BIOLOGY OF THE GREYHEADED PARROT

Poicephalus fuscicollis suahelicus Reichnow

by

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requirements for the degree of
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This dissertation is dedicated to my grandfather
THOMAS REGINALD SYMES (10/04/1910 - 01/02/1999)
who showed me the splendour in nature,
and introduced me to parrots

PREFACE

The work described in this dissertation was carried out in the Department of Zoology, School of Botany and Zoology, University of Natal, Pietermaritzburg, from January 1999 to January 2001, under the supervision of Professor Michael R. Perrin and the co-supervision of Dr Colleen T. Downs.

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

Chapters 2 - 7 are written in the format for submission to recognized international journals as indicated in Contents (page viii). Each chapter is set to read independently and may prevent continuity of the dissertation. Repetition between chapters is therefore unavoidable.

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Craig Symes

Pietermaritzburg

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ABSTRACT

This study was conducted to investigate the biology of the Greyheaded Parrot *Poicephalus fuscicollis suahelicus* in the wild. Field work was conducted in north-east South Africa in the southern limit of the range of the Greyheaded Parrot during two field seasons. Observations from August to December 1999 in the Levubu region, south of the Soutpansberg mountain range, included months of the non-breeding season when Greyheaded Parrots occur seasonally in the area. Observations in the Luvhuvhu-Mutale river confluence area from March to August 2000 included months of the breeding season. No field work was conducted from January to March 2000 due to exceptionally high rains in the southern African sub-region, that prevented access to sites.

The Greyheaded Parrot has a widespread distribution, through southern, south Central and East Africa, that has possible changed little in recent years. However, local populations are likely to have suffered extinctions due to habitat destruction and capture for the illegal trade. Populations in protected areas (Makuya Park and Kruger National Park) are less vulnerable to capture than unprotected areas. The conservation of the Greyheaded Parrot outside of protected areas is highlighted.

In various parts of the range of the Greyheaded Parrot seasonal movements occur in response to food and nest site availability. Nest sites are possibly limiting in certain parts of its range due to habitat destruction. During post-breeding flocking, the occurrence of larger flocks, possibly family units (mean ± S.E = 4.7 ± 0.2), is common, when birds wander in search for seasonally available food sources. During this period density of Greyheaded Parrots is 0.28 birds/100 ha. Monogamous pairs are more conspicuous during the breeding season (mean ± S.E = 2.1 ± 0.1) and density estimates are 0.14 birds/100 ha. Egg laying is synchronous between pairs with the timed appearance and flocking of juvenile flocks in spring (August/September). Breeding during the dry season reduces competition with other large cavity nesting bird species. Observations suggest that a skewed sex ratio exists in the population (males:females = 2:1).

Daily movements are characterised by a bimodal activity pattern. Early morning movements involve flights to activity centres where the accumulation of numerous smaller flocks occur. Here preening, allo-preening and socializing occur with drinking and/or feeding occurring if food and/or water are available. Thereafter, birds move to regular feeding sites, to feed. Activity

is decreased during the heat of the day with birds sleeping, resting and/or preening in the canopies of trees. Late afternoon activities involve increased levels of activity and late afternoon return flights to roosts.

Greyheaded Parrots are specialist feeders, accessing the kernel of predominantly unripe fruit. This feeding strategy reduces competition with other frugivore competitors. During any one time few tree species are fed on by the Greyheaded Parrot. Greyheaded Parrots were also observed feeding on bark in the breeding season. Two, almost fully fledged, chicks were found dead in a nest and the causes of death undetermined. Their crops contained numerous pieces of masticated bark and insect parts.

Behaviours and vocalizations of the Greyheaded Parrot were similar to that recorded in the Cape Parrot. Recognition of the Greyheaded Parrot as a separate species based on species specific calls and DNA warrants further investigation.

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CHAPTER 1

INTRODUCTION

Conservation of parrots

The majority of the worlds parrots are confined to the tropical regions of the world and most are forest dwellers in regions where destruction of their natural habitat has been, and continues to be, severe (Homberger 1985; Forshaw 1989; Collar & Juniper 1992; Collar, Crosby & Stattersfield 1994; Snyder, McGowan, Gilardi & Grajal 2000). Parrots belong to possibly one of the most threatened families of birds with an estimated 71 species (21.5 % of the Psittacidae) at risk of extinction, and an additional 29 considered near threatened (Collar & Andrew 1988). The recent IUCN Parrot Action Plan considers 95 (*c* 29 %) species globally threatened, discusses priority conservation projects and makes recommendations for parrot conservation (Snyder *et al.* 2000). This compares with a figure of 10 % for all bird species. Major causes of population declines have resulted from habitat destruction and fragmentation, human exploitation and trapping for the bird trade, and introduced competitors and predators (Beissinger & Snyder 1992; Collar & Juniper 1985, 1992; Snyder *et al.* 2000). Additional threats include disease and hybridizing with related taxa (Snyder *et al.* 2000). In South Africa, a country with a reputation for dealing in smuggled birds, over 115 000 wild birds of 200 species were exported from 1980 to 1993 (Mulliken 1994). These figures are known to represent a small portion of the total number of wild birds being exported (Mulliken 1994).

The Ethiopian region is depauperate of parrot species compared to the neotropics and Australasia (Forshaw 1989). Continental Africa is home to 18 species of four genera (*Poicephalus*, *Psittacus*, *Agapornis*, *Psittacula*) with most species having allopatric distributions (Forshaw 1989; Snyder *et al.* 2000). The diverse range of habitats in Africa results in a variety of pressures affecting these species (Snyder *et al.* 2000). For example, Meyer's Parrot *Poicephalus meyeri*, despite habitat destruction and occasional trapping in its range, is widely distributed with a low risk of extinction (Snyder *et al.* 2000). In certain parts of its range it lives freely with humans in heavily populated regions (pers. obs.). Restricted range species, on the other hand, face greater threats. The Blackcheeked Lovebird *Agapornis nigrigenis*, a Zambian near-endemic, was heavily trapped in the 1920's and numbers have possibly not recovered since (Benson & Irwin 1967; Dodman 1995; Dodman, Katanekwa, Aspinwall & Stjernstedt 2000). Also, a change in predominant agricultural crops from millet and sorghum to maize, which the Blackcheeked Lovebird does not feed on, may have caused recent population declines (Dodman *et al.* 2000; L. Warburton pers. comm.). In Namibia, illegal trade has likely reduced local populations of Rüppell's Parrot *Poicephalus rueppellii* (Selman, Hunter & Perrin 2000). Also nest predation may have had an effect on regulating numbers in the wild, presently estimated at *c* 10 000 (Selman *et al.* 2000). The Cape Parrot, a habitat and dietary specialist, is confined to the afromontane forests of south-eastern South Africa (Wirminghaus 1997). A combination of threats ranging from habitat destruction and reduced nest site availability, illegal capture for the avicultural market, shooting of pest birds and disease have contributed to recent population declines (Downs & Symes 1998; Perrin, Downs & Symes 1999; Wirminghaus, Downs, Symes & Perrin 1999).

African parrots therefore face a variety of pressures in the wild. As a result pressures on restricted to widespread species are different.

