiological difference in water requirements between large and small bodied parrots. Studies have shown that a small body size (< 100g) has a greater water regulatory efficiency budget than a large body size, and thus may be a derived physiological and evolutionary advantage (Macmillen & Baudinette 1993).

Drinking habits in relation to water quality

Timing and extent of the last rainfall within a given locality determine water quality as evaporation rates concentrates electrolytes (Fischer *et al.* 1972). Although water potability was not measured in this study, late in the dry season Black-cheeked Lovebirds in south Kafue National Park were observed drinking in algae-ridden water pools containing dying fish, despite the presence of other 'cleaner' water resources in the area, which might suggest that water quality may not be an important factor in Black-cheeked Lovebird water requirements. Conversely, Lilian's Lovebirds *A. lilianae* in Luangwa Valley, Zambia prefer "clear and running water" (Button 1953). While water quality may not be critical, disturbance caused by wild game or livestock trampling around the waters edge appears critical. Black-cheeked Lovebirds rarely drank from the disturbed areas.

Drinking habits and implications for species fitness

Although natural predation of Black-cheeked Lovebirds was rarely observed at water sources, it is logical to assume that drinking at isolated water sources in an arid region has several disadvantages, which include a greater risk of predation, energy expenditure in travelling to and from water resources and a loss of foraging efficiency due to competition for food resources around the immediate environs of the water (Fisher *et al.* 1972). Therefore, the physiological need to drink may be countered by the advantages of a granivorous diet (seeds as a food source being more dependable and in greater supply between seasons than other food items) (Fisher *et al.* 1972). Certainly, the food and nest-site requirements of the Black-cheeked Lovebird appear to be unlimited in terms of the species's survival, with the exception of dry season surface water supply.

Conservation implications

Although the cause for the decrease in annual rainfall (illustrated in figure 1) is unknown (either attributable to global climate change or part of a much longer natural cycle) it is clear that the Black-cheeked Lovebird's range is being reduced by gradual desiccation and its distribution has been affected by the drying up of water sources (Dodman 1995). Rainfall data from three additional meterological stations to those used in this study were analysed by Dodman (1995) who recorded a significant annual decline of 0.83% in rainfall between 1949 to 1994. Data used for this study showed an annual decrease of 5 mm per year over the same time period, clearly demonstrating a natural desiccation over the lovebird's range, which is reflected in wider climatic data. Experimental models suggest that declines in annual rainfall across the southern African region will continue, and by the 2080's could average 5 - 18% less than the mean rainfall experienced between 1961-1990 (Hulme 1995, Hulme & Sheard 1999).

The southern sub-population of Black-cheeked Lovebirds, constituting approximately two-thirds of the total population (Dodman 1995, Dodman *et al.* 2000), has been affected both positively and negatively by various anthropocentric water related activities. The major benefit has been the increased surface water supplies, suitable for lovebird use, through the digging of pools and construction of small-scale dams in otherwise dry river-beds. Similarly, in Australia, the spread of the pastoral industry into the arid interior has enabled an increase of range and abundance of various bird species (Fisher *et al.* 1972), and in Namibia, Rüppell's Parrots *Poicephalus rueppelli* (del Hoyo *et al.* 1997) and Rosy-faced Lovebirds (Rowan 1983, Fry *et al.* 1988) have benefited from man-made water resources. It is highly probable that the Black-cheeked Lovebird would not survive along the Ngweze River (the Black-cheeked Lovebird's type locality (Sclater 1906, Dowsett 1972)) and it's tributary Lunungu, without the digging of wells and provision of water for livestock.

Black-cheeked Lovebird dependence on man-made water resources has several 'drawbacks'. Although earlier studies (Kilmer 1994, Dodman 1995, Dodman *et al.* 2000) found lovebirds at Mutwanjili along the Ngweze River, the present study failed to locate any birds in this region. Interviews with local villagers confirmed the lovebird's absence, which is likely caused by reduction in surface water, as a result of increased well depth and translocation of cattle watering sites (see chapter 3).

Black-cheeked Lovebirds are cautious drinkers that abandon water sources subjected to regular disturbances at peak drinking periods. Also their twice daily habit of congregation at the same resource leaves them vulnerable to capture. Some small pools are created and maintained, usually by young boys, for the sole purpose of attracting and catching (by snares placed around the water's edge) birds for consumption or local trading (plate 1). Although lovebirds were not specifically targeted, if caught, they were readily consumed. While it was not possible to quantify the offtake of lovebirds, the current offtake is unlikely to represent a long-term affect on Black-cheeked Lovebird populations (Dodman 1995, this study), providing that consumption is confined to the local population, and other usable water supplies are available.

The recent establishment of hand-pumped bore-holes along the catchments of the Ngweze, Sichifulo and Machile Rivers (*pers. obs* L. Warburton) is likely to affect surface water availability during the dry season. Villagers pump water straight into containers with the small run-off usually channelled into a depression where livestock and the more human-habituated bird species (Blue Waxbills *Uraeginthus angolensis*, White-browed Sparrow Weavers *Plocepasser mahali*, Southern Grey-headed Sparrows *Passer griseus*, and various weaver and starling species) can drink. Given the high disturbance factor at these depressions, they are unsuitable water sources for lovebirds and other cautious avian drinkers (like Meyer's *Poicephalus meyeri* and Grey-headed Parrots *P. fuscicollis suahelicus*) (*pers. obs.* L. Warburton). This decrease in available surface water may well deleteriously affect Black-cheeked Lovebird survival in this region.

Conservation recommendations

Regular monitoring (at least once every 10 years) of the Black-cheeked Lovebird's status across it's range is recommended and should follow Dodman's technique (Dodman 1995, Dodman *et al.* 2000) of counting drinking birds at the height of the dry season, which also allows for water resource monitoring. The best agency to undertake such surveys would be the Zambian Ornithological Society, with assistance from the Zambian Wildlife Authority and the Livingstone Museum, all of whom were involved in the 1995 surveys and this study. Caution in interpreting Black-cheeked Lovebird numbers from water source counts is advised as the larger flocks congregating at water sources during the dry season likely comprise birds from a wide area, which may cause misinterpretations in terms of estimates of species abundance. More regular monitoring (annual) is recommended in the areas of greatest lovebird activity, like mid- Machile and Sichifulo Rivers and the Mabiya pools region of south Kafue National Park. Education programmes, following on from the one instigated in September 2001 (Warburton 2001[b,c]) should be used to encourage local people, particularly school children, to create suitable lovebird drinking sites and minimise disturbances at existing sites during the early morning and late afternoon. Other water resources in the region could be made more lovebird 'friendly' by erecting perching material 15 - 25 m from the water's edge, although there are likely few sites within the lovebird's range that they would not use given no other alternative. Particular attention should be directed at assessing the impact of pumped boreholes on surface water supplies. It is speculated that villages with pumps will reduce their water-source creation activities in riverbeds, thereby reducing water available for lovebirds and other avian species, causing the birds to desert the area. It is also essential that the trade ban on wild-caught lovebirds is upheld as any resumption would likely lead to the rapid demise of the species given it's highly localised range, predictable social gatherings and the general poverty of the human population in the area.

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CHAPTER ELEVEN

CONSERVATION BIOLOGY OF THE BLACK-CHEEKED LOVEBIRD *Agapornis nigrigenis* IN ZAMBIA

"We may regard the Black-cheeked Lovebird as a good liver and tenacious of life"

Mr. R. Phillipps, Breeding of the Black-cheeked Lovebird,
The Avicultural Magazine, Vol V, 1907-1908.

ABSTRACT

The Black-cheeked Lovebird, *Agapornis nigrigenis* underwent a severe population decline in the 1920's from which it has never recovered. Until recently little was known about the ecology of the species in the wild. It is now known that breeding success is high and nest-sites and food resources are not limiting (this study). One of the major factors constraining the population recovery has been the gradual desiccation of the Black-cheeked Lovebird's habitat. Therefore, conservation efforts for the Black-cheeked Lovebird should concentrate on maintaining and creating suitable water sources, which experience minimal external disturbance. Other recommended conservation actions include upholding the wild-caught trade ban in Black-cheeked Lovebirds, continuing environmental education with local schools, promoting lovebird conservation and continual population monitoring.

INTRODUCTION

Parrot conservation has been described as 'an extraordinarily challenging task' (Juniper 1998). Despite having one of the highest profiles of any family of birds (Lambert & Wirth 1992) parrots are the most threatened (Juniper & Parr 1998) with more than 90 of the 350 species facing extinction and a further 40 undergoing serious population decline (Collar *et al.* 1994). A number of key factors are implicated in the global decline in parrot diversity (Wright *et al.* 2001) particularly habitat loss and degradation (Evans 1991, Jones & Duffy 1993, Christian *et al.* 1996, Reintjes *et al.* 1997, Lalime-Bauer 1999, López-Lanús 1999) and trapping for the caged bird and avicultural trade (Evans 1991, Reintjes *et al.* 1997, Lalime-Bauer 1999, López-Lanús 1999). Seventy-three of the 90 species facing extinction are negatively affected by habitat loss, 39 face extinction due to trapping with at least 28 species affected by both pressures (Juniper & Parr 1998). Other factors include predation by introduced species (Wilson *et al.* 1998, Jones 1999, Holland & Collen 2000), competition for food and nest-sites with native and non-native species (Wilson *et al.* 1998, Woolaver 2000), hunting for food (Evans 1991, Lurie & Snyder 2001), hunting for feathers

(Armitage 1998, Mack 1999), persecution as crop pests (Halse 1986, Mawson & Temby 1996, Temby 1998), disease and parasitism (Snyder *et al.* 1987, Warburton & Perrin 2002), hybridisation with related taxa (Snyder *et al.* 2000) and disturbance from hurricanes (Snyder *et al.* 1987, Herzog 1996, Evans 1991, Reillo 2000, 2001).

The primary goal of parrot conservation should be the maintenance of viable populations within their natural range (Snyder *et al.* 2000). One of the first steps towards assuring this is an accurate assessment for the species status by determining the population size and range. If a declining population is identified, detailed ecological and demographic investigations are essential to establish the causes of the decline (Snyder *et al.* 2000) since numerous efforts to conserve endangered species have been jeopardised by the lack of basic ecological knowledge (Caughley & Gunn 1996, Snyder *et al.* 2000).

Despite their familiarity as cage birds the world over, few parrot species have been the subject of detailed ecological studies (Collar 1998). This is due to a number of reasons: many species inhabit remote habitats, most have large home-ranges, they are difficult to locate, observe and follow, and nest-sites are often in difficult to reach tree cavities (Snyder *et al.* 2000). The results of this study, which have focused on a single species may be useful in conserving other lovebirds, given that this is the first extensive ecological study on any of the *Agapornis* species.

Continental Africa is depauperate of parrot species compared with the Neotropics and Australasia (Forshaw 1989). Eighteen species in four genera (*Poicephalus, Psittacus, Psittacula, Agapornis*) are found, with most species having allopatric ranges across a diverse range of habitat types (Fry 1998, Forshaw 1989, Snyder *et al.* 2000). Until recently little was known about the status and biology of most African species (Low 1994). Recent research in southern Africa has shown that the threats to African parrots are varied. The Cape Parrot *Poicephalus robustus* population, currently numbering *c.*650 individuals is principally endangered by habitat destruction and degredation, illegal capture for trade and Psittacine Beak and Feather Disease (PBFDV) (Wirminghaus *et al.* 1999, Downs & Warburton 2002). Illegal capture for trade and nest predation reduce localised populations of Rüppell's Parrots *P. rueppellii* in Namibia (Selman *et al.* 2000). Grey-headed Parrots *P. fuscicollis suahelicus* are subject to capture for trade in some areas of their wide range; this often involves destruction of nest-sites preventing future use and so may limit nest-site availability (Symes & Perrin *in press*, *pers. obs.* L. Warburton). Brown-headed Parrots *P. cryptoxanthus* are also threatened by habitat loss and capture for trade in Mozambique (Taylor 2002) and South Africa (A. Glasson *pers. obs.*), which again often involves the destruction of nest-cavities (L. Warburton *pers. obs.*). Meyer's Parrots *P. meyeri* are also occasionally captured for sale across their southern African range, or may become locally extinct following habitat destruction (Fry *et al.* 1988) and in some areas are persecuted as crop pests (L. Warburton *pers. obs.*). However, Meyer's Parrot is not considered threatened given its wide range encompassing various habitat types (Snyder *et al.* 2000), although little is known about the status, distribution and possible areas of hybridisation of the six forms. Studies on African Grey Parrots *Psittacus erithacus erithacus* and *P. e. timneh* indicate that capture for trade is having a detrimental effect on this locally abundant species over its large range, resulting in local extinctions or reduction in numbers from common to scarce (Juste 1996, del Hoyo *et al.* 1999).

Unfortunately the recent scientific interest in African parrots has largely excluded the lovebirds, despite their popularity as captive birds. Various wild lovebird species have undergone high levels and prolonged capture for the international caged-bird trade. During the 1980's Fischer's Lovebird *A. fischeri* was the most numerous parrot species in world trade, with the minimum capture of wild Fischer's Lovebirds between 1982-1992 of approximately 1 million birds (Moyer 1995). Following an export moratorium in 1991 a population survey was conducted to determine the status of the species (Moyer 1995). Results of the survey indicate that prior trade was unsustainable and had led to severe decline in population densities throughout the species' range. The report lists 19 measures required to be implemented before trade on a sustainable basis could be achieved (Moyer 1995). Trade in Masked Lovebirds *A. personata* was prohibited in Tanzania in 1984 in response to concerns of a population crash resulting from high levels of capture for trade (Moyer 1995). At some localities the trade moratorium appears to have allowed populations to recover (Moyer 1995) assisted by increased trade in captive-bred birds from non-native countries (UNEP-WCMC unpublished data).

Unfortunately there is little documented historical evidence of the trade in wild-caught Black-cheeked Lovebirds (chapter 2). The assumption of a non-recovery of the wild population since heavy trade in the period between the species' discovery in 1904 (Sclater 1906) and first capture for trade in 1908 (Philips 1908) to a trade ban in wild-caught birds from Zambia in 1930, is made on the basis of few records. In 1909, Haagner refered to a shipment of *c.*1000 Black-cheeked Lovebirds from Zambia to South Africa, most of these captive birds apparently died during the First World War (Vane 1958); and between 1926-1930 imports of large numbers of Black-cheeked Lovebirds into Europe are documented (Prestwich 1952, Vane 1958). D. Gordon Lancaster recalls 16 000 Black-cheeked Lovebirds being caught in four weeks during June-July 1928/9 (Moreau 1948, appendix I).

Trade in wild-caught Black-cheeked Lovebirds was banned in Zambia in 1930, although some trade existed until the 1960s (Dodman 1995). Rumours of more recent illegal trade exist (in 1994 *c.*200 birds, believed to be of wild origin, sourced by a Zimbabwean, were imported into the UK via South Africa and Belgium (where they were fitted with leg-rings) (anon. source 1999). During the course of this study only one incident of trapping for trade in live birds was observed, when 10 birds were taken from the locality of the Sichifulo River to Livingstone and sold. All other lovebirds were trapped for local consumption. A survey of Black-cheeked Lovebirds conducted in 1994 using counts of birds at water sources during the height of the dry season, estimated a total population estimate of around 10,000 individuals inside a core range of 2,500km^2

In the Parrot Action Plan (Snyder *et al.* 2000) four projects were prioritised for Africa, one of which concerned status surveys and conservation of the Black-cheeked Lovebird. This study forms part of a larger study, which aimed to identify the ecological requirements of the species so that a conservation strategy for its survival could be prepared. This paper aims to put forward a realistic, practical and achievable conservation strategy for the Black-cheeked Lovebird based on its ecological requirements and potential threats, identified during 22 months of field-work in Zambia.

Overall, the reasons for the Black-cheeked Lovebird's apparent non-recovery since capture for trade was banned are not clear-cut. The following suggestions for non-recovery and of potential threats to the species were identified from the literature (Dodman 1995, Dodman *et al.* 2000, Birdlife International 2000) and the present study are reviewed and proposals for corrective measures are suggested:

1. Natural desiccation of the lovebirds range resulting in absence of dry season surface water supplies;
2. Disturbance by people and livestock at potential and actual lovebird drinking sites preventing lovebird's from drinking;
3. Decrease in man-maintained sources of surface water;
4. Local hunting of lovebirds as a food source and persecution as a crop pest;
5. Disease, principally PBFDV;
6. Potential resumption of illegal trade in live birds;
7. Potential reduction in food availability, in particular, sorghum and millet;
8. Habitat destruction for firewood and timber collection;
9. Destruction of riverine woodland resulting in lovebird food shortages and soil erosion;
10. Poisoning of water pools by local people as a fishing strategy.

RESULTS AND DISCUSSION

Water related threats

Between 1950 - 1997 the annual rainfall within the lovebird's range declined by over 5mm per annum (chapter 10), and experimental climatic models predict a continuation of this trend (Hulme 1995, Hulme & Sheard 1999). Daily observations of Black-cheeked Lovebirds over 22 months highlight the species dependence on accessible surface water, as they need to drink at least twice daily throughout the year. The lovebirds utilised a variety of water sources, including man-maintained resources, such as shallow wells dug in dry-river beds and water-filled wooden canoes serving as livestock water-troughs. The birds are particularly dependent on man-maintained water resources in the southern regions of their range, particularly along the Ngweze River, Lunungu tributary and Sichifulo River during the dry season. However, they are highly cautious drinkers avoiding any water sources subject to human or livestock disturbance at peak lovebird drinking times (early morning and late afternoon). Occasional disturbances force lovebirds to abort drinking attempts and it is likely that consistent disturbances deter lovebirds from using the resource altogether, and if no other suitable surface water is available the birds will desert the area. Of particular concern is the recent establishment of hand-pumped bore-holes along the river catchments (*pers.obs.* L. Warburton). It is logical to assume that local communities living close to the pumps will decrease their well and dam-digging activities thereby reducing available surface water, which may well deleteriously affect Black-cheeked Lovebird survival in these regions. Lovebirds are highly unlikely to utilise the water pools which form from pump run-off, due to the consistent high disturbance by people and livestock in the area (*pers. obs.* L. Warburton).

Besides being disturbance free, water sources must also have perching opportunities within 20 m of the water's edge as flocks gather in perching flocks both pre- and post-drinking (chapter 10).

Solutions

The cause of the decreased annual rainfall is unknown. It is speculated that it may be either attributable to global climate change or part of a much longer natural cycle. Unfortunately, there is little conservationists can do, especially on the regional scale, to arrest or reverse this trend, and thus attention and effort should be focussed on enhancing current, as well as providing new, suitable lovebird drinking sources, particularly during the height of dry season. Methods for enhancing existing water resources include: reducing disturbances, removing snares and providing perching (e.g. by planting a small bush, e.g. *Acacia* spp. within 20 m of the waters edge). Ideally water sources, such as small pools which are undisturbed at lovebird peak drinking periods, should be created and maintained during the dry seasons. Unfortunately, in some areas (e.g. Bombwe, Sichifulo River) local people have created pools specifically to trap birds coming to drink. Motivating for such pools to be made 'lovebird-friendly' would require sensitive negotiations with local communities. One way to achieve this is by using projects run by local primary schools, supervised by an external organisation (such as the Zambian Ornithological Society, or National Museum Board, to keep up the momentum and ensure that the created pools did not become disturbed and/or were not used for trapping). This type of project is most suitable for the Machile and Sichifulo River catchments, since large populations of lovebirds and people are found there. Observations of the wells dug along the dry courses of the Ngweze River and Lunungu tributary indicate the underground water level is relatively deep, and providing water for birds may best be achieved by drawing water to fill shallow troughs.

Local persecution

Local people within the southern Black-cheeked Lovebirds' range catch birds, usually using snares at water pools, but occasionally using catapults in ripening crop fields, or by coating frequently used perches with a glue-like substance. Lovebirds were, however, not specifically targeted, and doves, francolins and guinea fowls were more highly desired as food sources. During this study no observations were made of lovebirds being lethally persecuted as crop pests, although interview information from local people indicated that lovebirds were killed to prevent the lovebirds foraging in ripening millet and sorghum fields (chapter 5).