Taxonomic status and distribution of the Greyheaded Parrot

The taxonomic status of the Cape Parrot *Poicephalus robustus* Gmelin 1788 has recently been reviewed and significant morphometric, plumage colour, habitat requirements and separate ranges support the validity of two separate species (Clancey 1997; Massa 1998; Wirminghaus, Downs, Symes & Perrin In press a.). Three subspecies have previously been recognized: *Poicephalus* (Swainson 1837), type, by subsequent designation, *P. senegalensis* (L) Swainson = *Psittacus senegalus* Linnaeus: i) *Poicephalus robustus robustus* Gmelin, 1788, type locality - specimen lost, possibly Eastern Cape; ii) *Poicephalus robustus suahelicus* Reichenow, 1898, type locality: Msua, near Bagamoyo, eastern Tanzania (Taganyika), East Africa; iii) *Poicephalus robustus fuscicollis* Kuhl, 1820, Type locality: uncertain, probably Gambia. The revision proposed the recognition of two separate species *P. robustus* and *P. fuscicollis (P. f. fuscicollis* and *P. f. suahelicus*) (Clancey 1997; Wirminghaus *et al.* In press a.), both easily distinguishable on a visual basis (Forshaw 1989; Maclean 1993; Clancey 1997; Wirminghaus 1997). Preliminary DNA results support this separation (Solms, Berruti, Perrin, Downs & Bloomer 2000.).

The Cape Parrot is the smaller of the two species, and is distinguished from *P. fuscicollis* by an olive-green to yellow-green head and neck (Wirminghaus *et al.* In press a.; Fig. 1). Rowan (1983) describes the head and neck as an olive-yellow and Forshaw (1989) noted that the head is less variable, seldom with a bluish tinge as in *P. fuscicollis*. The head of *P. fuscicollis* is silvery-grey (Rowan 1983), yet varies to a grey-brown, as variation between individuals exists (Fig. 2). Also, the back and wing feather coverts are black to deep dark green in *P. robustus*, whereas in *P. fuscicollis* they are lighter green (Fig. 1 & 2). The colour variation between *P. f. suahelicus* and *P. f. fuscicollis* is less evident although the grey hood colour of *P. f. suahelicus* extends further down the throat and onto the breast, than *P. f. fuscicollis* (Wirminghaus *et al.* In press a.). Also, the hood colour is more a wash brown, extending onto the mantle in *P. f. fuscicollis* (Wirminghaus *et al.* In press a.; pers. obs). Colour variations within populations exist and are possibly a reflection of the age of individual birds and geographical differences (Wirminghaus 1995; pers. obs.).

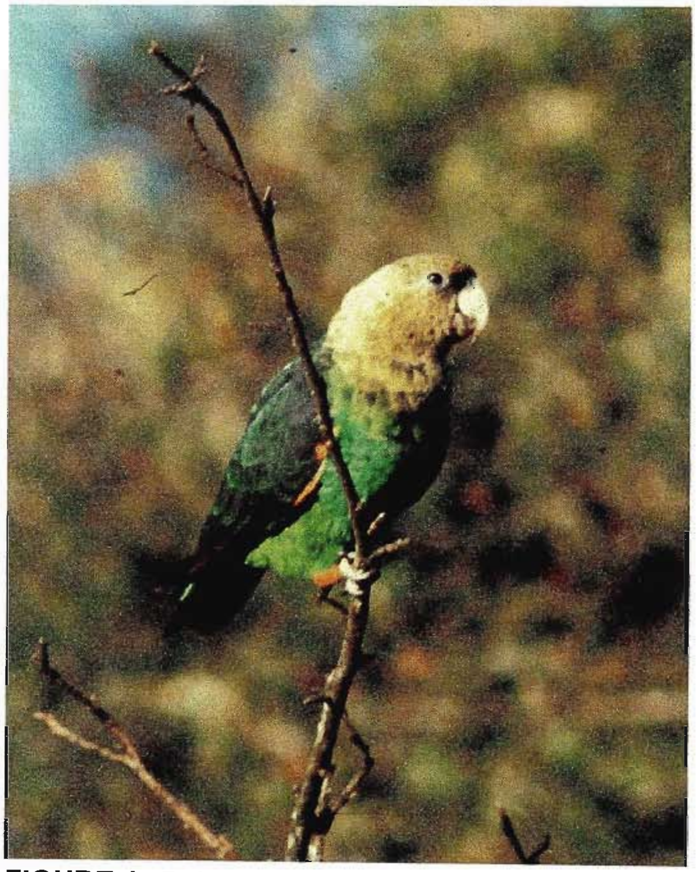


FIGURE 1. *Poicephalus robustus* (male).

The Cape Parrot *P. robustus* is confined to the austral range of the taxon in naturally fragmented mistbelt mixed *Podocarpus* forests of south-eastern South Africa (Sclater 1903;

Maclean 1993; Forshaw 1989; Clancey 1997; Wirminghaus 1997; Downs 2000). This is a forest-specific species, dependant predominantly on the Outeniqua Yellowwood *Podocarpus falcatus* as a source of food and as nest sites (Wirminghaus 1997; Wirminghaus, Downs, Symes & Perrin In press b). Historically this species had a wider distribution but habitat destruction and removal of large yellowwoods that provide nest sites, capture for the avicultural bird trade, shooting of birds as pests, and possibly disease have reduced the population to fewer than an estimated 1 000 birds (Boshoff 1980; Downs & Symes 1998; Symes & Downs 1998; Wirminghaus *et al.* 1999; Wirminghaus, Downs, Symes & Perrin 2000a). The present distribution ranges from Fort Beaufort and Alice in the Eastern Cape Province, through the forests of the former Transkei, to the Karkloof forests of KwaZulu-Natal Province. Specimens were previously collected outside the present range near Zuurbron in southern Mpumalanga Province in 1904 (British Museum of Natural History), Newcastle in KwaZulu-Natal Province in 1890 (British Museum of Natural History) and Haenertsberg in southern Northern Province in 1930 (Transvaal Museum) (Wirminghaus, *et al.* In press a.; C.T. Downs unpubl.data). A relict population of the Cape Parrot is found 400 km to the north in the escarpment forests of the Tzaneen region (Wirminghaus 1997; Barnes 1998; pers. obs.). The total population may number no more than 100 individuals (Barnes 1998), and is confined to indigenous forest of the region (Wirminghaus 1997; Barnes 1998). An additional population, may occur further north in the Soutpansberg forests (Kemp 1974; Wirminghaus 1997; Barnes 1998). The Important Birds Areas report records the presence of the Cape Parrot here and estimates approximately 10 - 15 remaining individuals (Barnes 1998). It was never recorded utilising afromontane forest in the eastern Soutpansberg and its presence here is questioned (Symes, Venter & Perrin 2000). *Podocarpus* spp. are scarce in this region, yet more common in the western Soutpansberg (N. Hahn pers. comm.; pers. obs.). The western Soutpansberg has not been investigated yet personal communications with landowners in the region suggest that it may be absent here (various pers. comm.).

The Brown-necked Parrot *P. f. fuscicollis* is confined to drier parts of west Africa, from Senegal to northern Nigeria, but is rare and local in the east of its range (Bannerman 1953, Elgood 1982; Forshaw 1989). It is a seasonal visitor to the northern regions of Ghana (D. Moyer pers. comm.), and the Plateau Province of Cote d'Ivoire in April and May (Bannerman 1953), where it is uncommon. In the mangroves of the Gambia it is more common (Bannerman 1953). It is said to occur in Cabinda, Angola, were it is an uncommon resident in forest (Chapin 1939;

Pinto 1983; Dean 1999), occurring north to Gabon and lower Congo (White 1965). However, birds along the lower Congo River, in north-western Angola may be intermediate between *P. f. fuscicollis* and *P. f. suahelicus* (White 1965).

FIGURE 2. *Poicephalus fuscicollis suahelicus* (male in foreground, female behind male).