Solutions

Since most of the bird hunting was done by young children, educational programmes encouraging them not to kill so many birds and heightening their appreciation of birdlife and other natural resources should be implemented and maintained at local schools, perhaps in conjunction with the youth ('Chongololo') clubs of the Wildlife Conservation Society of Zambia (after Dodman 1995). Additionally, energies should be channelled into learning about lovebirds, creating and maintaining water sources, as well as conducting regular lovebirds counts of the birds. The author initiated this process in September 2000 by visiting all the local primary schools, Zambian Wildlife Authority scout posts, and Headmen of 'prime' lovebird frequented villages within the range of the Black-cheeked Lovebird (Warburton 2001). Each 'leader' was presented with an education booklet (Appendix IV) and a poster translated into chiLozi. The educational booklet introduced lovebird conservation issues within a framework of environmental topics relevant to the local communities. The issue of the lovebird as a crop pest had to be handled diplomatically and with sensitivity to local priorities. It was explained that the lovebird, for most of the year, is a 'friend' of the farmer as it feeds on weed species that would otherwise compete with the agricultural crops for water and nutrients. It was stressed that lovebird capture was forbidden by Zambian law while taking care to make no inference to the potential captive value of the birds. The response by teachers, headmen and scouts was encouraging, with some teachers independently suggesting the formation of 'cikwele' (parrot) clubs. It is desirable that this environmental education process be strengthened and continued as such programmes do benefit parrot conservation (Butler 1992).

Persecution of lovebirds as a pest of agricultural crops is discussed under 'Potential reduction in food availability'.

Disease

Little is known about the diseases affecting lovebirds in the wild. During the course of this study one wild Black-cheeked Lovebird nestling tested positive for Psittacine Beak and Feather Disease Virus (PBFDV) (chapter 8, Warburton & Perrin 2002). Occasionally adult lovebirds were observed showing typical clinical symptoms of the virus suggesting that PBFDV is present in wild populations. Generally, lovebirds are thought to be quite susceptible to the PBFDV (Kock *et al.* 1993) which is often fatal for captive parrots.

Solutions

Further samples from wild lovebirds would be highly beneficial in verifying and assessing the status of the disease, as well as establishing levels of natural immunity for vaccine development. In Australia, more than 14 wild parrot species belonging to 12 families are infected with PBFDV, although most cases of naturally acquired acute PBFDV appear not to be fatal (Raidal & Cross 1995). With no known treatment, conservationists can only hope that naturally acquired PBFDV is rarely fatal, and that natural immunity has developed. 'Clean' captive populations from pure blood-stock must be encouraged to breed. A vaccine is currently being developed in a collaborative effort between the Universities of Cape Town and Bloemfontein, to which samples from this study have been forwarded.

Potential resumption in illegal trade

Compared with other lovebird species (particularly Masked Lovebirds *Agapornis personata*, Fischer's Lovebirds *A. fischeri*, Rosy-faced Lovebirds *A. roseicollis* and the Grey-headed Lovebird *A. cana*), Black-cheeked Lovebirds are relatively uncommon captive birds, with the largest captive collections probably found in South Africa. Breeding success in most collections appears to be good to fair, although hybridisation and lack of species purity appears to be a problem (*pers. obs.* L.Warburton). Interest in the species appears to haves escalated in recent years, increasing the market value to around £80 a bird in the UK (*pers. obs.*) and R200 in South Africa (Avizandum Magazine). Any resumption in the capture of wild birds for trade is believed to be potentially disastrous for the conservation of the species. Given the bird's predictable nature of daily gathering at the same drinking and feeding sites throughout most of the year across the highly localised range, large-scale capture would be possible. Given the lack of economic development within the lovebird's range, local communities are likely to be receptive to new sources of income generation and would willingly be coerced into trapping lovebirds for live trade.

Solution

Current law enforcement standards are unlikely to be capable of quashing illegal trade. Therefore stricter penalties for lovebird capture and trade should be put in place and more rigorously enforced. The author strongly believes that no trade in wild-caught Black-cheeked Lovebirds should be initiated, even if the current Zambian trade ban were to be lifted. The species is listed on Convention on International Trade in Endangered Species of wild fauna and flora (CITES) Appendix II.

Potential reduction in food availability in particular sorghum and millet

It has been suggested that a change in local cropping patterns towards maize away from millet and sorghum may have negatively impacted on Black-cheeked Lovebird populations (Dodman 1995, Dodman *et al.* 2000). The findings of this study refute this statement. As up to one third of the total lovebird population is found largely within the boundaries of Kafue National Park and surrounding Game Management Areas, it is likely they do not include agricultural crops in their diet. Although there is little doubt that the millet and sorghum crops represent discrete and super-rich food patches during the ripening season, they are not requisite to lovebird survival (chapter 5).

Solutions

There are several possible solutions to dealing with the Black-cheeked Lovebird as (or at least being perceived as) a pest of agricultural crops, such as increasing crop defence mechanisms, growing decoy crops (Naughton-Treves 1998), providing supplementary food (Eckert 1990), and implementing compensation schemes (chapter 5). Idealistically the goal of management should be to raise general tolerance of wildlife among farmers via education programmes (Warburton 2001) and to improve non-lethal methods of crop defence. Given the abysmal record of other compensation schemes in Africa, direct monetary compensation should be considered cautiously (Naughton-Treves 1998).

Habitat destruction

This study determined the importance of Mopane woodlands for Black-cheeked Lovebirds as a source of roosting and nesting cavities and habitat in which to forage. Destruction and/or degradation of the Mopane woodlands within the range of the Black-cheeked Lovebirds, particularly within a 10 km radius of permanent water sources (see Chapter 10), could potentially reduce the lovebird's food, roosting and breeding resources. Fortunately there was little evidence of habitat destruction, with the exceptions being small-scale clearing for agriculture and charcoal production. In fact, the area under Mopane within the region actually appears to be increasing with encroachment onto (the now drier) floodplains (Dodman 1995, *pers. obs* L.Warburton).

Solutions

Given that most of the Black-cheeked Lovebirds southern sub-population lives in an area under no formal protection, two Important Bird Areas (IBA) principally to protect the Black-cheeked Lovebird have been designated. The aim of the IBA programme is '*to identifiy and protect a network of sites, at a biogeographic scale, critical for the long-term viability of naturally occurring bird populations*' (Fishpool 1996). The Africa programme began in 1993 (Bennun 2000) and a continental directory of sites was published in 2001 (Fishpool & Evans 2001). Thirty-one IBAs have been identified for Zambia, covering a combined area of 86 413 km^2, two of these encompass most of the Black-cheeked Lovebird's range. The southern range of the Black-cheeked Lovebird defines the Southern Zambia Secondary Area (s051) of avian endemism (Leonard 2001). The IBA called 'Machile' (ZM008) covers *c.*300 000 ha (Leonard 2001), was identified by Dodman (1995), and encompasses the mid-Machile, mid-Sichifulo and lower Simatanga Rivers and all areas in between. This region supports over fifty percent of the total Black-cheeked Lovebird population (Dodman 1995). The 'Kafue National Park' IBA (ZM012) covers 2 240 000 ha, although Black-cheeked Lovebirds are only found in the southern section. These two IBAs also encompass the habitat of over 500 other bird species, including Wattled Crane *Grus carunculatus* and Lesser Kestrel *Falco naumanni,* both Vulnerable species and various endangered mammal species, including African Wild Dog *Lycaon pictus* and African Elephant *Loxodonta africana.*

However, the proclamation of an IBA does not involve any form of active protection or governmental ratification. In particular, demarcated areas under no other form of national protection are currently unlikely to be recognised outside academic circles. One solution would be to lobby the government of Zambia to recognise the importance of the area to the global survival of the Black-cheeked Lovebird and attain some national level of protection status.

Poisoning of water pools

Poisoning of water pools as a method of killing fish was identified as a potential threat to the Black-cheeked Lovebird by Dodman (1995). Although this activity was not observed during the course of this study, and is considered a minor threat to species survival it should be halted where possible.

Additional Targets

Monitoring

Access to reliable current population data is crucial for effective conservation management (Bennun 2000). By regularly monitoring it is possible to assess (and review) the status of a species (for example as a result of the Dodman 1995 survey of the Black-cheeked Lovebird, the species' status was downgraded from Endangered to Vulnerable following IUCN Criteria); and to gauge whether particular conservation measures, or capture levels are impacting on the species. Methods for counting birds are widely published, and reviewed (e.g. Bibby *et al.* 2000), and the nature of the monitoring scheme used will depend on the specific purpose for which the data is required (Bennun 2000). Regular counts (ideally annual but at least every five years) of the Black-cheeked Lovebird population, across the species range (similar to Cape Parrots (Downs & Warburton 2002) and Crane *spp.* (McCann 2003) counts) is suggested. Following Dodman 1995 and Dodman *et al.* 2000, I recommend that lovebirds are counted at water sources during the early morning or late afternoon in the mid- to late- (July to October) dry season. This approach is both time and cost-effective, given the lovebird's habit of gathering from across the local area to drink at the same water resource. Under certain conditions it also allows for comparison with previous studies. Following a survey of Fischer's Lovebirds in Tanzania, recommendations were made to use line transects following a systematic sampling scheme using a series of rectangular plots with a random orientation (Moyer 1995). This method is not wholly appropriate for the Black-checked Lovebird, as it requires intensive sampling effort given its clumped nature, with each flock encountered scoring as a single contact, following the distance sampling theory (after Buckland *et al.* 1993). This sort of survey could be used at specific priority sites to discover the density of lovebirds. Fischer's Lovebird surveys were recommended during the early rains when the species is breeding and local wandering in search for food and water (usually conducted in large flocks) is minimised (Moyer 1995). However, in Zambia, the logistics of moving around the Black-cheeked Lovebird's range during the early rains is not recommended given the area's propensity to flooding, which in combination with black-cotton soil rapidly becomes impassable.

It is proposed that local agencies, such as the Zambian Ornithological Society, Zambia Wildlife Authority (ZWA), Wildlife Conservation Society Zambia and National Museum Board, organise monitoring surveys. Project surveillance by a single agency is preferential to maintain standardised surveys and monitor the trends from the resulting data. Obvious constraints to this are securing the institutional and financial support for long-term monitoring work, and maintaining momentum. Local people could become involved in such surveys, and are likely to welcome the opportunity. Local involvement must however, be negotiated with area Chiefs and village Headmen. School children and ZWA scouts must be encouraged to participate in monitoring activities (Warburton 2001), which require few specialised skills (Bennun 2000), bearing in mind that the even the most basic recording materials, paper and pens, have to be provided. Annually it may be prudent to limit monitoring to key lovebird areas, in particular, the mid-Machile River region around the villages of Mutelo and Magumwi; mid-Sichifulo River around Bombwe and Chilale; the Lunungu Tributary around Lunungu Village; Mulanga Scout post in the Sichifulo GMA; and the Kalenje and Mabiya Pools area of Kafue National Park. Range-wide surveys could be conducted less frequently, perhaps every five years, to assess the status of the total population and which will by default assess changes in dry season surface water availability.

Opportunities for ecotourism

World tourism grew by 260% between 1970 and 1990, and currently generates 10.9 % of world gross domestic product (World Travel and Tourism Council figures http://www.wttc.org). In recent years 'parrot tourism' i.e. travelling by tourists specifically to view wild parrots in their natural habitat has become increasingly popular with an international clientele. Holidays, with wild parrots as their primary focus are now widely advertised, particularly for destinations in South American countries and Australia, and in some cases are directly contributing to parrot conservation (e.g. Munn 1992). With a highly localised and relatively remote range, the Black-cheeked Lovebird is a charismatic target for specialist birdwatchers visiting Zambia. Currently only specialised tours visit the lovebird area on a client-demand basis, which has the potential to develop further. Tourists can either visit the northern sub-population in the south of Kafue National Park, (although recently (December 2002) security problems with poachers attacking tourists has halted such trips) or the southern sub-population where it is desirable that visitors respect local communities and pay common courtesies to village headmen (Warburton 2002). The purpose of the visit must be explained to local communities making it clear that visitors have just come to view the lovebirds, otherwise some local people are likely to try and catch lovebirds to sell to the tourists (Warburton 2002). Although the region is unlikely to develop into a tourist 'hotspot', ecotourism largely centred around viewing the lovebirds has potential and if it does take place it is hoped that it would be developed sensitively to the birds continued conservation and with local people as primary beneficiaries. Potential benefits to local communities are revenue generation, employment opportunities and an upgrade in public services.

Captive breeding and reintroduction

The use of captive breeding in species recovery programmes, particularly as a 'last ditch' attempt to save a species from extinction, followed by reintroduction into the wild, has become rather popular in recent years (Snyder *et al.* 1996). In many cases these techniques are emotionally supported by the western public but not necessarily accepted by all conservationists (Durrell & Mallinson 1987), who are concerned that that captive breeding is being promoted as a recovery technique for many species that may not benefit from it (Snyder *et al.* 1996). The possibility of reintroduction is also widely used to justify both public and private collections of endangered species and in some cases, continuing trade in the species from the wild. Parrot conservation is particularly reliant on long-term captive breeding programmes which have both pros and cons. In terms of parrot conservation, captive breeding of rare species provides useful material for conservation education. It allows for research on certain biological aspects which cannot be accomplished on wild individuals (Snyder *et al.* 2000), in addition to (hopefully) decreasing trade pressures on remaining wild birds, and allows for the establishment of a breeding stock which may be releasable in the future. One of the major difficulties of organised species conservation programmes using captive-bred parrots has been a lack of commitment and co-operation from private aviculturists and the lack of interest in breeding parrot species by many zoological collections (Clubb 1992). Cons include continued and even increased trade pressures on wild-caught stock which may not be alleviated by having captive breeding programmes; even if capture is illegal, wild-caught birds might be cheaper in the market place than captive bred stock, as is currently the case for African Grey Parrots and Grey-headed Parrots (*pers. obs.* L.Warburton).

To date no review of parrot reintroduction/translocation projects is available. There have been notable successes (e.g. Echo Parakeets *Psittacula echo* (Woolaver 2000); Kakas *Nestor meridionalis* (Holland & Collen 2000) and Kakapos *Strigops habroptilus* (Merton 1999)), although few projects have been running long enough to assess levels of success or failure efficiently, and there is a tendency for only successful programmes to be reported (Snyder *et al.* 1996).

Theoretically, lovebirds make good candidates for reintroduction programmes, given the success of feral populations (e.g. Thompson 1987). However, populations of 'released' Black-cheeked Lovebirds in Zambia (chapter 3) and Grey-headed Lovebirds in South Africa (Clancey 1964)) have perished. Major constraints of reintroduction programmes would include: high cost, establishing a genetically pure captive population, domestication, disease, maintaining administrative continuity, and diverting attention away from the problems causing the species' extinction (e.g. reduction of surface water availability) (after Snyder *et al.* 1996). In the short to medium term, breeding Black-cheeked Lovebirds for release into the wild is not considered as a conservation management objective. Rather, meeting the demand for pure-bred specimens for the avicultural trade through captive breeding programmes should be the goal of captive breeders.

A studbook for the species kept in the UK is co-ordinated by the honorary rare species officer at the Lovebird (1990) Society (UK) and aims to establish and maintain a stock of pure normal Black-cheeked Lovebirds with as wide a genetic background as possible (Bradley 2000). The studbook maintains over 100 birds kept at nine public collections in the UK (London, Chester, Bristol, Drussilas, Twycross and Marwell Zoos, Beale Bird Park, Merrist Wood College and Tilgate Nature Centre (C. Bradley *pers. comm.* 2003)). It is unknown how many Black-cheeked Lovebirds are currently kept in private collections, but they appear to be uncommon except with specialist breeders on an international scale. Data from aviculturists indicate there are few difficulties in breeding Black-cheeked Lovebirds, although problems in maintaining purity of stock, breeding success between seasons and plucking of young in the nest appear to be commonly encountered problems (J. Boomker, D.v.d.Hofemeyer, U.Künzel, K. Lamke, B. Povlsen, G. Scopes & S.Waters, *pers. comm.*) (chapter 7). It is recommended that the studbook extends its scope to incorporate both private and public collections on an international basis.

Sustainable harvesting

In theory, the economic value of parrots could represent a means to their conservation if the revenue could be appropriately directed (Snyder *et al.* 2000). For some species at least, sustainable harvesting (of parrot chicks from nests in the wild) could provide advantages for conservation, aviculturists, the pet industry and local communities within the parrot's range (Snyder *et al.* 2000). However, challenges to such a system operating successfully, include gaining and maintaining sensitive and reliable methods of monitoring populations, and overcoming the numerous social, economic and political problems (Beissinger & Bucher 1992[a], Snyder *et al.* 2000). A key problem in south-central Africa would be the lack of appropriate legislation and lack of enforcement of legislation where it does exist, and corruption. Other foreseeable problems include lack of welfare and inappropriate care in husbandry, housing and transportation of birds. Failure to achieve success in a harvesting programme is likely to exacerbate conservation problems by stimulating harvest of parrots in an unsustainable manner (Beissinger & Bucher 1992[b]) and in the case of a highly localised and near endemic species such as the Black-cheeked Lovebird, could lead to rapid extinction in the wild. Given the likelihood of the inability that such a system could run effectively in Zambia, harvesting is not recommended as part of a current or future management strategy for the species.

Trade

Data from the Wildlife Conservation Monitoring Centre (WCMC, Cambridge, UK) show no trade in the Black-checked Lovebird either from Zambia, or from birds originating in Zambia since 1981 when records began. Export of captive birds (bred in South Africa) between 1980 to 2001 totalled 20 826, the majority in the last ten years (figure 1) with the highest number (4 388) being exported in 2000 (UNEP-WCMC unpublished data 2003). During the 1990s South Africa exported Black-cheeked Lovebirds to sixteen countries (Spain, Portugal, Israel, United Kingdom, France, USA, Saudi Arabia, Japan, Maldives, Italy, Czechoslovakia, Singapore, Germany, Namibia, Belgium and

Netherlands Antilles) (TRAFFIC unpublished data) indicating a broad international interest in keeping the species in captivity.

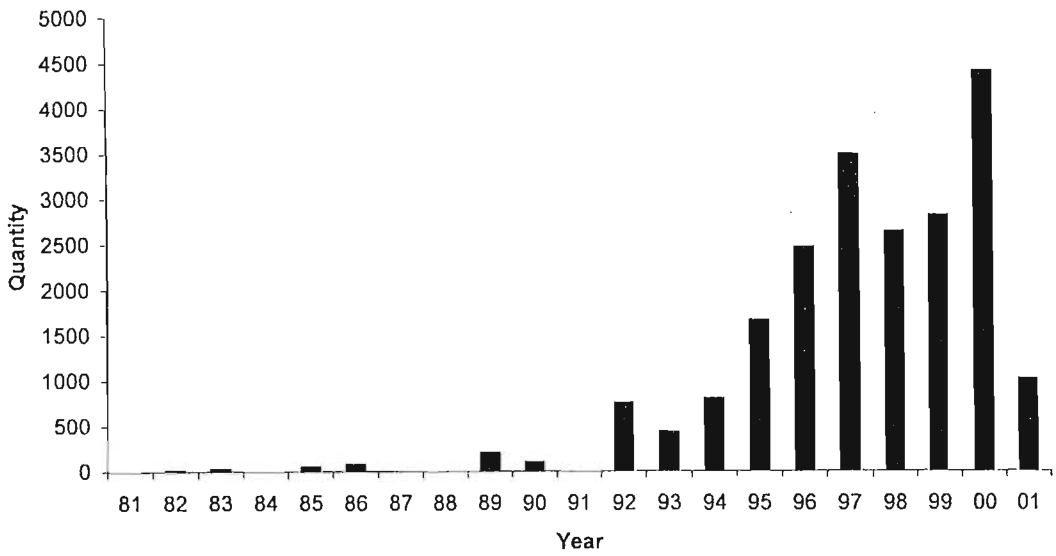

Figure 1. Exports of Black-cheeked Lovebirds from South Africa (UNEP-WCMC unpublished data).

RECOMMENDATIONS

It is recommended that both population monitoring and education programmes commence with immediate effect. Monitoring, through dry season lovebird counts at specific drinking sites, ideally, should take place annually, with range-wide counts every five years. Particular attention must be paid to changes in water availability, especially in relation to the increasing availability of boreholes. Enhancing water sources should be pilot-studied in the region of Machile and Sichifulo Rivers to ascertain whether lovebirds will use manipulated sources, and how the local communities react to the resource.

Education programmes involving local communities within the Black-cheeked Lovebird range should be an ongoing process, and ideally become part of Zambia's national curriculum. Alternative education programmes should target aviculturists, encouraging them to breed genetically pure Black-cheeked Lovebirds, to incorporate their breeding records into the studbook, and to take more responsibility for the welfare of the captive species. Ideally captive breeding should include some attempts to mimic the species's natural behaviours and requirements, for example, keeping birds in small colonies (6 - 20 individuals), allowing room for flight, sun-bathing and shelter, providing nesting material, a choice of nest box designs, feeding seeds and water at ground level and greens at a higher level to mimic arboreal foraging.

Concluding comments

For wildlife conservation to succeed in developing countries people who live in or near the wildlife resource need to be part of the conservation process (Lewis & Alpert 1997). Zambian wildlife management faces many challenges including quantitative monitoring and essential research on its wildlife resources (Lewis & Alpert 1997). Typically problems encountered in locally managed conservation programmes include a reluctance to devolve or delegate authority, slow disbursement and misuse of funds, incomplete accounting and inequitable distribution of benefits (Lewis & Alpert 1997). Projects are further hampered by poor roads, lack of transportation and lack of communication infra-structure.

Black-cheeked Lovebird population monitoring, conservation management and environmental education programmes should be evaluated regularly to determine how well each aspect of the programme has performed, thereby learning how to improve the overall effectiveness of the programme (Kleiman *et al.* 2000). The overall criteria for success would be the long term conservation of the Black-cheeked Lovebird in the wild; however, intermediate criteria and targets towards this overall goal will need to be determined to enable progress to be monitored. For example, by setting quotas for the number of water pools to be made available for lovebird use per river catchment following a pilot study, or the number of schools involved in monitoring schemes per catchment area.

The conservation of Black-cheeked Lovebirds is unusual in that the major threat to the species (natural desiccation) is one that we, as conservationists, can do very little about in terms of defence. Instead, the conservation of this parrot requires proactive management of water sources in collaboration with local communities. This will require some form of leadership in which ideas, negotiations and innovativeness are essential and deserves dedicated pursuit.

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John Caldwell from the WCMC, Cambridge, UK, and Claire Patterson from TRAFFIC, Johannesburg, South Africa, for trade data and aviculturists: J. Boomker, D.v.d. Hofemeyer, U. Künzel, K. Lamke, B. Povlsen, G. Scopes, and S. Waters for captive data.

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APPENDIX I

Copies of original letters between R.E. Moreau and G.D. Lancaster. Moreau was requesting information from Lancaster on the distribution of the Black-cheeked and Lilian's Lovebirds In Zambia. Lancaster's reply includes details on the trade in wild-caught Black-cheeked Lovebirds constitute the only historical record of a past more numerous population. Moreau went onto include Lancaster's information in the following paper:

Moreau, R.E. 1948. Aspects of the evolution in the parrot genus *Agapornis*. *Ibis*. **90**:206-239 and 449-460

All spellings as given in originals.

The original letters were located and returned to the Zambian Wildlife Authority (formerly the Department of National Parks and Wildliife Service) library at Chilanga, Lusaka, Zambia. File no: 200/2/2 598.2 R Subject: Zoological Birds: miscellaneous notes from 1937. The map Lancaster refers to was not found.

Letter from R. E. Moreau

R. E. Moreau, East African Agricultural Research Institute, Amani, Tanganyika Territory.

10 December 1945

Game Warden, Lusaka, N. Rhodesia

Dear Sir,

I have been making a special study of the genus Agapornis (lovebirds) here in Tanganyika and, while on leave recently, in the British Museum. One point that strikes me is the extraordinary mystery that surrounds the range of the Black-cheeked Lovebird Agapornis nigrigenys. I have made a number of enquiries from people interested in birds in Northern Rhodesia and from other sources and I have been unable to discover that any European has collected the bird, or seen it in the wild state, since the type specimens were obtained between Livingstone and Sesheke in 1906. Neither the British Museum nor the American Museum of Natural History possesses a single wild skin.

This is the more extraordinary because thousands of birds were exported alive to Europe and many used to come down through Southern Rhodesia to South Africa in cages. The evidence that A. nigrigenys does not occur in the same localities as the pink-headed (Nyasa) A.lilianae is pretty good. If it has a distinct range (or had: it might have been exterminated by bird-catchers), where is it ?.

I have just been told that a man named Pantopoulos at Batoka siding used to export Agapornis in very large numbers, and my informant thinks he saw among the consignments both the Black-cheeked and the Pink-headed (Nyasa). Would it be possible, please, to get in touch with Pantopoulos and get any information from him about the areas from which the two kinds of lovebirds have been obtained ? Has export continued of recent years ? And do Black-cheeked still occur in the consignments ? If so it might not be difficult to trace their ultimate origin.

I should be most grateful for any help you can give me working out the range of the Black-cheeked. It would be especially interesting to know whether it actually meets the Pink-headed anywhere.

May I ask for a reply by airmail ? Surface mail is unconscionably slow.

Yours faithfully,

R.M. Moreau.

Letter in reply to Moreau, from D. Gordon Lancaster

ZOO/2/2

P.O. Box 72, Lusaka

5th January, 1946

Dear Moreau,

Many thanks for your letter on the subject of the genus agapornis (lovebirds). You will by now have received Winterbottom's letter on the subject of which he kindly forwarded me a copy.

I enclose a map [not found*] showing a blue chalk circle in which during the year 1928/9 some sixteen thousand (lovebirds) agapornis nigrigenys were trapped during a matter of some four weeks and were sold in the Union for 16/6 a pair. The Walker Bros who trapped these birds with locally made bird lime were staying at camps allocated along the Barotse-Namwala Cattle Cordon Road. I personally was present throughout the trapping operations. All these birds were caught by the simple method of putting bird lime on trees near native gardens which contained growing ripe inyoti grain. (It would be about June-July). When a flight of birds settled on in the crops a tin was beaten and the birds rose and perched on the limed trees; all other trees in the vicinity were cut down and only those with lime left. The birds were then released their feet dusted with ashes and put in small cages and taken to the main camp where large cages had been made and thence by vanette to the railway line at Choma about 100 miles away. Owing to overcrowding in cages which caused a number of deaths, and to the vicious nature of these birds who frequently kill each other by striking at each other's heads with their strong beaks, complaints were laid of cruelty which led to the traffic in lovebirds being prohibited from this territory about 1930. I think I am correct in saying that not a single (Nyasa) pink-headed love-bird was caught in this area. I have marked on a map in blue straight lines what appeared to me in 1930 to be the limits in this area of the Black Cheeked love-bird. I have not observed them in any other part of Northern Rhodesia.

The pink-headed love-bird is found in the Zambesi Valley below the Victoria Falls from about Sijoba Drift on and off I believe to Feira and thence in patches up the Luangwa Valley to the Isoka District.

I have not yet located actually where they enter at the North End into Nyasaland but I believe near the Mwine Mpangala Coal Area not far from Fort Hill.

Mr. Pentopoulos who lives at Batoka Siding used to get pink-headed love-birds from the Zambesi Valley and I saw many in a cage which he had at Batoka.

If he has any black cheeked love-birds I am of the opinion that that they came from the area west of the railway line as marked on my map.

Personally I am of opinion that the railway line is a divide between the two birds i.e. A. nigrigenys to the West and A.lilianae to the East.

I am making further enquiries through farmers who live near the railway and who are well aquainted with the birds and country in question.

I hope this information will be of some use to you. I am forwarding a copy of these notes to Winterbottom.

Kind regards and best wishes for the new year.

Sincerely yours,

D. Gordon Lancaster

**The following handwritten note was found written across the letter*

<u>note</u>

P.S. I have asked Dr Winterbottom to return the marked map showing the area mentioned. 5/1/46.

APPENDIX II

GAZETTEER OF BLACK-CHEEKED LOVEBIRD LOCALITIES

	SOUTH			EAST	
DD	MM	SS.SS	DD	MM	SS.SS
15	15	3.7	25	59	1.4
16	6	50.8	25	58	28.7
16	8	56	25	58	51.1
16	9	34.8	25	59	9.2
16	10	16.5	25	59	24.2
16	10	42.8	25	59	34.3
16	10	44.9	25	59	31.4
16	10	47.9	25	58	52.8
16	11	22.7	25	58	58.9
16	11	28.8	25	59	56
16	11	29.1	25	59	57
16	11	32.5	25	59	56.5
16	11	33.1	25	59	39.3
16	11	34.6	25	59	38.1
16	11	54.5	25	57	24
16	12	2.1	25	58	17.3
16	12	4.3	25	57	48.6
16	12	6	25	57	32.3
16	12	6.6	25	57	57.1
16	12	9.1	25	59	2.3
16	12	19.7	25	57	27.4
16	12	28.2	25	58	44.9
16	12	29.3	25	58	55.6
16	12	35.1	25	57	23.2
16	12	37.2	25	59	33.6
16	12	48.4	25	57	16.6
16	12	49.4	25	58	39.9
16	13	2.7	25	58	58.6
16	13	9.6	25	58	30
16	13	15.8	25	58	8.1
16	13	18.5	25	58	27.8
16	13	37.7	25	58	7
16	13	46.6	25	58	38.1
16	13	58.2	25	59	30.2
16	14	55.4	25	57	29.2
16	15	15.7	25	56	10.6
16	15	35.3	25	58	48.4
16	15	39.5	25	55	49.5
16	16	12.7	25	57	23.8
16	16	17.5	25	57	29.6
16	16	20.9	25	57	26.9
16	16	25.9	25	57	21.7
16	16	26.7	25	56	33
16	16	28.8	25	57	1.3
16	16	33.1	25	57	24.3
16	16	39.4	25	58	33.2
16	16	39.9	25	58	38.6

	SOUTH			EAST	
DD	MM	SS.SS	DD	MM	SS.SS
16	16	42.4	25	54	52.7
16	16	46.2	25	59	27.5
16	18	21.6	25	58	28.1
16	18	27.1	25	56	54.3
16	18	37.1	25	58	23
16	18	53.3	25	57	9.2
16	18	388	25	56	859
16	19	38.5	25	57	27.4
16	20	1.2	25	58	45.6
16	20	18.1	25	57	23.2
16	20	22.3	25	58	43.9
16	20	894	25	58	772
16	21	7.8	25	58	18.2
16	21	31.3	25	56	41.1
16	21	37.2	25	57	27.2
16	21	489	25	56	947
16	22	22.7	25	59	5.7
16	25	40.4	25	59	53.1
16	48	418	25	31	618
16	48	479	25	30	847
16	49	346	25	29	835
16	53	15.6	25	8	2.8
16	54	394	25	19	244
16	55	35.9	25	16	0.07
16	55	56.3	25	15	27.9
16	55	155	25	17	516
16	57	51	25	9	27.2
16	58	55.9	25	17	11.3
16	59	43.2	25	9	51.4
16	7	53.4	26	2	23.2
16	8	5.5	26	6	11
16	8	21.6	26	5	57.5
16	8	22.4	26	2	12.3
16	8	44.1	26	1	55.5
16	9	4.6	26	1	43.4
16	9	22.5	26	1	43.8
16	9	41.2	26	3	36.3
16	9	47.2	26	1	57.8
16	10	30.1	26	4	35.2
16	10	45.5	26	6	24.7
16	11	19.1	26	5	37.8
16	11	54.5	26	1	57.6
16	11	59.5	26	1	55.4
16	12	19.2	26	1	2.4
16	12	21.2	26	0	16.5
16	12	50	26	0	19.6
16	24	13.6	26	0	8.5

	SOUTH			EAST	
DD	MM	SS.SS	DD	MM	SS.SS
16	25	4.4	26	0	6.3
16	25	19	26	1	6.3
16	25	22.5	26	0	3.6
16	25	47.5	26	0	32.6
16	25	48.8	26	0	8.7
16	25	53.8	26	0	5.8
16	26	13.6	26	0	23.7
16	26	14.1	26	0	26.3
16	26	20.4	26	0	30.4
16	26	34.1	26	0	36.2
16	26	575	26	3	447
16	27	9.9	26	0	59.2
16	28	1.6	26	0	51.7
16	28	53.5	26	0	51.7
16	29	19.4	26	0	49.5
16	30	10.3	26	0	29.1
16	30	55.2	26	0	33.9
16	30	57.8	26	0	10.2
16	31	5	26	0	57.8
16	31	36.3	26	0	22.7
16	32	26.2	26	0	42.1
16	32	179	26	3	697
16	33	32.8	26	0	48.5
16	33	34.4	26	0	47.3
16	33	348	26	2	721
16	33	808	26	0	859
16	34	31.1	26	0	53.3
16	34	52.6	26	1	1.9
16	34	52.6	26	1	1.9
16	35	50.6	26	1	15.7
16	38	0.1	26	1	31.3
16	38	43.8	26	1	34.4
16	38	49.6	26	1	37.6
17	7	931	15	11	135
17	8	240	24	9	799
17	0	45.7	25	9	28.4
17	0	55.9	25	17	48
17	1	15.1	25	11	54.3
17	1	52.8	25	18	7.4
17	2	4.8	25	9	34.1
17	2	28.6	25	11	25.2
17	2	49.1	25	3	15.1
17	3	16.5	25	3	0.3
17	3	20	25	10	9.9
17	3	20.4	25	10	10
17	3	51.7	25	18	45.5
17	4	13.4	25	9	37.1

SOUTH			EAST		
DD	MM	SS.SS	DD	MM	SS.SS
17	4	20.9	25	9	27.4
17	4	26.6	25	9	16.5
17	4	39.6	25	8	53
17	4	55.4	25	4	2.9
17	4	908	25	8	690
17	5	23	25	10	35.5
17	5	23.2	25	8	9.6
17	5	28.5	25	8	10.3
17	5	49.7	25	7	35.8
17	6	5.2	25	10	18.7
17	6	16.2	25	5	17.3
17	6	19.9	25	7	10.3
17	6	28.2	25	7	3.8
17	6	42.2	25	20	19.6
17	6	47.2	25	21	4
17	6	54.3	25	20	52.2
17	6	59.3	25	10	7.7
17	6	828	25	5	654
17	7	0.31	25	19	55.3
17	7	4.8	25	5	23.2
17	7	6.7	25	10	3.8
17	7	23.6	25	5	5.9
17	7	25.3	25	6	49.6
17	7	33.3	25	20	39.6
17	7	33.7	25	9	44.8
17	7	34.6	25	5	12
17	7	35.9	25	8	20.3
17	7	37.1	25	20	38.4
17	7	38	25	8	29.6
17	7	38.9	25	8	22.7
17	7	39.3	25	10	44.9
17	7	41.9	25	9	1.4
17	7	48.7	25	20	12.6
17	7	51.6	25	5	43.1
17	7	54.4	25	20	8.6
17	7	65.6	25	7	80.6
17	7	403	25	19	863
17	7	586	25	10	793
17	7	600	25	5	37
17	7	619	25	8	726
17	7	694	25	11	118
17	7	788	25	6	266
17	7	846	25	10	995
17	7	902	25	4	686
17	7	921	25	5	403
17	8	1	25	6	129
17	8	9.5	25	11	48.5

	SOUTH			EAST	
DD	MM	SS.SS	DD	MM	SS.SS
17	8	15.9	25	15	2.3
17	8	17.6	25	14	59.6
17	8	19.5	25	9	46.3
17	8	19.5	25	15	42.2
17	8	20.3	25	14	48.6
17	8	21.2	25	5	6.9
17	8	23	25	13	44.5
17	8	27.2	25	26	52.5
17	8	36.9	25	9	41.5
17	8	45.1	25	4	23.2
17	8	52.1	25	6	3
17	8	151	25	11	441
17	8	280	25	5	474
17	8	323	25	19	745
17	8	331	25	18	303
17	8	433	25	7	229
17	8	488	25	7	801
17	8	612	25	8	441
17	8	693	25	8	511
17	8	735	25	9	532
17	8	755	25	9	879
17	8	880	25	9	721
17	8	946	25	8	863
17	9	4	25	9	35
17	9	14	25	6	608
17	9	300	25	4	58
17	9	616	25	3	913
17	9	857	25	11	621
17	10	133	25	3	296
17	11	5.5	25	2	22.9
17	11	13.1	25	8	10.9
17	12	92.8	25	7	5.82
17	12	663	25	1	394
17	13	469	25	7	83
17	14	7.3	25	7	16.8
17	14	930	25	5	614
17	15	139	25	4	913
17	19	17.1	25	29	43.5
17	19	19.5	25	29	21.4
17	22	19.7	25	26	59
17	22	22.9	25	27	1.6
17	22	58.2	25	27	26.5
17	22	842	25	5	997
17	23	30.5	25	27	29.7
17	23	31.6	25	27	50.1
17	25	57.5	25	29	43
17	26	1.3	25	29	43.4
17	28	990	25	26	328
17	29	16.5	25	24	40.8
17	31	17.2	25	15	56.6
17	31	51.1	25	16	10.4

APPENDIX III

Information from labels of Black-cheeked Lovebird specimens in five museum collections (Livingstone Museum, Zambia; Transvaal Museum, Pretoria; Durban Museum of Natural History, S.Africa; Bulawayo Museum of Natural History, Zimbabwe & the Zoological Museum, Tring, UK).

Date of specimen collection	Location	Collector	Museum	Length (cm)	Wing L	Tail L	Iris colour	Bill	Feet	sex	other
04/07/06	N.W. Rhodesia	C.Wilde	Transvaal	-	-	-	-	-	-	-	-
29/08/06	German S.W. Africa	C.Wilde	Transvaal	-	-	-	-	-	-	-	-
17/09/07	N.W. Rhodesia	C.Wilde	Transvaal	14.2	9.1	5.0	brown	Red, white near nose	grey	M	White around eyes
18/09/07	N.W. Rhodesia	C.Wilde	Transvaal	14.5	9.4	4.7	brown	Red, white near nose	grey	M	White around eyes
10/09/07	N.W. Rhodesia	C.Wilde	Transvaal	15	9.2	5.5	brown	Red, white near nose	grey	-	White eye lids
19/09/07	N.W. Rhodesia	C.Wilde	Transvaal	-	-	-	-	-	-	M	V.worn tail
29/08/06	German S.W. Africa	C.Wilde	Transvaal	-	-	-	-	-	-	M	-
17/09/07	N.W. Rhodesia	C.Wilde	Transvaal	-	-	-	-	-	-	M	-
18/09/07	N.W. Rhodesia	C.Wilde	Transvaal	-	-	-	-	-	-	M	-
12/09/07	N.W. Rhodesia	C.Wilde	Transvaal	-	-	-	brown	Red, white near nose	grey	M	White eyelids
18/09/07	N.W. Rhodesia	C.Wilde	Transvaal	14.7	9.5	5.1	brown	Red, white near nose	grey	F	V. worn tail
18/09/07	N.W. Rhodesia	C.Wilde	Transvaal	-	-	-	-	-	-	-	-
08/09/07	N.W. Rhodesia	C.Wilde	Transvaal	15	9.5	5.2	brown	Red, white near nose	grey	F	-
18/09/07	N.W. Rhodeisa	C.Wilde	Transvaal	15	9.4	5.2	brown	Red, white near nose	grey	F	-
17/09/07	N.W. Rhodesia	C.Wilde	Transvaal	15	9.4	5.2	brown	Red, white near nose	grey	F	-
19/09/07	N.W. Rhodesia	C.Wilde	Transvaal	15.4	9.3	5.5	brown	-	grey	-	-
1/02/64	Livingstone, N.Rhodesia	-	Natural History, Bulawayo	-	-	-	-	-	-	M	-
25/03/57	Mulanga, N.Rhodesia	C.W. Benson	Natural History, Bulawayo	-	-	-	-	-	-	M	Testes small
17/6/49	Mazabuka	-	Natural History, Bulawayo	14	10	-	Black & brown	Red, white base	Grey	M	Skull 4
17/6/49	Mazabuka	-	Natural History,	14	10	-	Black &	Red, white	grey	F	Skull 5

			Bulawayo				brown	base			Ovaries 2
1/02/64	Livingstone	-	Natural History, Bulawayo	-	-	-	-	-	-	M	-
*10/06.62	Mabova Mopane, Ngweze River 17°30'S 25°06E	-	Livingstone	-	-	-	brown	red	Coral	M	Stomach:millet
*8/05/63	Livingstone	-	Livingstone	-	-	-	brown	red	grey	M	Stomach:millet
*1963	16°47'S 25°10'E	-	Livingstone	-	-	-	brown	red	horn	F	Stomach:millet
*June 1966	Mulobezi	-	Livingstone	-	-	-	brown	red	horn	F	Stomach millet
*June 1963	Choma, S.Province	Col. E.A. Zaloumis	Livingstone	-	-	-	-	-	-	M	'taken from African'
*June 1963	Choma, S.Province	-	Livingstone	-	-	-	black	red	horn	M	Stomach empty
*June 1962	Ngwezi River, 17°30S 25°06E	-	Livingstone	-	-	-	black	red	-	M	-
*10/06/63	Livingstone	Col. D. Swanepoel	Livingstone	-	-	-	black	red	grey	M	Stomach:grass seeds
*10/06/63	Livingstone	Col. D. Swanapoel	Livingstone	-	-	-	black	red	grey	M	Stomach:grass seeds
*June 1963	Choma	Col. E.A. Zaloumis	Livingstone	-	-	-	black	red	horn	M	Stomach:millet
*16/04/62	Ngwezi 17°30'S 25° 06'E	-	Livingstone	-	-	-	black	red	horn	M	Stomach:seed
*June 1962	Ngwezi River, S.Province 17°30S 25°06E	-	Livingstone	-	-	-	-	- -	-	F	Stomach:millet in large flocks
*June 1962	Ngwezi River, S.Province 17°30'S 25°06E	-	Livingstone	-	-	-	brown	red	grey	M	Stomach:millet large flocks in millet fields
*June 1962	Ngwezi River, S.Province 17°30'S 25°06E	-	Livingstone	-	-	-	black	red	Black-grey	F	'in ? wood'
*1/04/65	Livingstone	-	Livingstone	-	-	-	brown	red	grey	F	Stomach:millet non-breeding
*July 1963	Choma	-	Livingstone	-	-	-	black	red	horn	F	Stomach:millets 'taken from African'
*1963	Mulobezi	-	Livingstone	-	-	-	brown	red	horn	F	Stomach:empty Testes:non
*1963	Choma	Col. Zaloumis	Livingstone Museum	-	-	-	black	red	horn	F	Stomach:empty 'hawked by

											Africans'.
*June 1963	Choma	Col. E.A. Zaloumis	Livingstone	-	-	-	black	red	horn	M	Stomach:grass seeds testes:none 'taken from African'
-	-	-	Livingstone	-	-	-	brown	red	horn	F	Stomach:millet Ovaries:none
-	-	-	Livingstone	-	-	-	brown	red	horn	F	Stomach:millet Ovaries:none
-	-	-	Livingstone	-	-	-	brown	red	horn	F	Stomach:empty Testes:none
10.03.61	N. Bechuanaland	Captive ex-Mitchell Park, Durban	Durban	-	-	-	-	-	-	M	-
May 1960		Captive ex-Pretoria Zoo	Durban	-	-	-	-	-	-	M	-
June 1967		Captive ex-Mitchell Park, Durban	Durban	-	-	-	-	-	-	-	-
October 1946		Captive	Zoological Museum, Tring							F	
1909		Captive ex-Zoological Society London	Zoological Museum, Tring							F	
December 1927		Captive ex-Marquis of Tavistock	Zoological Museum, Tring							M	

BLACK-CHEEKED LOVEBIRD and ENVIRONMENTAL EDUCATION PROJECT

A booklet for the people who live with the lovebirds

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Project sponsors:

Loro Parque Fundacion (major sponsor), NRF, WCS, WPT, IFAW, BOU, ZCSP, Parrot Society, Lovebird (1990) Society, Conservation in Aviculture Society, Zambezi Society (UK), San Diego Zoological Society, British Airways Assisting Conservation & Station Africa.