The Greyheaded Parrot *Poicephalus fuscicollis suahelicus*, is found from northern Northern Province, South Africa, north through Zimbabwe, Mozambique, the Caprivi of Namibia, Angola and Zambia to north-western Tanzania, Rwanda, south-western Uganda and south-eastern Democratic Republic of Congo (Fry, Keith & Urban 1988; Forshaw 1989). In east Africa it is an uncommon resident of woodlands being patchily distributed in some regions and in the highlands of eastern Democratic Republic of Congo it occurs in montane forest up to 3 750 m a.s.l. (Chapin 1939; White 1945; Bannerman 1953; Lippens & Wille 1976; Traylor 1963; Benson & Irwin 1966; Britton 1980). In Zambia, where it is widely distributed (48 % of Atlas squares) (Aspinwall 1984), it is nowhere common (Benson, Brooke, Dowsett & Irwin 1971; Snow 1978; P. Leonard pers. comm.). In Malawi and Zambia it is generally uncommon in woodlands up to about 2 000 m a.s.l. (Benson & Benson 1977; Fry *et al.* 1988). Zambia is reported as one of its strongholds and seasonal movements are recorded (D. Aspinwall pers. comm.). These movements are noted as being more nomadic than those of other *Poicephalus* species (Forshaw 1989). In Angola it occurs up to 1 500 m a.s.l. in open areas of *Brachystegia*, forest edges and maize fields (Traylor 1963; Pinto 1983). In Zimbabwe it is widespread, yet uncommon, in woodlands along major river courses and scarce above 1 000 m a.s.l. (Smithers, Irwin & Paterson 1957). In Mozambique it has a scattered distribution, being recorded in 4.3 % of Atlas squares south of the Save River (Parker 1999), and in Botswana it is a sparse to uncommon resident of the extreme northern woodlands (Penry 1994).

Project rationale

The need to develop parrot conservation strategies depends on current knowledge of wild populations (Wilkinson 1998; Perrin, McGowan, Downs, Symes & Warburton 2000). Certain species are well represented in aviculture and breed successfully in captivity (Low 1982, 1995; Sharples 1989). The African Grey *Psittacus erithacus*, synonymous with pet parrots, has been well studied in the wild and captivity. Although captive breeding and commercial aviculture supplies birds to the avicultural and pet bird market, illegal trapping still threatens some wild populations (Collar & Juniper 1992; Juste 1996; Snyder *et al.* 2000). From 1984 - 1993, 40 400 African Grey Parrots were imported into South Africa (Mulliken 1994). Many of these are wild caught, and only a small proportion survive to their final destination (*c* 20 %) (Mountford 1990).

Members of the genus *Poicephalus* are confined to the Afrotropical region and their biology in the wild and captivity is poorly known (Forshaw 1989; Collar 1998; Wilkinson 1998; Perrin *et al.* 2000; Snyder *et al.* 2000). Recent initiatives in parrot research have aimed at increasing the knowledge of African parrot biology, yet efforts have concentrated on predominantly southern African species (Wilkinson 1998; Perrin *et al.* 2000; Snyder *et al.* 2000). The Yellowfronted Parrot *Poicephalus flavifrons*, confined to the highlands of Ethiopia, is poorly known in the wild and very few are known in captivity (Forshaw 1989; Wilkinson 1998; Perrin *et al.* 2000). For other species, knowledge is anecdotal and scattered in obscure literature sources. Because of their often cryptic colouration, large home ranges, difficulty to capture, confinement to canopies in forests and nesting in elevated and challenging to reach tree cavities, parrots are difficult to study (Snyder *et al.* 2000). Adequate knowledge and the identification of threats on wild parrot populations is required to implement efficient conservation measures (Wilkinson 1998; Perrin *et al.* 2000). This study intended to make available to scientists, aviculturists and conservationists, knowledge on the biology of the Greyheaded Parrot *Poicephalus fuscicollis*, a widespread, yet relatively unknown species. It is hoped that the findings will assist in the implementation of conservation strategies, aid aviculturists in successful captive breeding and develop the scientific knowledge of African parrots.

The Cape Parrot is possibly one of the most well studied African parrot species in the wild (Collar 1998; Wirminghaus *et al.* 1999). It is a specialist feeder accessing the kernel of unripe fruit (Wirminghaus *et al.* In press b.). Yellowwoods *Podocarpus* spp., found in the naturally fragmented mistbelt mixed *Podocarpus* forests of south-eastern South Africa, provide an important food source and nesting sites in natural cavities in dead trees (Wirminghaus *et al.* 2000a, In press b, c). Emergent yellowwood snags also provide important socialising and early morning gathering sites in these forests (Wirminghaus, Downs, Symes, Dempster & Perrin 2000b). Daily, and possibly seasonal, movements occur is response to local food abundance (Skead 1964; Wirminghaus, Downs, Perrin & Symes 2001).

It was hypothesized that the Greyheaded Parrot would exhibit similar feeding methods, although food type would differ. Feeding was expected to change in response to seasonal availability of food sources. A bimodal daily activity pattern, as exhibited in the Cape Parrot, was expected to be displayed by the Greyheaded Parrot. Also, vocalisations and behaviour were expected to be similar. In, addition it was hypothesized that local seasonal movements would occur as a result of food availability and breeding. Breeding was expected to be limited by nest site availability. Also, breeding between pairs in local populations was expected to be synchronous. Although the Greyheaded Parrot has a wide distribution its range was expected to be limited to dryer woodland, bushveld and savanna habitats. In certain regions of transition to tropical forest it was expected to occur sympatrically with Jardine's Parrot *Poicephalus gulielmi*.

Study area

The southern range limit of the Greyheaded Parrot occurs in Northern Province, South Africa, with sightings being recorded as far south as the University of the North, Pietersberg (23° 55' S, 29° 46' E) (D. Engelbrecht pers. comm.), and Satara (24° 24' S, 31° 51' E) (Wirminghaus 1997) and Skukuza (25° 00' S, 31° 32' E) (C. Burne pers. comm.), Kruger National Park (A. Kemp pers. comm.). It was in this region that a study investigating the biology and conservation status of the