CONTENTS

DEDICATION

This booklet is dedicated to the people of Zambia who live with the Black-cheeked Lovebird. During the course of my studies I met with many of you and asked countless questions about the birds. I asked for permission to stay in the villages and walk around the surrounding fields. Without exception I was met with the utmost courtesy and helpfulness. Without this hospitality the project would have failed. Thank you to everyone who helped me.

I hope this small book will have some use in teaching the children and their children what a special bird the Black-cheeked Lovebird is and how the responsibility for its survival, like our own, is a matter lying in our hands.

With very best wishes to you all,

Why research Black-cheeked Lovebirds ?

The purpose of my studies was to find out how the Black-cheeked Lovebird lives in the wild. This had not been studied before and is of much interest to many people around the world. The Black-cheeked Lovebird is very interesting because it is found in only one part of Zambia and nowhere else. We watched the lovebirds feeding and drinking, we counted numbers and found out where they go at night and when they breed. We looked to see if behaviours changed between seasons and how far the lovebirds moved in a day. We looked to see what dangers the birds faced, when they are pests in fields, and how the people of Zambia live alongside these birds. Now all this new information is being written up and will be available to all those people who want to learn about lovebirds.

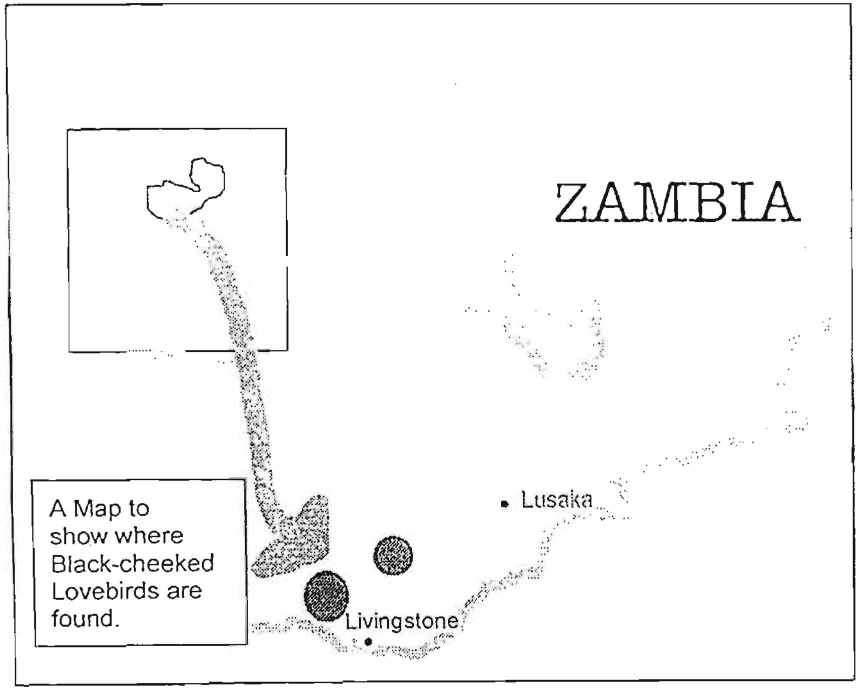
AIM OF THIS BOOKLET

This booklet and an accompanying poster have been donated to your village and school as part of the Black-cheeked Lovebird research project by the University of Natal in South Africa. Research student, Louise Warburton travelled up to Zambia and studied the lovebirds in their natural habitat from May 1998 to May 2000.

This booklet is partly a way to say thank you and also a way to carry on the project. Many people were amazed to learn that I had come so far to see these small birds and wished to learn so much about them. When we live with an animal we see everyday it can be hard to appreciate how special that creature may be to your area. In the case of the Black-cheeked Lovebird this is the truth - these birds can only be found in a small part of south-west Zambia and nowhere else in the whole world. Our children must be made aware of the specialness of these birds and learn that it is all of our responsibilities to look after and protect the Black-cheeked Lovebird.

In this booklet you will find an introduction to learning about being responsible for the natural environment with a special emphasis on the Black-cheeked Lovebird. The message is not saying that people and the improvement of living conditions are not important, but rather that development and everyday living should include some responsibility for the wildlife species that live around us - today's people owe our children and their children the chance to share what we have and enjoy today.

You can look up the meaning of certain words which are written like *this* in the Glossary section of this book, on pages 16 and 17.



Notice what a small area the Black-cheeked Lovebirds are found in – right where you live, and nowhere else!

This makes the Black-cheeked Lovebird a very special species of bird in your area, and one we must all look after.

ALL LIVING THINGS – an introduction.

We share the *Earth*, our home with all living things.

We depend on natural resources for our needs and health. Each plant and animal has a special job. We need to look after each *resource* to ensure the whole *environment* stays healthy, and then it can look after our children and us. We need to share the Earth's resources, like the air, the soil, water and wildlife wisely. We can achieve this by adopting lifestyles that respect and work within nature's limits. Let's learn HOW we can do this by taking the example of the Black-cheeked Lovebird, and learning what resources this bird needs to survive – just like us.

IMPORTANT RESOURCES FOR PEOPLE AND WILDLIFE ARE:

1. WATER
2. SOIL
3. TREES

1. WATER

Water is a very precious resource.

All living things need water to survive. Lovebirds, just like people need to drink everyday. In Zambia, people just like all the birds and wild animals need to survive the rainy season when the rivers flood, and the long dry season when water becomes scarce. People make their home where water is available in the dry season and where they can grow crops in the rains. Water resources need to be looked after through wise use and shared with other creatures in the *environment*.

1.1. Lovebirds and water

Lovebirds use water to drink and bathe. They gather at water early in the morning and late in the afternoon. In some places many birds are present. At this time the birds need peace and quiet from disturbance. Noise and activity by people at the water source may frighten the birds away. As birds are an important part of our natural *environment* let's learn to keep quiet and still during these times and allow the birds to drink in peace. There is a lot we can learn about the birds at this time:

- we could try counting to see how many kinds of birds there are,
- How many lovebirds come to drink?,
- do the numbers change at different times of the year?,
- Were there as many lovebirds coming to drink this time time last year?

This sort of information is important to record.

1.2. SCHOOL PROJECT IDEAS

Your school can make an important contribution to wildlife *conservation* by helping to monitor bird populations, in particular special birds found in your area like the Black-cheeked Lovebird. Students could conduct small research projects, for example counting the birds once a month at a particular pool and recording the species, numbers and any observations on the bird's behaviour they may observe. Remember that even if *no* lovebirds come to drink this information is still important research. No birds or less birds may indicate a population decline in the area. Greater numbers of birds may be recorded!. This could indicate a growing population or a movement of birds into your area, probably in search of a resource such as water to drink. It is only from careful record keeping over a number of years that changes in populations can be detected. Research projects which *monitor* important species like the Black-cheeked Lovebird are very important. Sending you records into the **Zambian Ornithological Society** (PO Box 33944, Lusaka 10101) or **Livingstone Museum** (PO Box 60498, Livingstone) makes an invaluable contribution to *science* and the long-term *conservation* of Zambia's wildlife heritage. A *recording sheet* suitable for monitoring bird numbers at water resources is printed on the next page. Students can copy this and fill in their observations.

RECORDING SHEET

Name of school.. Date ....
Place of observation .... Today's weather ....
Time of observation start .... and finish ....

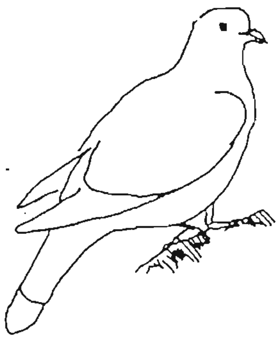
Time of each observation	How many lovebirds can you see?	What are the lovebirds doing? eg. drinking, flying, perching, feeding (record what), resting.

1. Keep quiet and still and watch carefully what the birds are doing.
2. If you are watching a water pool and NO lovebirds come to drink, or the water has run out, this is still important information and should be recorded!
3. Give your recording sheet back to your teacher. This information will become part of a very important monitoring project and will be looked after by the Zambian Ornithological Society.

1.2. Some birds to look out for and learn about:

We can learn that all birds are important and have different needs and special ways to live.

1. Doves

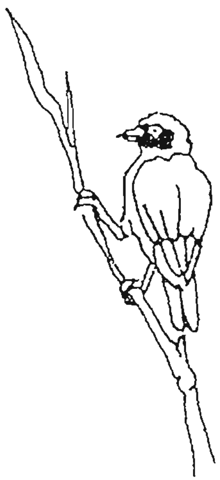


How many different types of dove can you see ?

There are 7 different species of dove which are easy to observe in your area. What are the differences between them?. Look carefully at the colours, and size. Listen to the different calls they make.

Doves are common birds, they learn to live near people and can breed all year. Have you noticed how they drink? They are very interesting because they can drink by sucking up water without tipping their heads back. Very few bird species can do this. Can you ?!.

2. Weavers

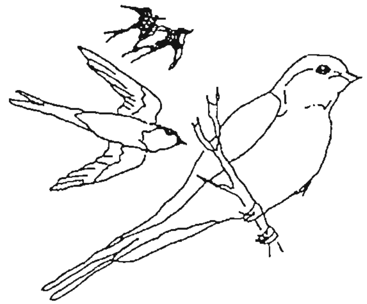


Weavers are most easy to see in the rainy season. The male birds change colour to a bright yellow colour and become very busy collecting grasses to weave nests. Once the nest is finished, the male bird tries to attract females to come and see what he has made. He hangs off the side of his nest and flaps his wings and calls. If the female does not like the nest she tears it down from the tree and the male has to start building all over again!.

Why do you think weavers like to build nests over water?
- Maybe it helps keep predators like snakes away?.

At harvesting time weavers can become a pest in fields of millet and sorghum. But during the rest of the year they help farmers by feeding on weed seeds in the fields.

3. Swallows

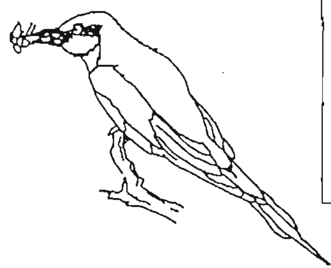


Swallows are easy birds to recognise in flight, they have long wings and tails divided into two parts.

They feed on insects which they catch in the air. Between October to April Zambia is the summer home of the European Swallow which flies south to escape the cold winter in Europe when there are not enough insects to feed on. This movement is called MIGRATION.

Other migrants to visit Zambia are some of the Bee-eater species.

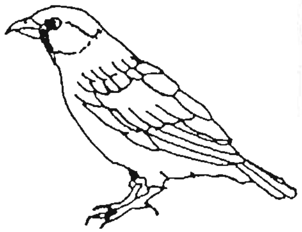
4. Bee-eater



Most Bee-eaters migrate to Zambia in the summer season when insects are most plentiful. They travel from other countries in Africa, like Tanzania and Kenya, although one species comes all the way from Europe.

Have you watched how bee-eaters catch insects in the air and then lands and knocks the insect against the tree to kill it before swallowing ?.

5. Sparrows



Sparrows feed mostly on grass seeds - the scientific term for this is *granivory*. However, during the breeding season they feed their chicks on insects which helps the young birds to grow strong and quickly.

Some sparrows make nests in the trees and other go inside holes.

They are a widespread species found all over the world, and have adapted well to live in cities.

There are 3 types of Hoopoe in this area. You can recognise them by their long curved beaks, which are used to feed on insects found on trees.

The Hoopoe with the red-beak is always found in groups. Young birds stay with their parents to help raise the next lot of babies. Not many creatures hunt this hoopoe as their bodies release a bad smelling oil, which also makes the meat taste bad!.

1.4. How does the climate affect us?

In south-west Zambia the ***climate*** is changing and becoming increasingly drier. This means less rain for people and lovebirds. Overall the ***Earth***'s temperature is rising. This process is called ***Climate Change*** or ***Global Warming***. It is the result of an increase in human population levels and development of industry which pollutes the air. Although we cannot look around and see climate change in our daily lives we need to ***adapt*** and take responsibility for ensuring our survival through caring for and managing our ***natural resources***.

The Black-cheeked Lovebird has already been affected by climate change. Today there are many areas along the Ngweze River where we cannot find these birds anymore, because it

is too dry and water can only be found by people digging deep wells which the birds cannot use. This means the lovebirds have less places to live. We need to look after the areas where lovebirds and people can survive by looking after our water resources.

1.5. How can we help ?.

In the dry season we must be careful not to waste water or cause ***pollution***. We should share the resource with the lovebirds and other wildlife by giving them a chance to drink without disturbance. Before the rains start we need to prepare to collect and store more water by digging out deeper areas where the water collects.

2. SOIL

Soil is a vital part of the ***ecosystem***.

Plants need soil to grow in. People and animals depend on plants for food and for materials to build homes and shelters with. Plants help look after the soil by protecting it from the impact of flooding by slowing the water ***flow*** down and allowing it to soak into the ground. It also ***binds*** the soil together, reducing the amount that gets blown away by the wind.

2.1. HOW can we look after the soil?

Farmers can look after the soil by ***rotating*** crops and by allowing the soil to rest under a cover of grass, and by not clearing large areas of land. This allows the soil to become richer in nutrients and protects loss of soil from rain and wind.

People and lovebirds depend on the plants for food and shelter. The plants depend on soil. We need to look after the soil to look after ourselves.

3. TREES

Mopane is an important tree for people and lovebirds. The wood provides: shelter, building poles for people, firewood for cooking and keeping warm, and small holes for lovebirds to sleep and nest in. The trees also provide shade and protection for the soil, and the cows and wildlife feed on the leaves when the grass has all dried.

3.1. Deforestation

Deforestation is the process of cutting down trees and not replanting. It is brought about by:

- clearing land for agriculture;
- commercial logging;
- felling of trees for firewood and building material.

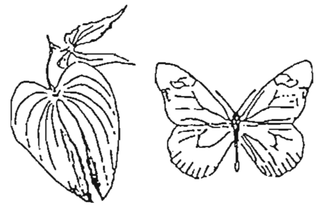
Without trees to protect the soil, the wind and water will wash and blow the soil away. This will result in poor crops and the rivers and pools will fill with soil reducing the availability of water in the dry season. Wildlife, like the lovebirds, who depend on the trees will disappear.

To look after our trees we need to:

1. use firewood sparingly;
2. plant trees near to villages and schools – use trees found naturally in your area which will grow best, like Mopane and Muchenje.

3.2. Let's learn about MOPANE trees.

Mopane trees are only found in Africa. Their *distribution* starts in the northern part of South Africa and spreads northwards through dry, low-lying areas including south-west Zambia. It is a tough tree *species* able to survive times of flooding and drought. The tree roots are shallow and spread out just below the ground. This results in a *sparse* cover of grass, mostly *annual* species which produce many seeds – no wonder you can find lovebirds and other seed-eaters like sparrows and weavers feeding here!.



Mopane leaves are a distinctive shape, looking like a butterfly. To limit water-loss during the day the Mopane leaves fold together to reduce the *exposure* of the leaf surface in the hotsun. This is why it is better to seek out a muchenje tree for some shade during the day rather than a Mopane!.

The big trees often have holes in them. This makes Mopane trees an important *resource* for wildlife species that depend on holes for breeding and sleeping in. Which birds use holes? Have you seen them?

Some birds can make their own holes, and others like the lovebirds and hoopoes rely on natural holes or those made by woodpeckers and barbets.

Some insects also favour hollow Mopane trees as resting sites, like the small "Mopane bee". These small bees always target sources of moisture and quickly fly into your eyes and nose – although they do not bite they quickly become very irritating!

3.1. SCHOOL PROJECT IDEA

Why not try and plant a Mopane tree?.

Collect a seed and plant it just below the surface of the soil. *Germination* will take 1-2 weeks if it receives some water, and your new seedling will slowly grow into a tree. Measure the growth and keep a record. Compare the growth of your tree with other students. Is there much variation?. Try planting another *species* of tree to see if the rate of growth differs from Mopane.

4. WHAT ELSE CAN WE LEARN ABOUT LOVEBIRDS ?

4.1. Flocks

Anyone who has seen lovebirds can notice they are very sociable and always move around in a *flock*. A flock is the word used to mean a group of birds, it is like being part of a team.

Lovebirds cannot survive on their own. When you walk through the Mopane it is easy to see that all the lovebirds from that area are together in one place, maybe, feeding, drinking or resting.

Like us, lovebirds need three basic things everyday: food, water and a place to stay. Black-cheeked Lovebirds find these three things in south-west Zambia, and no where else in the world!. This makes your home area a very special place.

4.2. Where do lovebirds go at night?

Every night the lovebirds fly back deep into the Mopane and go into holes in the trees in small groups. This helps to hide them away from *predators* and keeps them warm.

4.3. How do lovebirds breed?

Lovebirds make a nest from Mopane twigs inside a hole in the tree during the rainy season. The female stays inside the hole to look after the eggs and the male bird comes back with food to keep her fed. Once the chicks have hatched the female also goes out to find food. Up to seven chicks in the nest keep the parents very busy. When the chicks are ready to come out they look just like the adults. It is impossible to tell just by looking at a lovebird how old it is, and whether it is male or female. Not like chickens where it is easy to tell!.

4.4. What do lovebirds feed on?

All year long lovebirds feed mostly on the ground on grass seeds. They also enjoy certain flowers and some leaves, and sometimes insects and a little fruit. But most of all they like dry seeds, which is why they need to drink everyday and cannot survive far from water.

4.5. Taking care of the lovebirds

As long as the lovebirds can find food, water and a place to stay in the Mopane, we will continue to see them in our area. It is true that they may be a pest when they come to feed on our ripening millet and sorghum, and our food needs to be protected from them. But most of the year lovebirds are helping us, by feeding on weed seeds. This stops lots of

weeds growing once the rains fall and competing for water and soil nutrients just at the time our young crop plants are trying to grow.

We can really help lovebirds by making sure they are not disturbed at drinking times. The birds like to gather at pools in the early morning and late afternoon and can sometimes drink together in large numbers. **Catching lovebirds is against the law in Zambia.**

Perhaps visitors from other areas, even overseas, will come to visit the lovebirds and your area. This could become a real benefit for the people of Zambia, and outsiders will recognise the importance of your area as it is the only place to find this special bird.

4.6. All birds are important

Infact all birds, just like all people, are important. In many ways we are the same: requiring food, water and shelter for our survival. Zambia has many different types of birds, and looking after them is a responsibility each Zambian person must share. Our natural resources sustain us, and without them we cannot survive. All of us must learn to live our lives without destroying what we have. If we use a resource, like wood or water, we must do so wisely, and leave enough undamaged or grow more for tomorrow - for our children and their children.

5. GLOSSARY

The following is a list of meanings for the scientific words *highlighted* in the text.

ADAPT	Change in a organism resulting from natural selection.
ANNUAL	Refers to a plant which grows from seed once a year.
BINDS	Holds together.
CONSERVATION	Prevention of loss and damage.
CLIMATE	Weather conditions.
CLIMATE CHANGE	Change in weather patterns, can be natural or caused by man polluting the air from industry. The current patterns are going to make Zambia, and most of Africa drier.
DEFORESTATION	Removal of trees and destruction of forests from an area.
DISTRIBUTION	Arrangement of something over an area.
EARTH	The planet on which we all live.
ECOSYSTEM	A natural system in which living and non-living things interact with each other – like lovebirds, Mopane trees, soils, water.
ENVIRONMENT	The range of conditions in which something lives.
EXPOSURE	Left unprotected to possible damaging forces.
FLOCK	A group of birds.
FLOW	Movement over a surface, usually water.
GERMINATION	When seeds start to grow.
GLOBAL WARMING	Same as Climate change.
GRANIVORY	Eating only plant seeds.
MONITOR	Look after and observe what is happening.
NATURAL RESOURCES	All natural products, nothing man-made: includes wildlife, plants, soils, rocks.
POLLUTION	Addition of harmful substances into a system, like soap into drinking water.

PREDATOR	An animal which hunts another to eat.
RECORDING SHEET	A sheet of paper where scientists can record their observations.
RESOURCE	Supply of material.
ROTATING	Move around, like changing the type of crop grown in the same field to allow the soil to rest and restore nutrient levels.
SCIENCE	Knowledge learnt from careful observations and testing ideas.
SPARSE	Few.
SPECIES	A group of animals which look alike and live in the same way and breed together.
ZAMBIAN ORNITHOLOGICAL SOCIETY	The bird club in Zambia, which welcomes new members. The address is: PO Box 33944, Lusaka 10101

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Louise Warburton, September 2001,
University of Natal.

APPENDIX V

Water pools utilised by Black-cheeked Lovebirds.

This table gives the geographical co-ordinates of the water pools observed during this study, and the number of lovebirds observed, and may be of use to those wishing to further monitor the numbers of lovebirds at these sites.

GPS Co-ordinates						Location/Pool type	Date of obs.	Time of obs.	No. of lovebirds (drinking)
SOUTH			EAST						
17	14	8.1	25	7	17	Mopane pool	13/04/99		
16	34	52.6	26	1	2.1	Mopane pool	16/04/99		
17	7	48	25	20	12.2	Sichifulo River/Chilale Village	05/05/99 16/10/99	07:00 – 09.00 06:00 – 08:15	±100 347 (est. 400 +)
17	8	27	25	16	42.9	Mopane Pool	07/05/99	14:43	6
17	8	23	25	13	44.5	Mopane Pool			
17	8	20.9	25	13	29.3	Mopane Pool			
17	8	17	25	12	57.7	Mopane Pool			
16	12	17.4	25	57	57.5	Chelenge Plains Pool, KNP	17/06/98 26/06/98 16/07/98 30/07/98 02/08/98 23/08/98 24/08/98 24/08/98 08/09/98 17/09/98 18/09/98 18/05/99 24/10/99	14:54 – 17:00 14:50 – 15:15 07:00 – 09:00 06:40 – 09:00 16:25 – 17:10 16:30 – 18:10 06:54 – 08:15 15:30 – 17:45 16:00 – 17: 44 05:55 – 07:40 16:00 – 18:00 06:40 – 9.00 06:00 – 07:00	22 (fly over or perch) 9 7 17 13 14 6 (34 perch) 40 110 68 3 drink (40 + perch) 0 0
16	16	25.1	25	58	39.8	Plains pool, KNP			
16	12	37.2	25	59	33.6	Nanzhila River spring, KNP	30/05/98 13/06/98 06/07/98 29/07/98 29/07/98 09/09/98 23/09/98 07/10/98	16:00 – 17:30 15:30 – 17:30 15:45 – 17:15 06:45 – 09:30 15:10 – 17:45 06:44 – 08:00 16:15 – 17:55 06:00 – 08:00	9 49 (in fly over / perch) 0 (3 fly overs) 31 9 92 (perch or fly over) 54 (up to 79) 0 (68 in vicinity)

							19/05/99	07:00 – 09:00	30
							21/5/99	07:00 – 09:00	12
							22/7/99	15:50 – 17:30	33
							24/7/99	06:30 – 9:00	0
							26/7/99	07:00 – 09:00	84
							29/7/99	16:00 – 17:00	1
							06/9/99	07:00 – 09:30	14 (feed only)
							24/10/99	16:30 – 17:30	22 (fly over)
16	12	363	25	59	248	Kalenje Plains Pool, KNP	08/07/98	16:00 – 17:30	2 (+ 7 fly overs)
							15/7/98	07:15 – 09:20	4
							15/7/98	14:40 – 17:45	1
							14/8/98	15:15 – 18:07	15
							15/8/98	06:55 – 08:50	74
							20/8/98	16:40 – 17:55	34
							23/7/99	15:10 – 17:40	8
							24/7/99	06:30 – 9:00	39
							29/7/99	15:30 – 17:00	15
16	11	32	25	59	56.4	Mopane pool			
17	7	45.8	25	5	26.9	Mutelo Mopane Pool	3/6/99	15:00 – 17:30	1
17	8	49.1	25	6	4.1	Machile River, Nr Mutelo	24/9/99	15:00 – 18:10	380 (up to 450)
							16/10/99	16:15 – 18:15	326+
							19/10/99	06:00 – 08:30	150 +
							12/11/99	06:15 – 07:30	12 (fly over)
17	2	28.7	25	11	25.3	Plains Pool	21/6/99	10:40	2
16	55	8.2	25	16	39.4	Mulanga, Sichifulo GMA	29/09/98	05:45 – 07:00	132
							21/6/99	15:00 – 18:00	82 (150 – 200)
							02/11/99	16:00 – 18:20	115
16	31	30	6	26	00	Mabiya, KNP	13/08/98	14:00 – 18:00	150+
							22/08/98	06:50 – 10:00	200 +
							08/09/98	06:00 – 11:00	413
							10/09/98	05:55 – 10:00	800 *
							19/09/98	05:50 – 11:00	432+
							16/7/99	07:00 – 09:44	134
							01/9/99	15:00	6
							05/9/99	06:14 – 09:00	200 + to max. 300 (poacher activity)
16	12	5.5	25	57	32.3	Plains Pool, KNP	09/10/98	05:40 – 08:00	57 (up to 120 in vicinity)
							22/10/98	05:30 – 07:30	142
							22/10/98	16:40 – 18:05	80
							23/10/98	05:30 – 08:20	175

							23/10/98	15:50 – 18:00	57 (128 perch)
							18/7/99	15:30 – 17:39	29
							02/9/99	07:00 – 08:34	42
							03/9/99	06:24 – 08:40	100 +
							06/9/99	15:50 – 18:00	31 (lion disturbance)
							22/10/99	06:00 – 08:20	45+ (not drinking)
							24/10/99	06:00 – 08:00	54
							25/10/99	06:13 – 08:40	70 - 80
16	12	38	25	58	41.1	Plains Pool, KNP	30/7/99	08:35	18
16	14	306	25	57	394	Nanzhila River Pool, KNP	13/06/98	08:30 – 09:30	5 (up to 33 flyovers)
							11/07/98	07:15 – 08:40	7 fly over
							10/08/98	16:00 – 17:30	9
							30/7/99	09:30 – 12:54	2
							30/7/99	15:00 – 18:00	24
16	13	355	25	57	355	Nanzhila River Pool, KNP	25/9/98	07:15 – 09:20	2 (23 perch of fly over)
							07/9/98	07:00 – 09:10	8
							20/9/98	05:54 – 08:15	61 (up to 94 in vicinity)
							04/10/98	05:55 – 10:00	21 (69 in vicinity)
							04/10/98	16:35 – 17:45	5 (17 in vicinity)
							12/8/99	06:57 – 10:32	17
							30/7/99	15:00 – 17:00	0
							22/10/99	15:50 – 18:00	0
17	22	44.8	25	27	30.2	Lunungu (wells and troughs no natural pools)	05/8/99	16:28 – 17:45	29 (up to 150 – 200)
							07/8/99	07:00 – 08:00	90
								07:00 – 08:15	77
17	31	51.1	25	16	10.2	Siamakondo, Ngweze River	09/08/99	15:55 – 17:50	0
							10/8/99	06:30 – 08:30	4
17	7	43.5	25	9	52	Magumwi River crossing, Machile River	15/8/99	09:50 – 11:30	5
							18/10/99	16:30 – 18:00	67
							01/11/99	10:45 – 11:45	10 – 30 (fly over)
16	12	35.3	25	57	4.55	Plains Pool, KNP,	02/9/99	10:00 – 11:00	5
16	13	531	25	57	525	Zebra camp pool	12/07/98	07:10 – 08:30	8
							12/07/98	16:00 – 17:30	0
							20/09/98	06:25 – 08:25	34
							04/10/98	06:14 – 07:42	42 (up to 108 in vicinity)
							02/9/99	15:00 – 17:40	0 (lion disturbance)
17	13	44.1	24	06	8.11	Machile River	14/10/99		0 ideal habitat
17	14	27.6	25	6	43.6	Machile River			0 ideal habitat
17	17	620	25	8	634	Mopane Pool, nr Sichifulo River			Reported to use, dry by august
17	15	209	25	4	627	Machile River	14/10/99	15:00 – 17:53	13+

16	12	192	26	1	024	Nanzhila River	14/09/98 16/09/98 22/09/98 22/09/98 25/09/98 30/09/98 02/10/98 27/10/98 22/10/99	07:30 – 10:15 06:45 – 07:40 06:15 – 08:45 17:25 – 17:56 06:09 – 08:40 06:30 – 08:40 06:15 – 08:30 05:54 – 07:30 06:00 – 07:30	45 12 34 34 44 11 (up to 76 in vicinity) 3 (45 in vicinity) ± 90 drink (1,103 in total**) 36+ (no drinking)
16	49	346	25	29	835	Plains Pool, Muduli, Sichifulo GMA	04/11/99	16:15 – 17:25	6
16	32	147	26	02	990	Shomwendo Pool, Mopane, Billi GMA	06/11/99	16:08 – 17:49	4
16	43	961	25	41	609	Mopane and mixed woodland	05/11/99		0 ideal habitat
16	39	437	26	8	280	Billi Hot Springs, Billi GMA	06/11/99		0 locals report sightings June - Oct
16	25	40.4	25	59	53.1	Nakabula Pools, KNP	31/07/98 11/09/98 19/09/98	06:40 – 08:30 07:00 – 10:07 06:30 – 10:52	253 (fly over) 171 (fly over) 1 drink (161 fly over)
16	11	325	25	59	565	Mopane Pool, KNP LB24	14/06/98 12/07/98	06:40 – 17:30 07:15 – 17:30	29 5
16	16	263	25	57	217	Nanzhila River Pool, KNP	04/07/98 07/07/98 10/08/98	15:15 – 17:40 15:30 – 17:30 15:15 – 17:35	6 1 4
16	21	78	25	58	182	Nanzhila River Pool	27/06/98 05/07/98	16:45 08:15 – 17:30	18 46 (fly over only)
16	15	373	25	55	509	Mopane Pool, KNP	28/06/98	09:45	2 (fly over)
16	16	399	25	58	386	Plains Pool	13/07/98 27/07/98 28/07/98 28/07/98 21/08/98	14:15 – 17:30 16:00 – 17:30 06:40 – 10:25 15:20 – 17:30 06:45 – 09:40	4 7 (fly over) 32 28 11
16	9	115	26	1	385	Nanzhila River, Bilili GMA	11/08/98	16:35 – 17:41	17

In 1998 rains began on 07/11/99. In 1999, rains begin on 17/11/99. Lovebirds immediately drink at the widely scattered newly formed pools.
Where dates and times are the same simultaneous counts were conducted.
Subsequent studies should note that most pools are seasonal and dry-up as the dry season progresses and their existence and form vary annually.
* Absolute count made as the lovebirds flew in to perch before drinking between 06:06 – 07:11.
** Approx. 1,000 of these observations were fly-overs, flocks 10 – 25s, noisy and flying high. Subsequent counts in the same area never repeated this observation, and the origin and destination of these birds remains a mystery. Total count is likely an underestimate as the observer had to move due to presence of lions.

Black-cheeked Lovebirds in the Wild

by LOUISE WARBURTON, Research Centre for African Parrot Conservation, University of Natal

It's not easy to see a Black-cheeked Lovebird (*Agapornis nigrigenis*). By the time I finally saw my first flock, home, in the gentle green hills of Oxfordshire, seemed an unreality. This was May 1998 in south Kafue National Park, Zambia. Eight Lovebirds flew up from the ground, a silent flash of vivid green disappearing into the nearest canopy cover of small thorny *balanites* bushes.

The core distribution of these Lovebirds is found in a disjointed belt of mopane woodland, between the Zambezi River to the south and Kafue River in the north. A small break in the mopane between these two catchments seasonally divides the Black-cheeks into two sub-populations. I spent last year camped out in the Nanzhila plains observing the northern population, mapping their distribution, estimating abundance and attempting to identify their habitat requirements including diet, watering, roost and nest sites.

The Study Site

The south Kafue National Park is characterised by wide open grassland plains interspersed with bushes and termiteria. Most of the termite mounds are well vegetated, with the insect's underground earthworks bringing up minerals that the plants exploit. The elevation of the termite mounds also protects the roots from waterlogging during the summer rains when much of the area is flooded - and impassable to wandering Lovebird researchers. Fringing the plains are the *Colosphopermum mopane*, mopane, and *Brachystegia*, miombo woodlands. The Park is the largest protected area within Zambia, covering around 22,480 km², making it one of the largest four in the world. The Nanzhila study site was chosen based on information from the Tim Dodman Black-cheeked Lovebird survey (1994) and Zambian Ornithological Society records.

During the months of fieldwork intense efforts were made to open up routes around the study area and to locate water sources. This was followed up with routine monitoring for Lovebird use and drying dates. The study area is bisected by the Nanzhila River from north to south, which had already dried into isolated pools by May. Pool numbers continued to decrease as the dry season progressed. Woodland pools in the mopane had largely dried by July, but refilled with the first rains in November.

Find that Lovebird!

The Lovebirds were usually located by sound. Once sighted their location was recorded by GPS, together with as much information as possible on flock-size, activity, interaction with other species and habitat data. Each Lovebird sighting, water pool and feeding site was numbered and stored on the GPS for subsequent reference as the season's progressed.

Throughout the region Black-cheeked Lovebirds were found in localised population clumps. As the field season progressed it became possible to recognise "ideal" Lovebird habitat. However this was no guarantee for locating the Lovebirds who appear to be absent from large areas of suitable habitat within their already highly localised range. Some which were Lovebird-free from May until mid-September were used by the parrots during the height of the dry season, presumably attracted by the availability of water.

The Importance of Water

The early stages of fieldwork concentrated on locating water sources, to see if they were utilised by Lovebirds. The characteristics of utilised and non-utilised pools were recorded. Contrary to earlier speculation the Lovebirds drank from a variety of pool types, in early morning and late afternoon. The exact arriving times changing with increasing day-length. Typically the pools appeared to be positioned between the overnight roosting location and the daytime feeding area. At regularly observed pools morning arrival

directions were reversed, indicating that roost sites remained constant.

Behaviour at the pools changed seasonally as the availability of water became reduced. As the dry winter season progressed, the number of birds arriving to drink increased. The arrival and meeting up at the pools became a significant social event. From May to July Lovebirds would come to drink in small flocks, typically of 5 or 6 individuals, perching briefly before dropping silently to drink, then retreating to the same bush for a brief preen or rest. The flock would then depart together, generally calling, typically as another flock flew in. By late August Lovebird numbers began concentrating at drinking time. Flocks would arrive, contact-calling, in the vicinity of the water pool, gathering in a single or a few neighbouring trees (typically the tallest, or with the barest canopy). Early arrivals settled to preen, sun-bathe and contact call the next arrivals in. The largest recorded number of individuals arriving at a single pool was exactly 800. The time taken from the first arrival to the first drinking wave was exactly one hour. Large flocks of doves and Red-billed Quelea drank during this time, with the Queleas 'meeting' in small bushes before drinking in large groups. In contrast to the silent approach to the water of the smaller Lovebird flocks earlier in the season, these large waves of birds seemed to generate a lot of excitement, making them wary to land long enough to drink. Most Lovebirds would then disperse in small flocks to feed, although 'returns' to drink in small flocks were common.

Food

Around eighty per cent of feeding observations were made with Lovebirds foraging for grass seeds at ground level, usually under the canopy of Mopane termiteria woodland, often near the (scrub) fringes bordering grassland plain, and a sub-canopy of bushes such as *Balanites aegyptiaca* or *Boscia angustifolia*. The mean feeding flock size was 9 individuals. When foraging, the birds covered the ground fairly

fluttering. They fed almost non-stop with all heads down at the same time. At ground level the Lovebirds fed almost without exception in silence, until disturbed, whereupon the flock would take off in silence usually retreating to perch in the nearest canopy. Then the Lovebirds either dropped down again to resume feeding, or individuals would start to softly contact-call to stray Lovebirds who did not retreat to the same tree.

Lovebirds were also observed to feed arboreally. Species fed on included *Acacia polyacantha* (leaves), *Capparis tomentosa* (flowers), *Combretum paniculatum* (flowers), *Syzgium cordatum* (unopened flower buds) and scale insects on mopane leaves in June. As the project progresses effort to document the species fed on by Black-cheeks will continue. A likely hypothesis is that as the dry season progresses until the later rainy season when the grasses seed, ie. October through to mid-January, the Lovebirds depend more on non-grass seed nutrition (ground feeding decreases). Black-cheeked Lovebirds coincide their breeding with grass-seed production making the exact time of breeding variable, but on average slightly later than the widely published November-December season.

Resting and Preening

The Lovebirds were observed to rest at any time during the day, usually retreating into the shaded mid-canopy of the Mopane in the vicinity of feeding areas or in the locality of a water pool. They slept with either their heads tucked around onto their back with the bill buried into the back feathers, or facing forwards with the orange bib (and all body feathers) puffed out and the bill resting on top. The Lovebirds slept in small flocks, usually a combination of heads back and puffed bib, with one or two remaining awake to preen or observe. They usually fell asleep almost immediately once perched, and slept continuously until alarmed. The duration of

Black-cheeked Lovebird being examined in Kafue National Park. *Photo: Louise Warburton*

was usually around twenty minutes, although fifty minutes to one hour were not uncommon when there was no disturbance. Other small bird species such as Red-billed Quelea, Southern Grey-headed Sparrow and Blue Waxbill also commonly rested near by.

The Lovebirds were often observed to scratch, and also to mutually, allo-preen and self preen. Sunbathing was common in the cold early mornings and pre-sundown during May, June and July. In the heat of September and November a few Lovebirds were observed clearly panting, with their feathers sleeked to their body, an upright posture, wings held away from the body slightly drooped and the bill gaped open.

Predation

Although commonly observed in the near locality of potential predators, like the *Accipiter* species, only one observation was made of a pair of Lovebirds being 'buzzed' by a Lanner Falcon. Little Banded Goshawks (Shikra) were routinely observed at water pools, often swooping down on mixed Quelea, Sparrow and Lovebird flocks at the water's edge. However the

perch right next to (and surround !) a Shikra in a small *Acacia* bush, and African Fish Eagles who were observed to kill doves and a Grey-headed Sparrow on one occasion. Evidence of one killed Lovebird was found under a small Mopane tree next to a water pool. It was almost certainly a raptor kill as feathers from all over the body had been plucked, and there was evidence of other small avian victims having been consumed from the perch above.