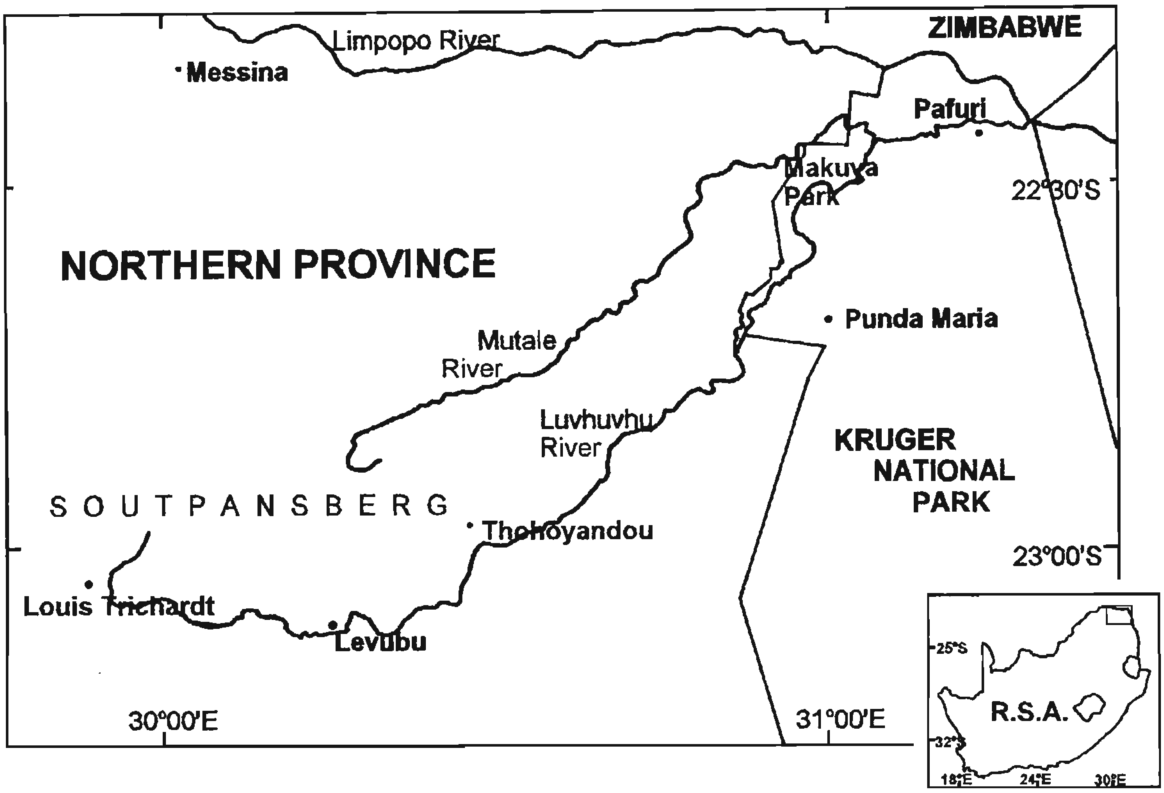
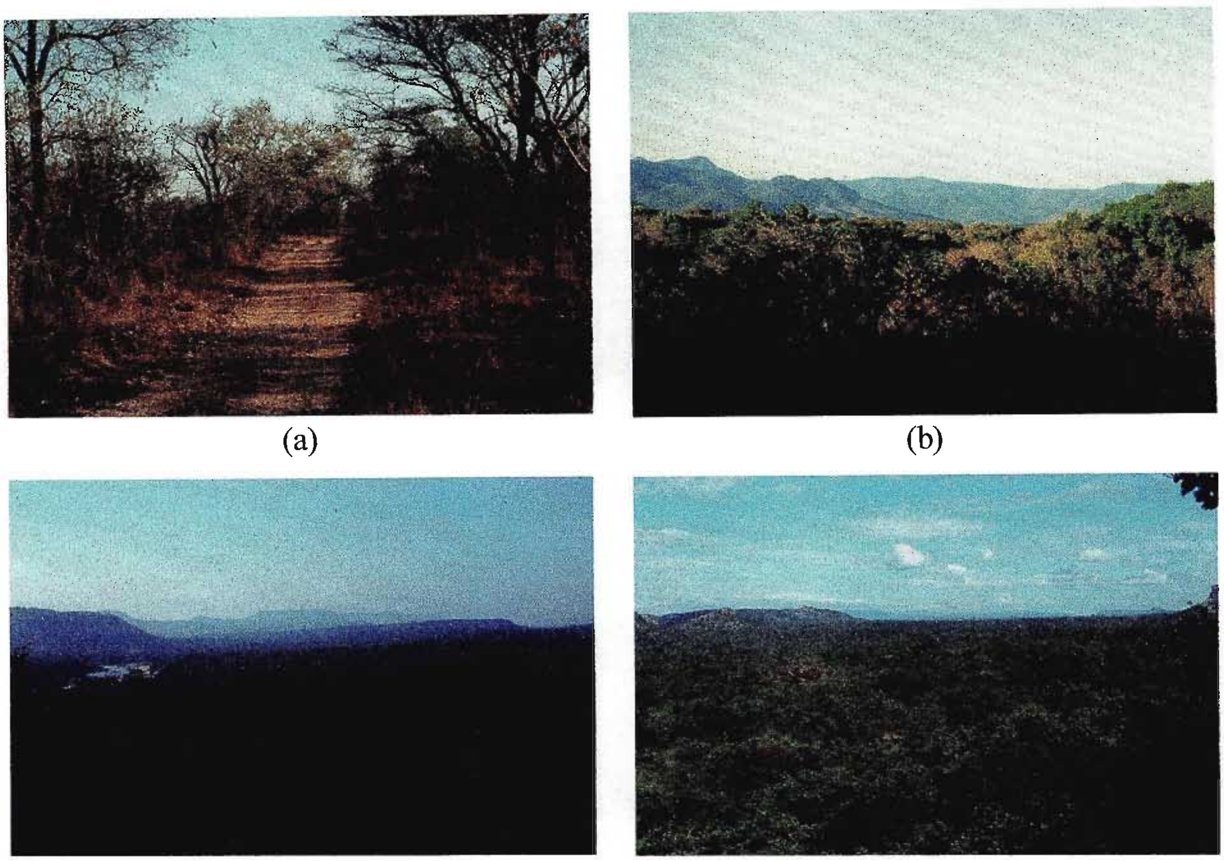


FIGURE 3. Location of study sites in north-east South Africa.

Greyheaded Parrot was conducted (Fig. 3).

The Soutpansberg mountain range (23° 05' – 22° 25' S, and 29° 17' – 31° 20' E) (Fig. 3), lies west-east in northern Northern Province, South Africa at *c* 300 - 1 700 m a.s.l. The mountains end north of Thohoyandou, south-west of the Luvhuvhu and Mutale river confluence (Fig. 3). Afromontane forest occurs at high altitudes being prominent on south-facing slopes (Fig. 4b). Lower altitudes are dominated by mixed broad-leaved and fine-leaved savanna (Fig. 4a), with intensive agriculture practised in particular regions (Scholes 1997). Riparian fringes occur along river courses (Scholes 1997), with bush encroachment occurring where land has been left fallow (various pers. comm.). Rainfall in the region is seasonal, falling mostly in the summer (October – March). Entabeni, near Levubu, receives highest rainfall (*c* 1 800 mm/a.), with the Drakensberg rainshadow causing Louis Trichardt, to the west, to receive *c* 540 mm/a. Rainfall decreases to the east, with Punda Maria, at *c* 450 m a.s.l., receiving *c* 620 mm/a. Temperatures are hot in summer, but cooler with increased altitude in the mountains. Levubu town is situated on the Luvhuvhu river between Thohoyandou and Louis Trichardt. Field work was carried out in the Levubu district (23° 00' - 23° 15' S, and 30° 05' - 30° 30' E,) from August to December 1999. This study period covered the non-breeding season of the Greyheaded Parrot and covered months of the year when Greyheaded Parrots occur seasonally in the area. Intensive agriculture is practised in the region with banana, macadamia, mango and tropical crops being planted (pers. obs.). A well developed road network in the region allowed easy access to most sites to locate parrots. East of Levubu, in the former Venda homeland, agriculture is predominantly subsistence, and slash-and-burn clearing is practised. As a result much land has been cleared for agricultural development.



(a) (b) (c) (d)

FIGURE 4. Photographs showing vegetation at respective study sites. a: view on Prinsloo's farm at Levubu where Greyheaded Parrots were observed roosting and feeding (23° 08' S, 30° 20' E), b: view of Soutpansberg Mountain range from Joubert's farm where Greyheaded Parrots were observed feeding (23° 04' S, 30° 14' E), c: view from Makuya Park from vicinity of a nest site overlooking Luvhuvhu river (left of figure) and Kruger National Park (22° 29' S, 31° 03' E), d: view overlooking a valley near the Mutale river, Tshikuyu, where few Greyheaded Parrots were observed (22° 27' S, 30° 55' E) (note conspicuous baobab left centre).