Unusual Colouring

Two Black-cheeked Lovebirds were observed at the Mabvigo water pool on the 08/09/98 which did not conform to the described type (after Sclater 1906). One was much yellower on the breast with a brighter orange forehead and crown. The other was of normal body colouring but had a much paler culmen which looked near white.

Aggression

Overall the Lovebirds were not observed to be an aggressive species. The vast majority were not observed to perch as a pair, ie. the stereo-typical Lovebird

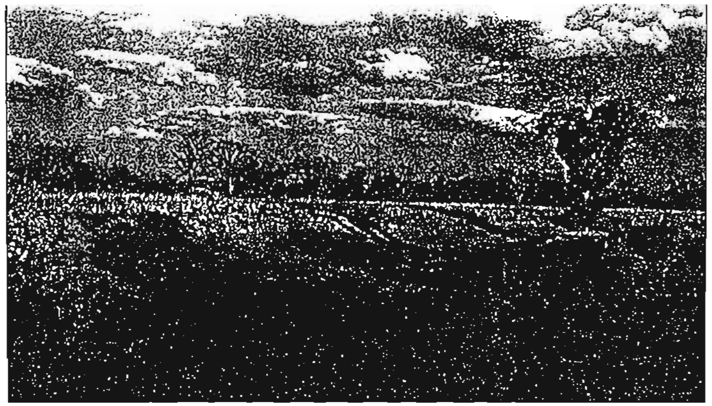
Contd. from page 5

close by to each other but with personal space, frequently on separate branches in the same canopy strata. Common to other species of birds which allo and mutually preen there appears to be a narrow margin between preening behaviour and aggression.

Habitat Intact

Contrary to the conservation challenges of the majority of parrot species, the Black-cheeked Lovebird's natural habitat does not appear to suffer from immediate or foreseeable destruction. The area is both remote and does not hold any special economic potential. Indeed, as a first impression, the Lovebird appears to be successful where villagers have settled to farm in the Game Management Areas. This will be investigated during the 1999 fieldwork season. Poaching inside the Kafue National Park (and GMA's) is common and widespread. The significance for Lovebird conservation is that illegal trade in wildlife products goes on almost unchecked and at the moment is unpoliceable given the lack of resources within the Parks Department. Lovebirds would prove any easy target to capture with their dependence on daily access to water and social habits.

Factors limiting the population's recovery after the 1920's trade are both subtle and accumulative, both attributable to man (change in cropping patterns from the Lovebird preferred millet and sorgham to maize (Dodman 1995) and nature (increasing desiccation of the region resulting in lower dry season water availability). Like many other species of parrots, Lovebirds also appear traditional in their habits. In such a harsh environment knowledge of the local area, learnt from your parents/flock-mates may prove paramount to survival which may inhibit the Lovebird's from exploring 'new' or moving back into old areas. The long-term survival of the Black-cheeked Lovebird may depend upon manipulation of the existing lovebird utilised resources to try to encourage movement back into areas of



Typical Black-cheeked Lovebird habitat

historically known range that have since been deserted.

Perhaps the provision of Lovebird-friendly water sources could be developed by creating new water sources with perching space in the locality, and growing strips of millet and sorgham away from the villagers fields to try to supply and redirect the Lovebirds feeding away from farmer's crops. In reality it is difficult to envisage such measures being possible without special long-term provision and outside management. The Lovebirds share their environment with Zambian villagers who live on a subsistence basis, resources such as water and grain crops being extremely precious. Conservation of natural resource education is non existent, and will certainly be encouraged through the local interest which will be aroused during the time of fieldwork.

Implications

The 1999 fieldwork will commence in the Sichifulo Game Management Area around the villages of Mulanga and Bombwe. Particular attention will be paid to the Lovebirds use of village crops and their interaction with human neighbours. This information will form an interesting comparison to the northern sub-population studied this year which lives almost without any human contact.

Objectives for the study are:

1. To map the distribution of *A. nigrigenis*
2. Estimate abundance
3. Identify habitat requirements
4. To evaluate all threats limiting the population's recovery
5. To create a sound method of population monitoring
6. To involve local people in the development of a long-term monitoring programme

During 1999 particular attention will be paid to the Lovebird's use of village water sources and crops to gain an insight into the importance of these crops as a source of food. The favoured choice of crop, level of utilisation, the role of other crop-raiding species, and the Lovebird-human interaction will be investigated. It is likely that the field work will be conducted on a more mobile basis, moving between the villages on a regular sampling basis, exploring new areas of possible Lovebird habitation, and visiting sites where they were known to occur historically; in addition to routinely monitoring sites measured in the 1998 season.

I would like to take this opportunity to appeal to captive breeders of Black-cheeked Lovebirds for breeding record information, which would provide interesting and useful data for the project. Any information is much appreciated even if you do not keep methodical records, and full acknowledgment will be given to data sources.

I am particularly interested in:-

- Egg laying and hatching intervals
- Clutch size
- Incubation (time and habits)
- Hatching and fledging success rates
- Growth curves
- How long does the juvenile 'darker' colouring of the bill last for?
- Pattern of parental care
- Seasonality of breeding
- Longevity

Also,

- Where and when did you get your Black-cheeks?
- Have you found them an easy species to breed?
- Have you had any particular health management problems?

Thank-you.

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Acknowledgements

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Blackcheeked Lovebirds in the hand

Louise Warburton

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Most parrot species do not lend themselves easily, or indeed painlessly, to bird ringing. Lovebirds, however, by virtue of their relatively small size, dependence on water and largely terrestrial foraging habits are somewhat softer targets – so soft in fact that none of us have a lasting scar to show for the experience! Few lovebirds have previously been caught with the intention of collecting ringing records, and the current SAFRING database is almost void of any lovebird records.

In 1998 I began two and a half years of fieldwork in south-west Zambia researching the basic ecology of the Blackcheeked Lovebird *Agapornis nigrigenis*, continuing the status and distribution work of Tim Dodman and team (Ostrich 71: 228–234). Tim has the honour of being the first person to ring Blackcheeked Lovebirds, catching seven birds between 30/11/94 and 01/12/94.

Zambian ringer Pete Leonard and Kate Knox kindly interrupted their holiday in the Nanzhila region of Kafue National Park to assist with the initial ringing portion of my study. On the afternoon of the 24/10/98 we erected nets around a pool with a total circumference of 64 metres. The pool was 225 metres from the lovebird's assembly tree, a tall *Acacia polyacantha*, and 15 metres from their pre-drinking perching trees. Prior to this, my field assistant, Debbie Smy and I had carefully observed various lovebird preferred drinking sites to get a clear idea of arrival patterns (timing and direction), perching positions (assembly tree and pre-drinking), drinking spot preferences, size of lovebird flocks and utilisation of the pool by other species (the large furries and huge flocks of Redbilled Quelea *Quelea quelea* were best avoided!). October is known as the 'suicide month' in the Zambezi Valley for good reason. It's very hot and dry, forcing increasing numbers of lovebirds to flock to the last remaining pools of surface water.

The timing of lovebird arrivals to the assembly tree, first drink and departure from the area were remarkably constant and predictable, allowing us to set up the nets and sit back to await the first lovebird arrivals on cue. One of our major problems was trying to prevent the quelea from getting caught in the

Adult Blackcheeked Lovebird.

able 1. Measurements of Black-cheeked ovebird (includes data of Tim Dodman's am).

	n	Mean	Range
ass	28	38.8 g	35–46 g
ing length	28	98.0 mm	91–103 mm
il length	21	44.1 mm	42.25–45.5 mm
ursus length	25	14.2 mm	12.8–14.8 mm
ulmen length	25	15.4 mm	15.5–16.5 mm
ulmen width	28	9.5 mm	8.5–10.4 mm

ets before the lovebirds. Prior to drinking ie quelea assemble in the bushes close to the ool and go down to the water before the ovebirds. Our quelea deflection strategy was have Pete jump out from under one of the ushes just before the quelea went down to rink to temporarily scare them away.

On our first attempt we caught 6 lovebirds nd 14 more the following morning. As we xtracted the birds the nets were closed given ie slightly lengthy extraction and processing mes. Some lovebirds managed to avoid the ets by flying over them and landing inside ie edges of the pool. The birds netted on our irst attempt were kept overnight as their lock-mates disappeared to their roost-sites oon after drinking. The captured birds re- ained quiet and settled. The following orning prior to the first lovebird arrival at 5h40 the nets were unfurled and Pete rawled under the quelea bush. The previous venings captives were hung in the shade of he assembly tree, to be released once the nets iad been emptied to avoid recapture. By 5h53 47 lovebirds had been counted flying nto the assembly tree. As more lovebirds lew in, the captive birds started to respond y returning calls. I wondered whether they ecognised individual calls of arriving flock- nates as they had remained silent until this oint. At 06h14 the first lovebirds went down o drink. A few birds were netted immedi- ately although a large number bounced straight out of the nets. The majority contin- ued trying to reach the water, with a few even

Once in the net, the (14) lovebirds remained quiet, although they screeched loudly while being extracted. Other species caught included: Lilacbreasted Roller (*Coracias caudata*), Southern Greyheaded Sparrow (*Passer diffusus*), Common Waxbill (*Estrilda astrild*), Blue Waxbill (*Uraeginthus angolensis*), Redbilled Firefinch (*Lagonostica senegala*), Yelloweyed Canary (*Serinus mozambicus*), Greater Blue-eared Starling (*Lamprotornis chalybaeus*), Cape Turtle Dove (*Streptopelia capicola*), Blackeyed Bulbul (*Pycnonotus barbatus*) and Redbilled Quelea. As soon as the nets were closed the previous evenings captives were released, and flew straight into the assembly tree where the rest of the lovebirds had retreated to and were calling noisily from. In follow-up visits several days later the same number of lovebirds were still using the pool.

On 04/11/98, in the company of ringer Lauren Gilson, three nets were set up at the same pool. Unfortunately this time the deflection of large flocks of quelea and waxbills was not so successful, and disturbed the approaching lovebirds, the majority of whom circuited the pool, and only one was caught. By 07/11/98 the rains had sufficiently set in to fill the pans in the Mopane woodlands allowing the lovebirds to disperse over a wide area to drink.

With hindsight the optimum ringing time would have been from the beginning of September through October, although predictable lovebird flocks were observed at pans from mid-July onwards. 'C' overlap rings were supplied by the Zambian Ornithological Society with the recovery address being Livingstone Museum. I personally feel that it is highly unlikely that lovebirds can be netted away from drinking sites, although the use of 'decoy' birds, or perhaps sound-recording might lure the birds into a specific area. It may also be possible to trap birds during the crop-ripening of millet and sorghum, although the use of nets in front of local villagers would be a highly foolish act in terms of lovebird conservation.

Most lovebirds showed some body moult,

Juvenile Blackcheeked Lovebird.

majority of tails displayed some form of abrasion, a feature generally expected in cavity roosters. Iris colour ranged from pale to dark brown. Juvenile birds have a dark iris, although all birds caught were presumed to be at least seven months old. Measurements were taken (Table 1, includes Dodman data). Other measurements taken, but not shown here, include: tarsus width, beak (cere-tip), hind-claw, colour definition on head and nape and signs of sexual activity.

Between February and April 2000 the lovebirds were observed breeding and first records of breeding behaviour in the wild were collected. During this period my field assistants were Darryl Birch and Frankie Hobro from the Mauritius Wildlife Foundation, who brought invaluable experience from the Echo Parakeet project with them. Although 78 nests were found, and 64 climbed up to cavity height, only 5 nests had large enough cavity entrances allowing human access to the nests. Eighteen chicks were briefly removed and measured, photographed and blood sampled. Seven of the larger chicks (lovebirds are asynchronous) were

five days later, it was noticed that the leg area around the ring looked slightly red. The ring was probably exerting some pressure on the tarsus since the chick was inactive in the nest. We removed all but one ring (that chick subsequently fledged). I would therefore like to suggest that rings are not fitted onto unfledged lovebirds, although this is standard practice with captive birds. The chicks did not appear stressed by the handling, and adult birds resumed parental duties almost immediately. We did however feel that after the second handling the older near-fledged chicks were less relaxed, and would like to recommend that in future projects lovebird chicks are only removed from the nest for measurements once.

Acknowledgements

The project was funded largely by a grant from the Loro Parque Fundacion, with additional funding from various other organisations and supervised by Prof. Mike Perrin. Ringers Pete Leonard and Lauren Gilson are gratefully acknowledged for their expertise and field assistants Debbie Smy, Darryl Birch

Cikwele Muikwa* returns

*Parrot white (wo)man

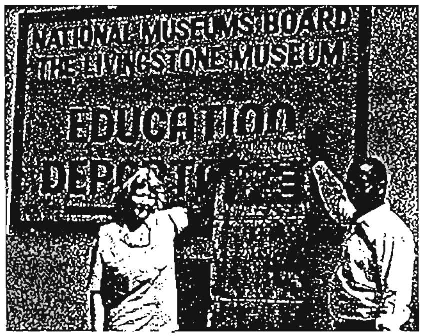
By: Louise Warburton

A research project on the status, ecology and conservation of Zambia's Black-cheeked Lovebird was initiated in 1998. The overall aim of the project is to ascertain the present status of the species, to evaluate all threats, and to encourage the local human population in the species' protection and continued conservation.

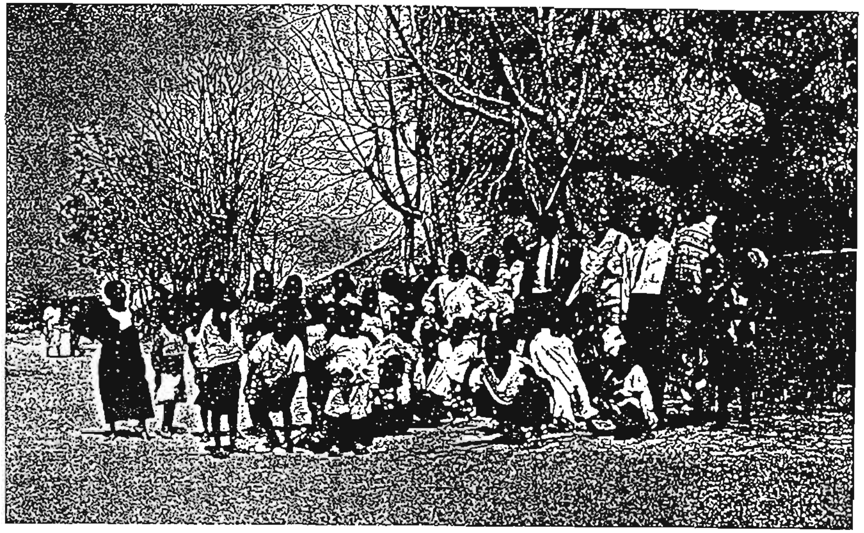
For three dusty weeks, tracks through the range of Zambia's Black-cheeked Lovebird *Agapornis nigrigenis* were once again negotiated by University of Natal student Louise Warburton, assisted by fellow parrot researcher Craig Symes and Zambian Aaron Muchindu. The objective of the trip was to deliver an education project on the importance of protecting the species, to schools, national park wildlife scouts and village headmen, who live within the range of the Black-cheeked Lovebird. Information was presented in booklet and poster format and audiences addressed orally (Aaron translated into chiLozi). Thanks to Vincent Katenkwa, Director of Livingstone Museum, the poster could also be translated into chiLozi, making the information more widely accessible.

Black-cheeked Lovebirds, a near endemic species to south-western Zambia, live in a highly localised range of 2,500km² of Mopane woodland. Even within this range the distribution of the lovebirds is highly clumped, which is probably correlated with reduced surface water availability during the dry winter months – lovebirds are highly dependent on water and need to drink twice a day. The species has recently been downlisted from Endangered to Vulnerable (Birdlife International 2000) because >2,500 individuals are known to exist. Although this is good news, there is little room for complacency with an estimated total population of only 8-10,000 individuals. The lovebird's range also appears to be shrinking as a result of habitat desiccation and increasing human disturbance at remaining dry season water pools. Other threats include illegal capture of lovebirds for local consumption and possibly Psittacine Beak and Feather Disease (PBFD).

The education booklet introduced lovebird conservation issues within a framework of wider environmental topics relevant to the local society. Five main themes: water, soil, trees, climate and bird conservation emphasised the importance to humans and lovebirds of these resources, suggesting ways how each could be managed. The main aim of the Black-cheeked Lovebird research project was also carefully explained, as the local people had often questioned why there was so much interest in the 'cikwele', especially since they primarily regard the species as a crop pest. The small range of the species was explained in terms of river catchments, which local people could identify with – everyone was surprised to learn that this familiar bird was just found in their region. Throughout the study we had been careful to clarify that our aim was just to watch these birds and observe their behaviour, and no handling (for ringing and measurement) took place anywhere near villages. References were not made to the species in captivity or their economic worth – capture is against Zambian law and highly undesirable. It would probably lead to a rapid demise of the species in the wild. The issue of the lovebird as a crop pest had to be handled diplomatically and with sensitivity to local priorities. It was explained that the lovebird, for most of the year, is a friend of the farmer as they feed in the fields on weed species that would otherwise compete with the crops for water and nutrients. Our observations from the 2000 crop-ripening season of farmer-lovebird interactions actually gave little reason for concern, the lovebirds were only disturbed from feeding on crops in 25% of all (245) observations when farmers were present in the fields, with no fatal consequences!.



Louise Warburton handing over to Vincent Katenkwa, director of the Livingstone Museum, an educational poster created by LPF.



Louise Warburton with teachers and pupils from Mulonga Primary School.

School project ideas were included in the booklet, and the importance of long-term monitoring of the lovebirds was explained to teachers, who were all highly supportive of the idea of their students undertaking lovebird projects. Suggestions included keeping regular counts of numbers at local waterholes and submitting these records to Livingstone Museum. A few of the teachers, independently suggested setting up Lovebird clubs and the importance of getting young people interested and knowledgeable about protecting the species.

Booklets and posters were also distributed to wildlife scouts and the newly formed Visitor Education Centre in Kafue National Park, which runs wildlife education courses for local schools and the Chongololo (youth) Club of the Zambia Wildlife Society. Livingstone Museum was also presented with three different posters from the project, including one produced by the Loro Parque Fundacion and another presented by Louise at the Pan African Ornithological Congress held in Kampala, during September 2000. Overall, the importance of exposing Zambians to environmental education principles is an urgent requirement. The majority of Zambians live a subsistence-based lifestyle, dependent on gathering natural resources to meet basic needs and in general, wildlife, even within National Parks, faces severe threat from the bush-meat market. Hopefully our simple start can make some difference.

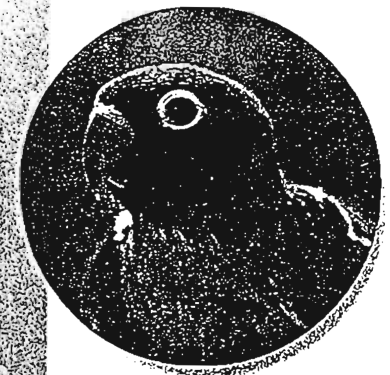
Perhaps the next education project should target Black-cheeked Lovebird keepers in the avicultural world – making captive welfare suggestions based on observations of the species in the wild, the importance of ensuring pure-breeding and maintenance of genetic vigour within the captive population – watch this space!.

And, of course, for us, tuning into the calls and once again observing the lovebirds in their natural habitat was an absolute pleasure. Long may their vibrant presence be found in this dusty – and at times waterlogged! – corner of Zambia.