Exceptionally high rains during January 2000 to March 2000 throughout the southern African sub-region, and flood damage in the study areas prevented fieldwork during these months. These rains also significantly damaged riverine vegetation in the region, with many large trees removed by flooding waters (pers. obs.).

The Luvhuvhu River originates east of Louis Trichardt and flows west–east, south of the Soutpansberg range (Fig. 3). East of the Soutpansberg it flows north-east, meeting the Limpopo River at Crooks' Corner in northern Kruger National Park. The Mutale River originates at Thathe Vondo forest, flows north-east and joins the Luvhuvhu in north-west Kruger National Park, west of Pafuri Gate. East of Thohoyandou, altitude is low (< 300 m a.s.l.). Rainfall is seasonal, falling mostly in the summer, and daytime temperatures are hot (+ 30 ° C). Vegetation is predominantly woodland (broad- and fine-leaved), with riparian vegetation fringing river courses (Scholes 1997; Fig. 4c). Dominant tree species include Mopane *Calophospermum mopane*, Lebombo Ironwood *Androstachys johnsonii* and *Combretum* spp., with Baobab *Adansonia digitata* widespread and conspicuous, but not common. Field work took place in the region west and south of the Luvhuvhu-Mutale river confluence (22° 26' - 22° 32' S, and 30° 50' - 31° 05' E), from April 2000 to September 2000 (Fig. 3 & 4d). This season covered the breeding season of the Greyheaded Parrot. Although a rudimentary network of roads was found in the area, access to find parrots was through rough terrain, requiring the use of 4x4 transport. Very few sightings were made of parrots where human population density was highest. However, the landscape is not as anthropogenically altered as Levubu and observations of parrots occurred mostly in protected areas i.e. northern Makuya Park and the north-western Kruger National Park (Fig. 4c). Outside of protected areas wood and tree removal is high, and businesses operating from far afield as Thohoyandou (80 km distant) collect wood from the area (S. König pers. comm.). Dead wood removal, although not investigated in this study, possibly has implications for populations of cavity nesting bird species in the region (pers. obs.). Crop planting occurs along river courses where there is access to water (pers. obs.).

References

Aspinwall, D. 1984. Movement analysis chart: comments on Brown-necked Parrot. *Newsletter Zambian Orn. Soc.* 14: 146-148.

Bannerman, D.A. 1953. *The birds of west and equatorial Africa.* Oliver & Boyd. Edinburgh.

Barnes, K.N. 1998. *The important bird areas of southern Africa.* BirdLife South Africa. Johannesburg.

Beissinger, S.R. & Snyder, N.F.R. 1992. Introduction. In: Beissinger, S.R. & Snyder, N.F.R. *New* *world parrots in crisis: solutions from conservation biology.* Smithsonian Institution Press. Washington and London.

Benson, C.W. & Irwin, M.P.S. 1966.The Brachystegia avifauna. *Ostrich* Suppl. 6: 297-321.

Benson, C.W. & Irwin, M.P.S. 1967. A contribution to the ornithology of Zambia. *Zambia Museum Papers* 1: 41-43.

Benson, C.W., Brooke, R.R., Dowsett, R.J & Irwin, M.P.S. 1971. *The birds of Zambia.* Collins. London.

Benson, C.W. & Benson, F.M. 1977. *The birds of Malawi.* Mountfort Press. Limbe.

Boshoff, A. 1980. The status and conservation of the nominate race of the Cape parrot (*Poicephalus robustus robustus*) (Gmelin) in southern Africa. Unpublished report.

Britton, P.L. (Ed) .1980. *Birds of east Africa: Their habitat, status and distribution.* East Africa Natural History Society. Nairobi.

Chapin, J.P. 1939. The birds of the Belgian Congo, Part II. *Bull. Am. Mus. nat. Hist.*, 75: 1-632.

Clancey, P.A. 1997. The Cape Parrot: an additional valid species. *Honeyguide* 43: 61-62.

Collar, N.J. & Juniper, A.T. 1985. *Threatened birds of Africa and its islands.* ICBP/IUCN Red Data Book, 3rd Ed., Part 1. International Council for Bird Preservation. Cambridge.

Collar, N.J. & Andrew, P. 1988. *Birds to watch: the ICBP world check-list of threatened birds.* United Kingdom, International Council for Bird Preservation Tech. Publ. 8. Cambridge.

Collar, N.J. & Juniper, A.T. 1992. Dimensions and causes of the parrot conservation crisis. In: Beissinger, S.R. & Snyder, N.F.R. *New world parrots in crisis: solutions from conservation biology.* Smithsonian Institution Press. Washington and London.

Collar, N.J., Crosby M.J. & Stattersfield, A.J. 1994. *Birds to watch 2: the world list of threatened birds.* BirdLife International. Cambridge.

Collar, N.J. 1998. Information and ignorance concerning the world's parrots: an index for twenty-first century research and conservation. *Papageienkunde* (2): S. 201-235.

Dean, W.R.J. 1999. *The birds of Angola.* BOU Checklist No. 17. British Ornithologists Union. Tring.

Dodman, T. 1995. Status and distribution of the black-cheeked lovebird. *Psittascene* 7(4): 11.

Dodman, T., Katanekwa, V., Aspinwall, D. & Stjernstedt, R. 2000. Status and distribution of the Black-cheeked Lovebird, Zambia. *Ostrich* 71(1&2): 228-234.

Downs, C.T & Symes, C.T. 1998. Cape Parrots. Report on the second Cape Parrot big birding day, (25 April 1998). *Psittascene* 10(3): 5-7.

Downs, C.T. 2000. Cape Parrot *Poicephalus robustus*. In: Barnes, K.N. 2000. (Ed). *The Eskom Red Data Book of birds of South Africa, Lesotho and Swaziland.* BirdLife South Africa. Johannesburg.

Elgood, J.H. 1982. *The birds of Nigeria.* British Ornithologists' Union. London.

Forshaw, J.M. 1989. *Parrots of the world.* Lansdowne Books. Willoughby, Australia.

Fry, C.H., Keith, S. & Urban, E.K. 1988. *The birds of Africa. Vol. III.* Academic Press. London.

Gmelin, 1788. *Syst. Nat.*, vol. i, part1, p. 344.

Homberger, D. 1985. Parrot. In: Campbell, B. & Lack, E. (eds). *A dictionary of birds.* United Kingdom. T & A.D. Poyser. Calton, Staffordshire.

Juste, J.B. 1996. Trade in the Gray Parrot *Psittacus erithacus* on the island of Principe (São Tomé and Principe, Central Africa): initial assessment of the activity and its impact. *Biological Conservation* 76: 101-104.

Kemp, A. C. 1974. The distribution and status of birds of Kruger National Park. *Koedoe* monogr. 2: 1-352.

Kuhl, 1820. *Consp. Psitt.*: 93 (Gambia).

Lippens, L. & Wille, H. 1976. *Les oiseaux du Zaïre.* Lanoo a Tielt. Brussels.

Low, R. 1982. Breeding the Cape Parrot. *Avicultural Magazine* 88: 1-11.

Low, R. 1995. Breeding the Cape Parrot at Palmitos Park. *Psittascene* 7(2): 10-12.

Maclean, G.L. 1993. *Roberts' birds of southern Africa.* John Voelcker. Cape Town.

Massa, R. 1998. A molecular approach to the taxonomy and biogeography of African parrots. In: Adams, N.J. & Slotow, R.H. (Eds) Proc.22 Int. Ornithol. Congr., Durban. *Ostrich* 69: 406.