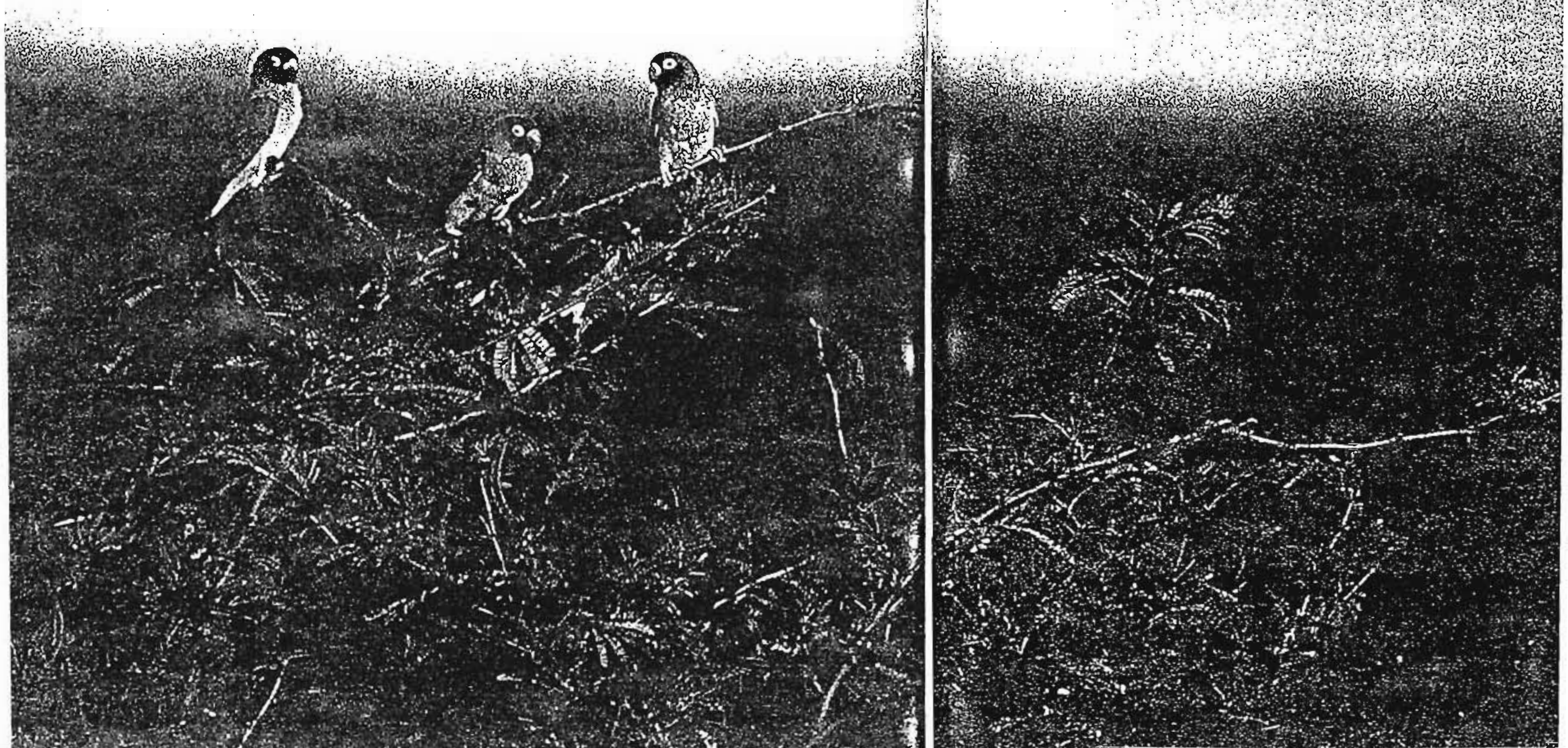
Acknowledgements

This trip was funded by the project's major sponsor the Loro Parque Fundacion, with additional funds from the San Diego Zoological Society. Additional thanks to Craig Symes and Aaron Muchindu for their field assistance, and project supervisor Prof. Mike Perrin for the use of the vehicle and leave from my thesis write-up!. Dr Jim Taylor from WESSA's Share-net, Javier Almunia from the Loro Parque Fundacion RSPB, Birdlife South Africa and WPT-USA assisted with ideas for the education material.

BLACK-CHEEKED LOVEBIRD



Africa's most threatened lovebird



Text and photographs
by Louise Warburton

The Black-cheeked Lovebird Agapornis nigrigenis *remains somewhat tenuously on the southern Africa bird list, with a few unconfirmed sightings south of the Zambezi. However, birders in the far north of the region should remain on the alert – and here's an update of what to look out for.*

All commonly used fieldguides are in need of some form of updating regarding Black-cheeked Lovebird data. The illustration in *Roberts' VI* fails to show both the orange-coloured bib on the upper and mid-chest and the less definitive characteristic of a pale skin cere. *Newman's* (1983) plate does nothing to illustrate the beauty of the species, and once again the cere is missing. The *Sasol* (1997) illustration of the adult provides an accurate portrayal, but the dark-beaked juvenile without a white eye-ring has not been observed in the wild nor, to my knowledge, in captivity.

An alternative name for the species is the Black-faced Lovebird. However, it should not be confused with the Tanzanian species, the Black-masked Lovebird *A. personata*.

HISTORICAL INFORMATION

Black-cheeked Lovebirds, the last of Africa's parrots to be discovered, were first described in 1906. Population numbers today appear to be considerably lower than they were in the early 20th century. Only one historical record of a more numerous population exists from D. Gordon Lancaster who reported personally witnessing the capture of some 16 000 Black-cheeked Lovebirds in four weeks in 1929, just prior to the trade ban in 1930. More recently there appear to have been further population declines, or at least range reductions, and some local extinction in areas of apparently suitable habitat. This is probably caused by the lack of surface water in the dry season and increased human disturbance at the remaining sources.

DISTRIBUTION

This lovebird is near-endemic to Zambia, and highly localised in the south-west region. Its total range is approximately 4 550 square kilometres, although the actual area occupied by the species is only 2 500 square kilometres (Dodman *et al.* 2000). The range is confined to mid-Zambezi tributaries, between the Kafue River to the north and the Zambezi to the south. Lilian's Lovebird *A. lilianae* is also found in Zambia, approximately 150 kilometres further east along the Zambezi. The two species are separated by a block of unsuitable habitat and there is no evidence to suggest that the ranges of these two lovebirds have ever overlapped.

POPULATION

Although the species has recently been described as 'Africa's most threatened lovebird' (Perrin *et al.* 2000), it has also been downlisted from 'Endangered' to 'Vulnerable' under IUCN classification on the basis of the total population exceeding 2 500 individuals (BirdLife 2000). A 'Vulnerable' species is one that faces a high risk of extinction in the wild in the near future, as defined by any of the following criteria: rapid decline; small range; small population and declining; very small population; very small range. The current population size is estimated at 10 000 individuals (Dodman 2000).

One of the easiest ways of locating the lovebirds is to find a flock's favourite waterhole (here, in the southern part of Kafue National Park). At dusk and dawn they may often be seen perched in bare tree-tops.

Mopane woodland, seen here during the first rains of the year, is prime habitat for the Black-cheeked Lovebird.

My study indicates that the current population of Black-cheeked Lovebirds is stable, although population numbers are likely to decrease in the long term. There appears to be no single factor limiting population growth.

FIELD CHARACTERS

Twenty-eight adult Black-cheeked Lovebirds have been ringed and measured (Dodman caught seven birds during 1994 and Warburton caught 21 birds during 1998). The following mean measurements were taken.

Weights & measures

Mass 38.85 g (n=28, range 35–46)

Wing length 97.96 mm (n=28, range=91–103)

Tail length 44.11 mm (n=21, range= 42.25–45.5)

Tarsus length 14.22 mm (n=25, range=12.8–14.8)

COLORATION

In adults, the sexes are alike. The forehead and crown are a deep orange-brown, changing to olive green towards the hindcrown and nape. The cheeks and throat are blackish brown. The eye is surrounded by white skin, matched by a skin-coloured cere, and the bill is bright red-orange. The upper breast is light orange while the rest of the body and rump is bright green. The shoulder through the coverts to the secondaries is darker green. Tail feathers are normally concealed unless flared, hiding a delicate beauty of yellow through orange to a black band before a green termination. The feet are grey. The eye's iris colour is brown, with some variation.

The juvenile is almost identical to the adult but its bill is slightly more orange. Some individuals have dark markings, often just below the cere, and/or faint veining from the base. Vocalisations are the most distinctive feature in the newly fledged birds. The eye colour is dark, although the iris can be distinguished from the pupil.

Confusion with any other species within the range is unlikely.

HABITAT AND MOVEMENTS

The Black-cheeked Lovebird is closely associated with mopane woodland *Colophospermum mopane*, which it uses for both roosting and breeding. It is resident, and undertakes a daily commute in search of food and water. Feeding and drinking areas, which can be more than eight kilometres away from the roost, include riverine, acacia woodland, grassland plain, agricultural and human settlement habitats. The species is highly water dependent, needing to drink twice a day, and is never found in areas which lack local surface water.

Other bird species that are normally found in the habitat of the Black-cheeked Lovebird include the Red-billed Hornbill *Tockus erythrorhynchus*, Meves' Long-tailed Starling *Lamprotornis mevesii*, the Southern Grey-headed Sparrow *Passer diffusus* and the White-browed Sparrow-weaver *Plocepasser mahali* (Dodman 1995). >

FOOD

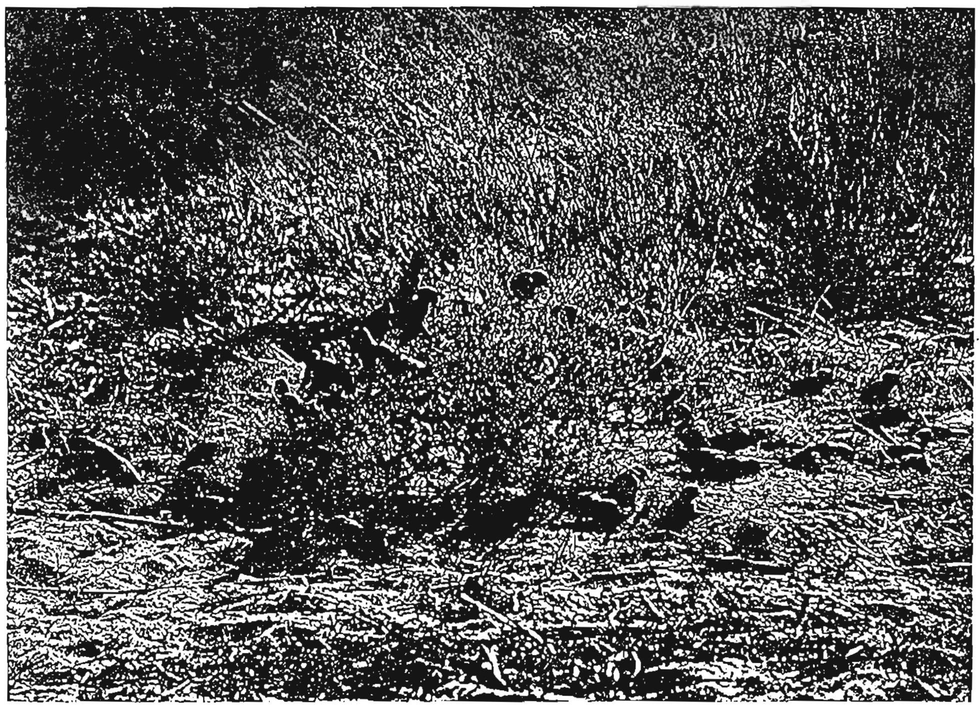
The Black-cheeked Lovebird forages primarily in flocks on the ground, where grass seeds, particularly those of the annual jungle rice *Echinochloa colona*, which are found under the mopane canopy, comprise its staple diet. Where its range overlaps with agricultural areas, the lovebird is considered a pest by the local people as it feeds on the ripening millet and sorghum crops. However, for most of the year it subsists on the seeds of agricultural weed species, particularly favouring the alien species 'Upright starbur' *Acanthospermum hispidum*. A wide variety of other vegetation is also utilised, including tree, creeper and herb species; flowers and leaves are commonly eaten, with fruit, bark, resin, insect larvae and lichen also being consumed occasionally.

Sorghum is a popular forage where the lovebird's range overlaps agricultural areas.

GENERAL HABITS AND BREEDING

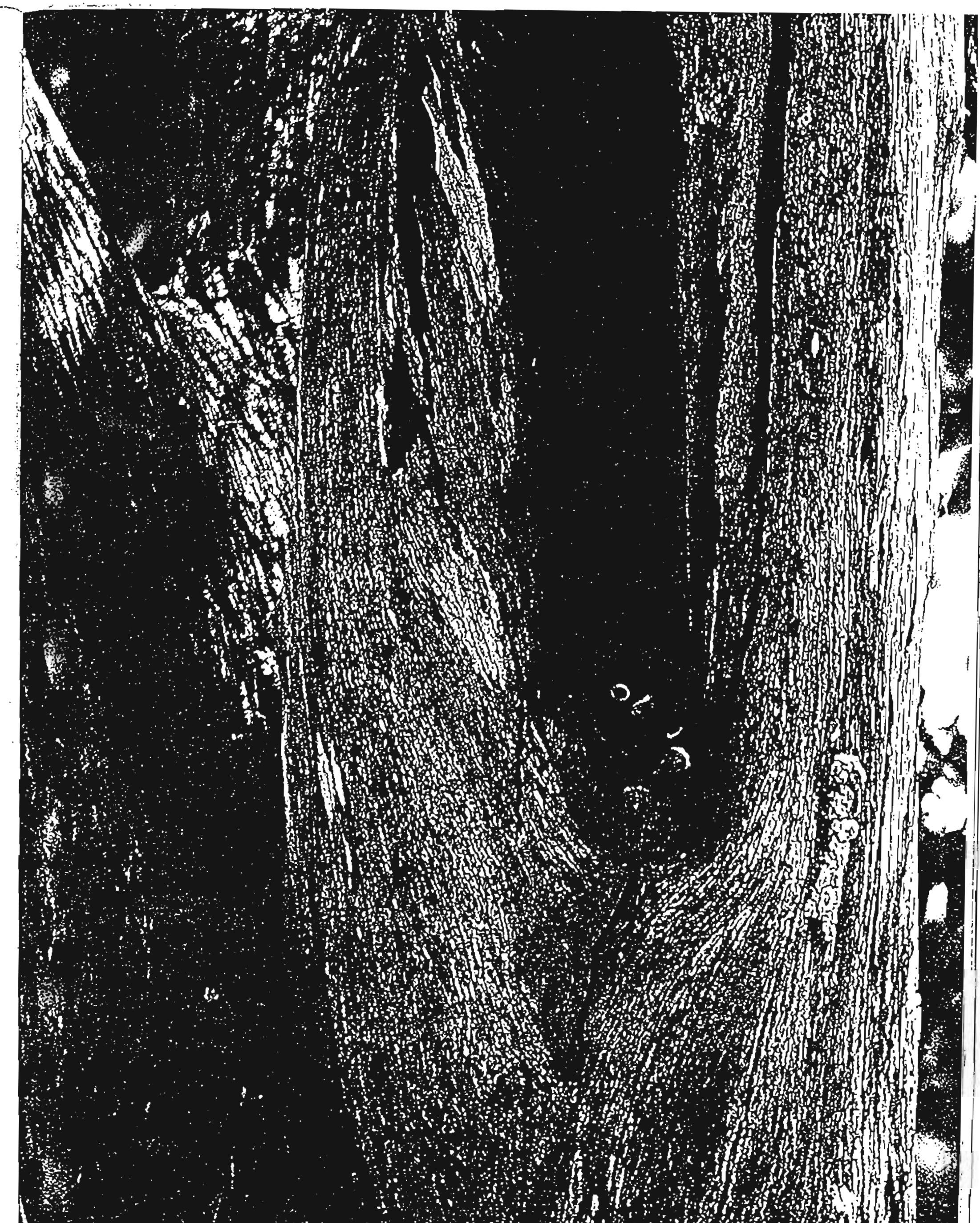
This is a highly sociable and gregarious species, with all activities being conducted in flocks, which usually comprise eight to 12 individuals. The largest flock gatherings occur towards the end of the dry season at watering holes. The lovebirds roost in loose colonies in natural mopane tree holes, usually a pair per hole but up to six birds have been recorded going into one hole. They enter and exit the roosts at sunset and sunrise respectively.

Breeding takes place in similar and sometimes the same holes as those used for roosting. Nests are constructed within the tree holes from mopane leaf twigs carried into the cavity in the bill. Breeding behaviour has been recorded from February through to April, later than the previously suggested dates ▷



Above *The agricultural weed 'Upright Starbur' is a favourite lovebird food.*

Opposite *Black-cheeked Lovebird chicks allo-preen at the entrance to their nest.*



of November to December. It is likely that the first copulations and nest construction commence in mid-January.

While observations in the wild are limited by the small cavity entrance which obstructs viewing, two clutches of seven and eight chicks respectively have been observed. The mean clutch size from captive data is five (n=76, range 2–8).

A fledged juvenile watches an adult perching above the nest cavity entrance.

CONSERVATION

The Black-cheeked Lovebird is listed in CITES Appendix II, with trade in wild-caught birds being banned under Zambian law since 1930. Current threats to the species include natural desertification across its range and increasing human pressure on the remaining water resources in its range. Resumption of trade for the avicultural market and local capture for human consumption are also ongoing threats.

Only an estimated 35 per cent of the population is found within the boundaries of Kafue National Park and surrounding game management areas, leaving most of the birds in areas which have no formal protection.

SPOTTING TIPS

As in most parrot species, Black-cheeked Lovebird activity peaks in the early morning and late afternoon, when the largest flocks gather at water sources to drink and feed. The best way to find the birds is to listen for them; they frequently give their contact call in flight. This can rise to a screech if the birds are alarmed or decline to a soft chatter when they are perched and resting. When trying to visually locate each other or when gathering at water or feeding sites, the birds perch on treetops, commonly on the uppermost bare branches. During the day perching is usually in the mid-canopy where the birds can rest in the shade.

Generally all lovebirds in an area drink at the same waterhole, so patience and consecutive watches at various pools may be required to locate their preferred waterhole. Two other parrot species commonly observed in the same region are Meyer's Parrot *Poicephalus meyeri* and the Grey-headed Parrot *P. suahelicus*.

The range of the Black-cheeked Lovebird is relatively remote, undeveloped and largely roadless. The northern part of the species' range is found within the southern region of Zambia's Kafue National Park. If you intend to visit the area you will require a 4x4 with good clearance, and you will need to be self-sufficient, including carrying your own water. The region is only accessible during the drier months, from May to November depending on when the year's rains fell.

Visiting the Park is to be encouraged since the habitat is undeveloped and 'getting away from it all' is certainly possible here! It is, however, a troubled paradise, as many game species are under serious threat from poaching for the bushmeat trade. Perhaps a surge in tourism would bring the area to the attention of the Zambian Wildlife Authority and interested NGOs?

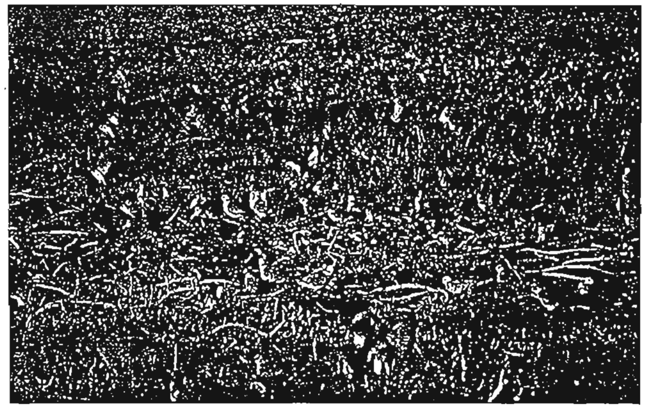
Feral lovebirds

Lovebird species are frequently observed as feral birds. The closest feral colony to wild Black-cheeked Lovebirds can be found in the town of Victoria Falls, where a mixed flock of up to eight lovebirds comprising Rosy-faced *Agapornis roseicollis*, Lilian's and Black-cheeked can easily be spotted (but no 'ticking' as the birds return to an aviary at night).

The occasional lovebird has been seen flying over the Zambezi about 30 kilometres west of the Falls, and again it is very probable that these are feral birds. One woman in the area admitted to letting a few of her aviary birds out, and there is a 1967 record of some captive Black-cheeked Lovebirds being released in Choma, about 100 kilometres east of their natural range. These birds survived for at least a year, but there have been no recent sightings. Slightly further afield, near Main Camp in Hwange National Park, Zimbabwe, there is a mixed feral flock (Rosy-faced and Lilian's) which was released from a nearby safari lodge, and there are established colonies of Rosy-faced in Borrowdale, Harare, and Centurion, Pretoria.

In 1998 *BirdLife News* (1(2):11) reported a sighting of Black-cheeked Lovebirds at Okaukuejo Restcamp in Etosha National Park, Namibia, in the same vicinity as the naturally occurring Rosy-faced Lovebird; a subsequent newsletter (2(1):29) revealed that the Black-cheeked Lovebirds belonged to a member of staff in the Park.

These are just some feral records for southern and East Africa; many more exist.



In the early morning and late afternoon lovebirds often gather to drink in mixed flocks.

The more southern part of the lovebird's range is found in areas inhabited by local subsistence farmers, who are largely unaffected by the outside influences of Western development. Our trips into the area have been met with the utmost courtesy and hospitality, with the local people being interested to learn the reasons for our visit and often providing valuable tips for locating this elusive lovebird.