Mountford, G. 1990. The desparate plight of the worlds parrots. *Psittascene* 2(1): 1.

Mulliken, T. 1994. South Africa - An important player in the exotic bird trade. *Africa - Environment and Wildlife* 2(4): 20-21.

Parker, V. 1999. *The atlas of the birds of Sul do Save, southern Mozambique.* Avian Demography Unit and Endangered Wildlife Trust. Cape Town and Johannesburg.

Penry, H. 1994. *Bird Atlas of Botswana.* University of Natal Press. Pietermaritzburg.

Perrin, M.R., Downs, C.T. & Symes, C.T. 1999. Final blows for the Cape Parrot? *Psittascene* 11(3): 12.

Perrin, M.R., McGowan, P., Downs, C.T., Symes, C.T. & Warburton, L. 2000. Africa. In: Snyder, N., McGowan, P., Gilardi, J. & Grajal, A. (eds). *Parrots. Status, survey and conservation action plan (2000-2004).* pp. 90-97, IUCN, Gland, Switzerland and Cambridge, UK.

Pinto, A.A. da Rosa. 1983. *Ornitologia de Angola.* Instituto de Investgacâo Científica Tropicale. Lisboa.

Reichenow, A.N.T. 1898. Bericht uber die Februar-Sitzung. *Journal fur Ornithologie* 46:314.

Rowan, M.K. 1983. *The doves, parrots, louries and cuckoos of southern Africa.* David Phillip. Cape Town.

Scholes, R.J. 1997. Savanna. In: Cowling, R.M., Richardson, D.M. & Pierce, S.M. *Vegetation of southern Africa.* Cambridge University Press. Cambridge.

Sclater, W.L. 1903. *The birds of South Africa Vol. III.* R.H. Porter. London.

Selman, R.G., Hunter, M.L. & Perrin, M.R. 2000. Rüppell's Parrot: status, ecology and conservation biology. *Ostrich* 71(1&2): 228-234.

Sharples, A. 1989. Breeding the Cape Parrot *Poicephalus robustus suahelicus. Watchbird* 6:52-54.

Skead, C.J. 1964. The overland flights and the feeding habits of the Cape Parrot, *Poicephalus robustus* (Gmelin) in the eastern Cape Province. *Ostrich* 25(1): 202-223.

Smithers, R.H.N., Irwin, M.P.S. & Paterson, M.L. 1957. *Checklist of the birds of Southern Rhodesia.* Rhodesian Ornithological Society.

Snow, D.W. (Ed.). 1978. *An atlas of speciation in African non-passerine birds.* British Museum (Natural History). London.

Snyder, N., McGowan, P., Gilardi, J. & Grajal, A. (eds). 2000. *Parrots. Status, survey and conservation action plan (2000-2004).* IUCN, Gland, Switzerland and Cambridge, UK.

Solms, L., Berruti, A., Perrin, M., Downs, C. & Bloomer, P. 2000. Phylogenetic relationships of the three subspecies of the Cape Parrot *Poicephalus robustus.* 17th Congress of the South African Genetics Congress. June 2000. Pretoria.

Swainson, W. 1837. On the natural history and classification of birds, vol. ii, p. 301. Green and Longman. London.

Symes, C.T & Downs, C.T 1998. The role of nest sites in population declines of the Cape Parrot. *Avizandum.* Sept 1998: 32-33.

Symes, C.T., Venter, S.M. & Perrin, M.R. 2000. Afromontane forest avifauna of the eastern Soutpansberg mountain range, Northern Province, South Africa. *S. Af. J. For. Res.* 189: 71-80.

Traylor, M.A. 1963. *Checklist of Angolan birds*. Publicações Culturais. Lisbon.

White, C. M. N. 1945. The ornithology of the Kaonde-Luanda Province, Northern Rhodesia. - Part III. - Systematic List (*cont.*). *Ibis* 87: 309-345.

White, C.M.N. 1965. *A revised checklist of African non-passerine birds*. Govt Printer. Lusaka.

Wilkinson, R. 1998. The conservation status of African Parrots: a review for the World Parrot Trust - Part 1. *Psittascene* 10(2): 6-9.

Wirminghaus, J.O. 1995. Colour variation and anomalies in South African parrots. *Birding in South Africa* 47: 76-77.

Wirminghaus, J.O. 1997. Cape Parrot *Poicephalus robustus*. In: Harrison, J.A., Allan, D.G., Underhill, L.L., Herremans, M., Tree, A.J., Parker, V. & Brown, C.J. (Eds). The atlas of southern African birds - Vol 1. Birdlife - South Africa. Johannesburg.

Wirminghaus, J.O., Downs, C.T., Symes, C.T. & Perrin, M.R. 1999. Conservation of the Cape parrot. *Poicephalus r. robustus* in southern Africa. *S. Afr. J. Wildl. Res.* 29(4): 118-129.

Wirminghaus, J.O., Downs, C.T., Symes, C.T. & Perrin, M.R. 2000a. Abundance of the Cape parrot in South Africa. *S. Afr. J. Wildl. Res.* 30(1): 43-52.

Wirminghaus, J.O., Downs, C.T., Symes, C.T., Dempster, E. & Perrin, M.R. 2000b. Vocalisations and behaviours of the Cape parrot *Poicephalus robustus* (Psittaciformes: Psittacidae). *Durban Museum Novitates* 25: 12-17.

Wirminghaus, J.O., Downs, C.T., Perrin, M.R. & Symes, C.T. 2001. Abundance and activity of the Cape Parrot *Poicephalus robustus* in afromontane forests in southern Africa. *African Zoology* 36(1): 71-77.

Wirminghaus, J.O., Downs, C.T., Symes, C.T. & Perrin, M.R. In press a. Taxonomic relationships of the subspecies of the Cape Parrot *Poicephalus robustus* (Gmelin). *J. Nat. Hist.*

Wirminghaus, J.O., Downs, C.T., Symes, C.T. & Perrin, M.R. In Press b. Diet of the Cape Parrot *Poicephalus robustus* in afromontane forests in KwaZulu-Natal, South Africa. *Ostrich.*

Wirminghaus, J.O., Downs, C.T., Symes, C.T. and Perrin, M.R. In press c. Breeding biology of the Cape Parrot *Poicephalus robustus. Ostrich.*

CHAPTER 2

Habitat, distribution and abundance of the Greyheaded Parrot *Poicephalus fuscicollis suahelicus*

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The Greyheaded Parrot *Poicephalus fuscicollis suahelicus* has a widespread distribution from the northern Northern Province of South Africa, southern Zimbabwe, northern Botswana and the Caprivi of northern Namibia, north through Southern and south Central Africa to south and north-western Tanzania, Rwanda, southern-western Uganda and south-eastern Democratic Republic of Congo. Although it is widespread in Africa, it is nowhere common. It is widely sympatric with members of the *P. meyeri* superspecies group and is recorded in different woodland habitat types throughout its range. This study conducted in north-eastern South Africa showed that habitat use varied seasonally between two study sites, Levubu and Makuya. Differences in habitat were reflected by tree species present within breeding and non-breeding regions of the Greyheaded Parrot. Vegetation structure (tree size; height and DBH) was similar between sites, yet tree density differed, being greater at Levubu than Makuya. Bird species communities were different between sites, reflecting changes in climate, range distributions of different species, altitude and vegetation composition. Density estimates for the non-breeding season (Levubu: 0.28 birds/100 ha.) were greater than the breeding season (Makuya; 0.14 birds/100 ha.). During the non-breeding season birds were more abundant.

Key words: **Greyheaded Parrot, *Poicephalus fuscicollis suahelicus*, distribution, habitat, vegetation, bird species abundance.**

INTRODUCTION

The Greyheaded Parrot *Poicephalus fuscicollis suahelicus*, has a widespread distribution from the northern Northern Province of South Africa, the Caprivi of Namibia and northern Botswana, north through Zimbabwe, western Mozambique, Angola, Zambia, Malawi, to south and north-western Tanzania, Rwanda, south-western Uganda and south-eastern Democratic Republic of Congo (DRC) (Snow 1978; Fry, Keith & Urban 1988; Forshaw 1989). It is widespread in Africa, where it is widely sympatric with members of the *P. meyeri* superspecies group (Snow 1978). However, details concerning distribution and habitat use are poorly known. Throughout most of its range it occurs in seasonal deciduous woodland and is partly allopatric with the other member of the *P. robustus* superspecies group, Jardine's Parrot *P. gulielmi* (Snow 1978).

A study was conducted in north-east South Africa to investigate the biology and conservation status of the Greyheaded Parrot. This study aimed to review and clarify the distribution of the Greyheaded Parrot with reference to literature on local distributions and habitat use within these distributions.

In the Levubu district (approximate region: 23° 00' - 23° 15' S, and 30° 05' - 30° 30' E) vegetation is dominated by mixed broad-leaved and fine-leaved savanna, with intensive agriculture practiced in particular regions (Scholes 1997). Riparian fringes occur along river courses (Scholes 1997). Rainfall in the region is seasonal, falling mostly in the summer (October – March). Temperatures are hot in summer, but cooler with increasing altitude in the mountains. Greyheaded Parrots were recorded here during the non-breeding season (Chapt. 3).

Greyheaded Parrots were recorded breeding in the Luvhuvhu-Mutale river confluence (approximate region: 22° 25' - 22° 35' S, and 30° 50' - 31 ° 05' E) area from April to September 2000 (Fig. 1; Chapt. 7). Altitude is low (*c* 150 - 350 m a.s.l) and vegetation variable from broadleaved woodland and riverine vegetation to mopane bushveld and mixed bushveld.

The closely related Cape Parrot *Poicephalus robustus* is a habitat specific species confined to mistbelt mixed *Podocarpus* forests in south-eastern South Africa yet has occasionally been observed feeding away from forest (Wirminghaus 1997; Wirminghaus, Downs, Symes & Perrin 1999; pers. obs.). The distribution of the Greyheaded Parrot covers a broad range of general habitat types yet is primarily associated with woodland (Wirminghaus 1997). It was hypothesized that the Greyheaded Parrot would make use of a variety of habitat types throughout its range, and unlike the Cape Parrot, would not be confined to a specific habitat type. However, overall distribution was predicted to be confined to woodland with an association with forest, where forests occur. Recording possible temporal population fluctuations would be difficult because of its widespread distribution, yet this was expected because of the widespread influence of human activities in Africa. It was predicted that although present day distribution may have changed very little, pressures such as habitat destruction and capture for the illegal trade have likely caused extinctions of local populations. The status within certain areas of its range was thus investigated.

The Cape Parrot has recently been described as a separate species to the Greyheaded Parrot with speciation being accounted for by the Forest Refugia Hypothesis (Wirminghaus 1997; Wirminghaus, Downs, Symes & Perrin In press). The evolutionary implications of this species within the *P. robustus* superspecies group are also discussed.

MATERIALS & METHODS

Distribution

Bird atlas data (Snow 1978; Lewis & Pomeroy 1989; Penry 1994; Wirminghaus 1997; Parker 1999; Carswell, Pomeroy, Reynolds & Tushube In press), museum skin collections and sighting records were consulted to interpret the present and historical distribution of the Greyheaded Parrot. The distribution of the Brown-necked Parrot *P. f. fuscicollis* was also considered with reference to published accounts of local distributions.

Vegetation

Two study sites in north-eastern South Africa were investigated (Fig.1). At Levubu and Makuya, where Greyheaded Parrots were recorded, two and three localities respectively were selected and vegetation sampling conducted. At each locality tree species were identified, tree height estimated and diameter at breast height (DBH) measured, 5 m each side of 50 m straight line transects.

Vegetation transects were conducted at Levubu in an area where Greyheaded Parrots were observed roosting, and where they have been observed feeding in the past (Fig. 1; Prinsloo's - locality 1; 23° 07.6' S, 30° 20.4' E; altitude *c* 620 m a.s.l.), and in thick secondary growth bush, approximately 12 km away, where feeding and socialising were observed (Fig. 1; Joubert's -

locality 2; 23° 04.3' S, 30° 14.0' E; altitude *c* 720 m a.s.l.).

At Makuya, vegetation transects were conducted nearby the Levubu river (Fig. 1; Horseshoe - locality 3; 22° 30.9' S, 31° 01.2' E; altitude *c* 300 m a.s.l.) where Greyheaded Parrots were observed breeding in the past, and approximately 6.5 km away, near the Mutale river (Fig. 1; Tshikuyu - locality 4; 22° 25.6' S, 30° 59.7' E; altitude *c* 350 m a.s.l.) where Greyheaded Parrots were observed feeding and socializing. An additional site (Fig. 1; Bileni - locality 5; 22° 27.0' S, 30° 56.2' E; altitude *c* 350 m a.s.l.) where a failed nesting attempt was observed was also sampled (Chapt. 6).

At Prinsloo's, Joubert's, Horseshoe, Tshikuyu and Bileni, 10, 3, 12, 12 and 5 transects were walked respectively during the respective study periods (Table 2). Analyses were completed using STATISTICA (StatSoft, Inc. 1995).

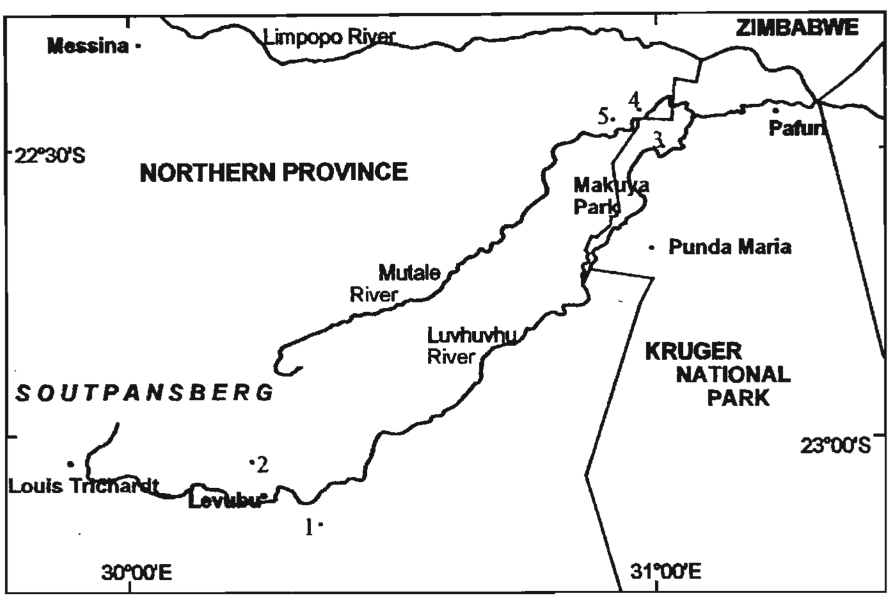

Figure 1. Study sites in north-east South Africa showing localities at each site (Site 1 - Levubu: locality 1 -Prinsloo's and locality 2 - Joubert's; Site 2 - Makuya: locality 3 - Horseshoe, locality 4 - Tshikuyu and locality 5 - Bileni).