The local name given to these birds by chiLozi and chiTonga speakers is '*Sichikwele*', the same name given to all the parrots in the region (the others being Meyer's and the Grey-headed parrots). However they differentiate the lovebird as being '*tunini*' (small) and the others as '*ikulu*' (large).

If you do visit the area, observe some basic codes of social conduct and you could enhance the conservation of the Black-cheeked Lovebird and protect the local people's integrity and cultural values. Having a local guide able to speak chiTonga and chiLozi is important. On arrival at a village, seek out the headman and introduce yourself and explain the reason for your visit. Often showing an illustration or photograph of the lovebird can elicit the information as to whether the bird is found there or not. Be very clear that you have just come to see the bird: some people may interpret your interest in the lovebird as you wanting to catch it, thereby placing some monetary value on the species. Introducing the notion of attaching any economic worth to the capture of the species could well lead to its rapid extinction in the wild and should be avoided at all costs. If people wonder at your specific interest in the bird, explain by saying that it is very special because it is only found in such a small area of Zambia, which is true! Most locals will be amazed as the lovebird is such an inherent part of their environment.

Permission to walk around the village and its surrounds is then usually granted and often a local guide commissioned. Little, if anything, is expected in return, although common courtesy should be served with discretion. Practical, useful gifts such as soap, vegetable seeds, clothing, a football, pens, or perhaps a book for the local school would be much appreciated.

It would be a great achievement if the Black-cheeked Lovebird could become, albeit by default, an ambassador for this rural region.

If you do see the species south of the Zambezi, don't forget to let us know! I for one will be counting the days until I see the magic little green parrots again. □

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Rußköpfchen (Agapornis nigrigenis) sind anfällig für PBFD

PBFD bei frei lebenden Rußköpfchen in Sambia

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Einleitung

Das Rußköpfchen (*Agapornis nigrigenis*) ist eine bedrohte Art (Birdlife International 2000), die in einem 2.500 km² großen Gebiet im Südwesten Sambias vorkommt (Dodman 1995, Dodman et al. 2000). Sie wird in Anhang II des Washingtoner Artenschutzübereinkommens aufgeführt, obwohl der Handel mit Wildvögeln laut sambesischem Gesetz seit 1930 verboten ist. Das Verbreitungsgebiet ist eine recht abgelegene Gegend mit nur geringer landwirtschaftlicher Nutzung. Es gibt keine Anzeichen dafür, dass Vögel dort früher in Menschenobhut gehalten wurden oder zur Zeit gehalten werden, aber in den 1920er Jahren wurden viele Vögel für den Handel gefangen. In Menschenobhut ist das Rußköpfchen selten; es wird vorwiegend von spezialisierten Züchtern gehalten, und zwar vor allem in Südafrika. 1998 wurde von der University of Natal ein Forschungsprojekt zum Studium der Ökologie des Rußköpfchens im Freiland gestartet. Eine Pilotstudie, die im Rahmen des Zambia Bird Atlas Project durchgeführt worden war, hatte ergeben, dass die Rußköpfchen in Sambia in zwei Subpopulationen aufgeteilt sind (Dodman 1995; Dodman et al. 2000).

Das Psittacine-Beak-and-Feather-Disease-Virus

Bis vor kurzem war nur wenig bekannt über die Schnabel- und Federkrankheit (Psittacine Beak and Feather Disease, PBFD), ihre Übertragunswege, Symptome und natürlich vorkommende Resistenzen. Das PBFD-Virus ist ursprünglich in Australien aufgetreten, hat sich aber bis nach Nord-Amerika, Europa und Asien (Ritchie & Carter 1995) sowie Afrika ausgebreitet. Neuere Untersuchungen lassen vermuten, dass frei lebende Populationen des stark bedrohten Kap-Papageis (*Poicephalus r. robustus*) in Südafrika mit dem Virus infiziert sind (Wirminghaus et al. 1999; Downs, pers. Mitt.). Für Papageien in Menschenobhut ist die Krankheit im Allgemeinen tödlich. Agaporniden gelten als sehr anfällig für das Virus (Kock et al. 1993). Der Infektionsstatus des Reichenows Kap-Papageis (*Poicephalus robustus suahelicus*) und des Goldbugpapageis (*Poicephalus meyeri*), die beide im selben Verbreitungsgebiet wie das Rußköpfchen vorkommen, ist nicht bekannt.

Das Virus aus der Familie der Circoviren wurde zuerst bei verschiedenen Arten von australischen Kakadus in den 1970er Jahren beschrieben (Ritchie & Carter 1995). Es gibt allerdings einen viel früheren Bericht über eine mögliche PBFD-Infektion in einer frei lebenden Population von Singsittichen (*Psephotus haematonotus*) (Ashby 1907). Die verschiedenen Circoviren scheinen wirtsspezifisch zu sein, mit eigenen Protein- und DNA-Charakteristiken. Eine Übertragung zwischen unterschiedlichen Vogelfamilien ist unwahrscheinlich und auch noch nicht beschrieben worden. Bisher sind in Australien im Freiland bei vierzehn verschiedenen Arten aus zwölf Familien Circoviren nachgewiesen worden. Auch bei vielen in Menschenobhut lebenden Arten wurde das Virus nachgewiesen; vermutlich ist es über den internationalen Vogelhandel verbreitet worden (Ritchie & Carter 1995). Jüngst wurde eine PCR-Analyse entwickelt, mit der man das Virus sehr effektiv nachweisen kann (Ypelaar et al. 1999).

Die Symptome der PBFD sind abnormes Federwachstum, Verlust der Dunenfedern, abnormes Schnabel- und Krallenwachstum sowie im letzten Stadium Lähmung des Tieres. Einige Vogelhalter berichten vom Wachstum gelber Federn bei infizierten Rußköpfchen (Scopes, pers. Mitt.). Die klinischen Symptome sind bei Rußköpfchen und jungen Gelbhaubenkakadus in Menschenobhut häufig (Ritchie & Carter 1995). In Australien ist die akute Form der Krankheit bei jungen Kakadu-Wildfängen häufig, aber mit einer Wahrscheinlichkeit von 90 % überleben die Tiere die Krankheit (Raidal & Cross 1995). Allerdings können auch Sekundärinfektionen mit Bakterien, Pilzen oder anderen Viren auftreten (York et al. 2000). Das Virus kann auch akute Hepatitis verursachen (Raidal & Cross 1995). Die meisten infizierten Vögel sind jünger als zwei Jahre, aber auch ältere Vögel können erkranken, vor allem wenn sie gestresst sind (York et al. 2000). Einige infizierte Vögel zeigen überhaupt keine Symptome, sind aber Überträger des Virus und können andere Vögel anstecken. Einige Rußköpfchen-Kolonien in Großbritannien wurden positiv auf das PBFD-Virus getestet, aber die Vögel überlebten während des Beobachtungszeitraums von zwei Jahren, brüteten ganz normal und zeigten keinerlei klinische Symptome (Scopes, pers. Mitt.).

Die Virusübertragung scheint sowohl von der Mutter auf das Ei (Penning 2000) als auch von Vogel zu Vogel möglich zu sein. Während experimenteller Untersuchungen konnten Papageienküken auf unterschiedlichen Wegen infiziert werden: oral, über die Kloake, durch subkutane und intramuskuläre Injektionen sowie intranasal. Vermutlich kann eine Übertragung auch über die Atemwege durch Einatmen verseuchter Luft und über den Verdauungstrakt durch die Aufnahme infizierter Materialien ablaufen. Gefiederstaub ist vermutlich die bedeutendste Übertragungsquelle (Ritchie & Carter 1995).

Ein PBFD-positives Testergebnis von einem Vogel mit abnormem Federwuchs ist ein deutliches Zeichen dafür, dass das Tier eine akute Infektion hat. Ein positives Ergebnis von einem Vogel mit keinerlei Federproblemen bedeutet entweder, dass der Vogel ein Träger des Virus ist oder dass er diesem erst kürzlich ausgesetzt war und unter Umständen noch eine Immunantwort entwickelt und das Virus eliminiert. Einige wenige infizierte Tiere verschiedener Arten, darunter auch Agaporniden, haben sich von einer vermuteten PBFD-Virusinfektion mit Federabnormitäten wieder erholt (Ritchie & Carter 1995). An der Universität von Syndey wurde ein Impfstoff entwickelt, der offenbar wirksam eine Immunität bei negativ getesteten Vögeln bewirkt (Raidal et al. 1993).

Untersuchung an Rußköpfchen

Das Verbreitungsgebiet der Rußköpfchen in Sambia liegt 15-17°S und 24-26°O. Die nördliche Population lebt in geeigneten Habitaten entlang des Nanzhila River, vorwiegend beschränkt auf den Kafue National Park und umliegende Wildschutzgebiete. Die südliche Population kommt in der Gegend des Sichifulo River und Machile River vor, im Norden begrenzt durch den Simalanga River, im Süden durch den Ngweze River.

Junge Rußköpfchen sehen aus ihrer Nisthöhle heraus

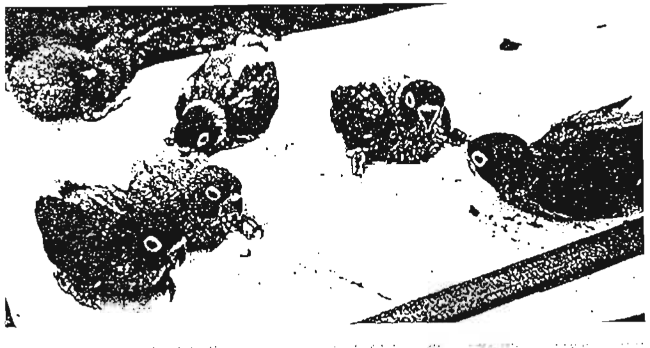
Für die Untersuchung wurden im März und April 2000 (Brutsaison) Blutproben von Tieren aus dem mittleren Machile-River-Gebiet entnommen. Beobachtungen wurden vom Mai 1998 bis Dezember 1999 im ganzen Verbreitungsgebiet gemacht. Als Teil einer Studie über die Brutbiologie wurden 18 Nestlinge aus fünf Nestern kurzzeitig entnommen, gemessen und fotografiert. Außerdem wurde neun Jungvögeln aus vier verschiedenen Nestern Blut abgenommen: Sechs Junge stammten aus dem selben Nest (ein Gelege von sieben, der jüngste Nestling war noch zu klein für eine Blutentnahme), die andern Proben wurden je einem Jungvogel aus drei weiteren Nestern entnommen.

Die Blutentnahme erfolgte aus der Flügelvene mit einer dünnen Nadel. Die Proben wurden auf das Vorhandensein von PBFD-Viren sowie von Polyomaviren und Chlamydia psittaci untersucht. Außerdem wurde das Geschlecht der Tiere bestimmt.

Ergebnisse

Die Blutprobe eines Jungtiers aus einem Nest mit sieben Jungen war PBFD-positiv. Dieser Jungvogel war männlich, sechs weitere der getesteten Tiere waren weiblich, zwei Proben konnten nicht bestimmt werden. Das Alter des positiv getesteten Vogels wurde anhand des Fotos auf etwa 28 Tage geschätzt (Scopes, pers. Mitt.). Die Küken dieses Nestes wurden zwei Mal für Messungen der Körpergröße entnommen. Bei der erste Entnahme am 26. März 2000 wurde von den fünf ältesten Jungen Blut genommen, bei der zweiten Entnahme am 1. April 2000 wurde auch vom zweitjüngsten Küken eine Blutprobe genommen. Der jüngste Nestling war zu klein für eine Blutentnahme. Bei der zweiten Entnahme wurde der älteste Jungvogel tot aufgefunden, ohne erkennbare Todesursache. Dies war der Vogel, der im Test PBFD-positiv war: Sein Gefieder war fehlerlos, und er war bereit zum Ausfliegen. Kein anderes Pathogen konnte nachgewiesen werden.

Zwischen Februar und April 2000 wurden 78 Rußköpfchen-Brutbäume gefunden. 59 wurden zur Untersuchung der Nisthöhlen bestiegen. Bei 16 Höhlen war es möglich, vom Eingang aus das Nest einzusehen. 13 Nester enthielten Junge, vier davon auch tote Nestlinge (in einem Nest sogar zwei tote Jungvögel). Eine fünfte Nisthöhle roch, als würde ein totes Junges darin liegen, aber der zu kleine Höhleneingang verhinderte die genaue Untersuchung. So enthielten etwa 31 % der einsehbaren Nester (n = 13) mindestens einen toten Jungvogel. Wird auch das fünfte Nest in die Rechnung aufgenommen, sind es etwa 38 %. Einer der toten Nestlinge wies Wunden am Schädel auf, was entweder auf einen Angriff durch Räuber oder Infantizid hindeutet. Das im selben Nest gefundene zweite tote Junge war schon stark verwest und hatte einen zertrümmerten Schnabel. Einer der toten Jungvögel war noch mit Federkielen bedeckt, ein weiterer war kurz vor dem Ausfliegen. Das Alter der anderen toten Nestlinge konnte nicht ermittelt werden.



Jungvögel des Siebener-Geleges, aus dem das PBFD-positiv getestete Tier stammte

Alle Nester mit toten Jungen (inklusive des verdächtigen fünften Nestes) enthielten auch noch lebende Jungvögel.

Während der 19 Monate dauernden Beobachtung im Freiland wurden im gesamten Verbreitungsgebiet fünf erwachsene Vögel gesehen, die ungewöhnliche kahle Stellen oder einen schlechten Gefiederzustand aufwiesen, der mit PBFD in Verbindung gebracht werden kann. Die Symptome waren Verlust der Federn an Kopf, Wangen und Rücken, ein Vogel zeigte einen sehr hellen, an der Basis nahezu weißen Schnabel. Einige Farbmutationen konnten beobachtet werden, aber sie sind vermutlich nicht mit der Krankheit assoziiert. Andere Faktoren, die solche Symptome hervorrufen können, sind das Polyomavirus, Chlamydien, psychogene und ernährungsbedingte Ursachen (Penning 2000).

Rußköpfchen mit PBFD-Symptomen wurden in beiden Subpopulationen beobachtet, allerdings wurden Blutproben nur in einem Brutgebiet im Süden entnommen.

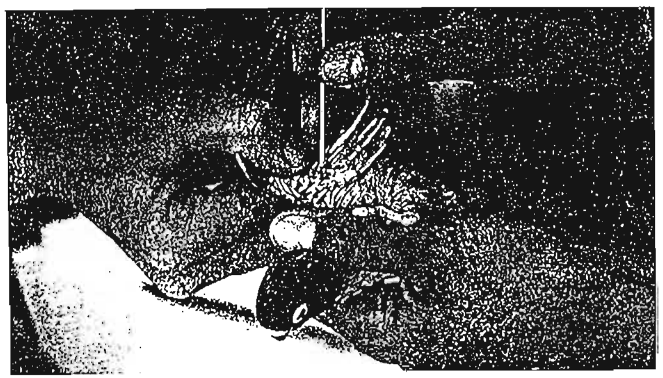
Weitere Forschungen

Untersuchungen in Simbabwe an PBFD-infizierten Rußköpchen und Erdbeerköpfchen (*Agapornis lilianae*) zeigten eine Sterblichkeitsrate von 100 % bei Tieren in Menschenobhut. Alle Tiere schienen zum Zeitpunkt des Todes in guter körperlicher Verfassung, lediglich eine leichte Erhöhung der Respirationsrate war zu verzeichnen. Rosenköpfchen (*Agapornis roseicollis*) und Pfirsichköpfchen (*Agapornis fischeri*), die im engen Kontakt mit kranken Vögeln lebten, die starben, waren nur vorübergehend betroffen oder gar nicht infiziert (Kock et al. 1993).

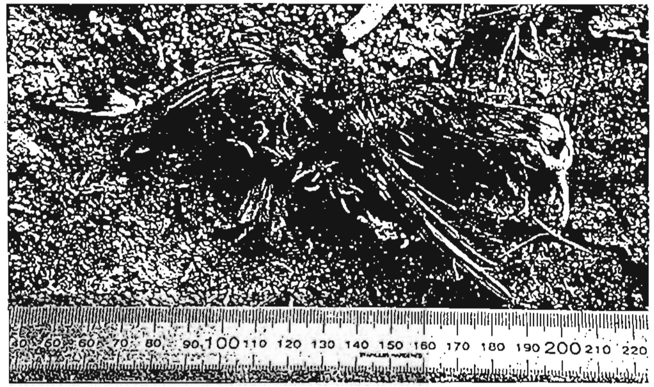
Rußköpfchen und Erdbeerköpfchen werden von einigen Autoren als Unterarten derselben Art angesehen (Fry et al. 1988, Eberhard 1998). Ihre Verbreitungsgebiete überlappen nicht, und die ökologischen Bedürfnisse scheinen gleich zu sein. In Sambia sind ihre Populationen durch ein etwa 160 km breites, für sie unbewohnbares Gebiet mit Basaltschluchten voneinander getrennt (Benson & Irwin 1967). Rosenköpfchen kommen im nördlichen Angola, in einem Großteil von Namibia und in der Kalahari in der Republik Südafrika vor; Pfirsichköpfchen leben in Tansania sowie Ruanda und Burundi. Die scheinbare Widerstandsfähigkeit der weit entfernt von Ruß- und Erdbeerköpfchen lebenden Agapornis-Arten lässt vermuten, dass Arten aus unterschiedlichen Gebieten offenbar auch für verschiedene Typen des PBFD-Virus anfällig sind. Bisher wurde jedoch nur ein Virus-Typ identifiziert, und Viren, die bei verschiedenen Arten gefunden wurden, zeigten dieselben morphologischen Merkmale, übereinstimmende immunologische Wirkungen und riefen vergleichbare mikroskopische Veränderungen hervor (Ritchie & Carter 1995). Pfirsich-, Erdbeer-, Rosen- und Schwarzköpfchen (*Agapornis personatus*) werden von Ritchie & Carter (1995) als anfällig für das PBFD-Virus angegeben, obwohl klinische und pathologische Symptome bei den Arten variieren. DNA-Untersuchungen zeigten, dass Papageienvögel der Alten Welt die größte Empfindlichkeit gegenüber PBFD-Viren aufweisen. Es wurden verschiedene Agaporniden und Kakadus sowie Edelpapageien (*Eclectus roratus*) und Graupapageien (*Psittacus erithacus*) untersucht: Die Unzertrennlichen waren in 30 % der Fälle PBFD-positiv, fast dreimal häufiger als die Edelpapageien auf „Platz zwei" (Ritchie & Carter 1995).

Bedeutung für den Artenschutz

Für den Schutz der Rußköpfchen im Freiland sieht es düster aus, genauso



Entnahme einer Blutprobe aus der Flügelvene bei einem Jungvogel



Überreste eines toten Jungvogels, die aus einem Nest entnommen wurden

auch für den Kap-Papagei und vermutlich für andere afrikanische Papageienarten. Ohne Behandlungsmöglichkeiten können die Artenschützer nur hoffen, dass PBFD im Freiland nur selten tödlich ist und sich eine natürliche Immunität entwickelt. PBFD-freie Populationen müssen vermehrt zum Brüten angeregt werden, um einen gesicherten „Gen-Vorrat" zu bilden. Frei lebende Populationen sollten über lange Zeit überwacht und der Fang von Vögeln für den Markt verboten werden. Weitere Forschungen zu Übertragung und Epidemiologie des Virus sollten durchgeführt werden. Warum war nur ein Küken aus einem Siebener-Gelege PBFD-positiv? Wie lange können infizierte Tiere überleben? Welche Stressfaktoren führen zum Ausbruch der Krankheit? Was kann getan werden, um diese Faktoren im Freiland zu mildern? Wie hoch ist die Sterblichkeitsrate im Freiland? Wenn ein Impfstoff entwickelt werden sollte – könnten frei lebende Tiere geimpft werden?

Das ausgeprägte Sozialverhalten der Rußköpfchen, das auch für die meisten anderen Papageienarten typisch ist, könnte die Ausbreitung des PBFD-Virus begünstigen, zum Beispiel durch direkten Kontakt der Tiere oder über kontaminiertes Wasser oder verseuchte Futterstellen. Untersuchungen haben jedoch ergeben, dass die horizontale Übertragungsrate zwischen adulten Rosakakadus nicht sehr groß ist (Raidal et al. 1993). Infizierte Populationen einiger australischer Papageien scheinen sich weiterhin gut zu entwickeln. Die Aussichten für die bereits gefährdeten und nur lokalen Populationen des Rußköpfchens sind allerdings nicht sehr positiv, vor allem, da sie noch weiteren Gefahren für ihr Überleben ausgesetzt sind.

Erfahrungen von Tierärzten und Vogelhaltern werden gerne entgegengenommen.

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