Bird community sampling

Bird communities were investigated at each study site. At localities 1 - 4, a single 300 m transect was walked 16 times each month. Transects were walked from October to December at Levubu and from May to July at Makuya. Each day was divided into four time periods (before 09h00, 09h01 - 12h00, 12h01 - 15h00, after 15h00). Four transects were walked for 30 min at undetermined times during each time period to account for temporal variation in different activity patterns of various bird species. The same time period was walked only once in a day and transects were surveyed in both directions. Presence of all bird species were recorded visually and audibly. Relative abundance of each bird species was calculated by determining the proportion of transects each species was recorded in as a fraction of the total number of transects walked in each month (i.e. 16 transects/month). Taxonomy follows Maclean (1994).

Bray-Curtis Complete Link analysis was used to compare monthly bird species communities at each site using BioDiversityPro (McAleece, Lambshead, Paterson & Gage 1997).

Cape Parrots are reported to occur in the Afromontane forest of the Soutpansberg (Barnes & Tarboton 1998). The presence/absence of Greyheaded and/or Cape Parrots, and other forest utilizing bird species was investigated (Symes, Venter & Perrin 2000).

Abundance

Abundance was estimated at Levubu and Makuya. The maximum number of birds for each area was estimated from daily flock sightings at each study site (Chapt. 4). The area of each study site was calculated from 1:50 000 maps of the area.

RESULTS AND DISCUSSION

Distribution

The general distribution of the Greyheaded Parrot is summarized according to the localities of study skins in museum collections (Wirminghaus *et al.* In press), atlas records where such projects are in progress or are completed, published records of sighting observations, and various communications with birders in Africa (Fig. 2). Lack of recent data for Mozambique north of the Save River, the eastern and southern DRC, Burundi and Rwanda required inferences on distribution to be made. Additional information in Angola is required to confirm the continuous distribution of *P. f. suahelicus* there. This information has been generalized on a broad scale and is not correlated with general habitat types in each area. Therefore, althoughAtlas records may reveal QDS where the species does not occur, the distribution map will portray its presence.

Distribution and habitat of *P. f. suahelicus*

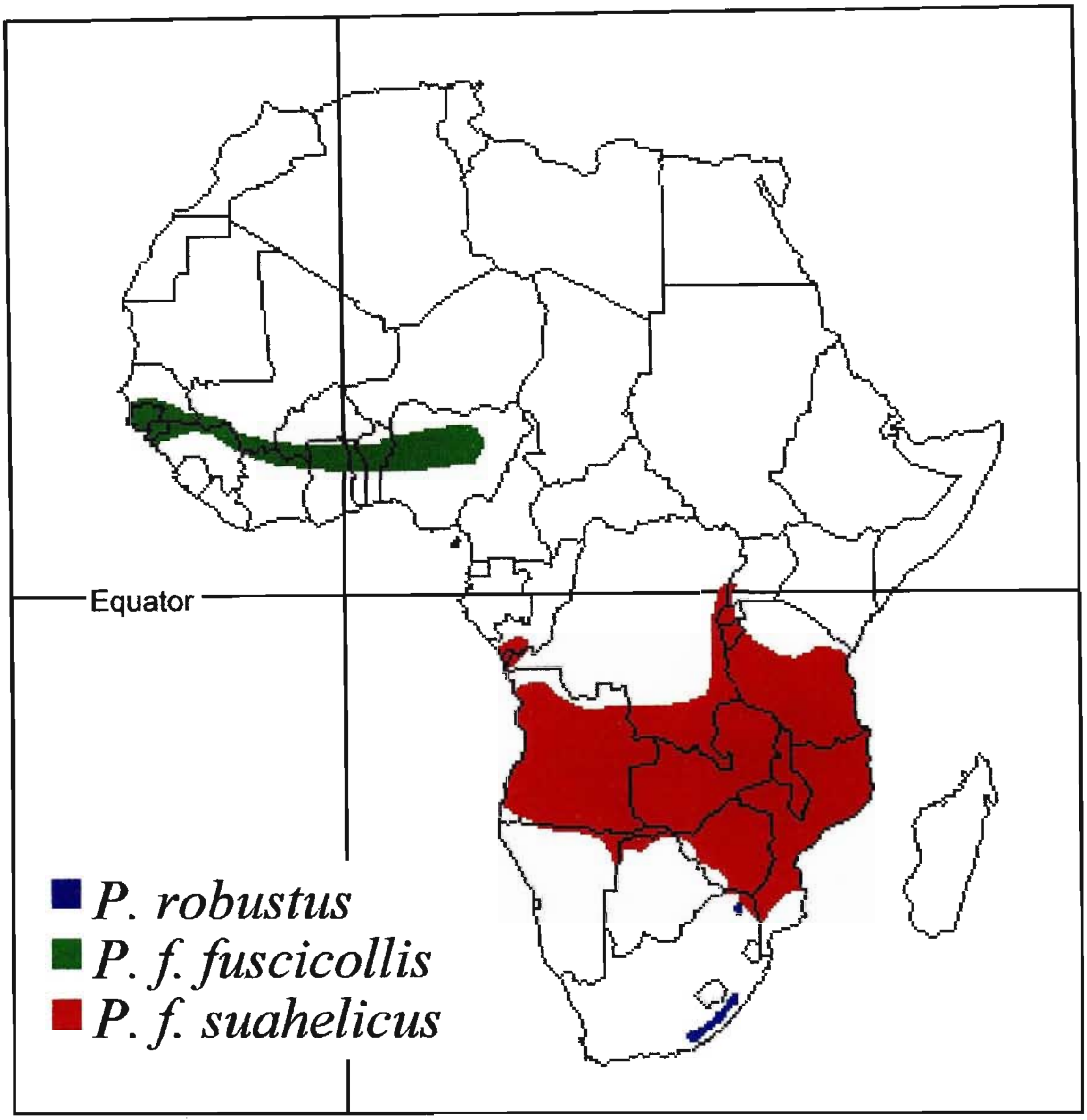

Figure 2. General distribution of the Greyheaded Parrot as determined from literature records.

The southern distribution limit of the Greyheaded Parrot occurs in Northern Province, South Africa (Wirminghaus 1997). In the Kruger National Park (KNP) it is restricted to the north where it is uncommon and most frequently seen in riparian vegetation (Kemp 1974; Wirminghaus 1997). Vagrant sightings have been recorded south at the University of the North, Pietersberg (23° 53' S, 29° 46 ' E) (D. Engelbrecht pers. comm.), Satara (KNP) (23° 55' S, 30° 46' E) in late-May 1999 (C. Burne pers. comm.) and Skukuza (KNP) (24° 59' S, 30° 36' E) (A. Kemp pers. comm.). However, Kemp (1974) considers records at Klopperfontein (22° 38' S, 31° 10' E) and Punda Maria (22° 42' S, 31° 01' E) as vagrants (Fig. 1). During late winter to summer (July - February) movements of birds are recorded into the Levubu region (23° 00' - 23° 15' S, and 30° 05' - 30° 30' E) south of the Soutpansberg (various pers. comm.). Birds in the Levubu region are thought to originate from the northern Kruger National Park, moving up the Levubu and Mutale Rivers, in what is thought of as post breeding dispersal (Chapt. 3). It is this post-breeding movement that is likely responsible for the occurrence of seasonal, out of range, sightings. In the Levubu region Greyheaded Parrots were never seen west of Albasini Dam (30° 08' E) (various pers. comm.). They were once seen flying south-east over Shamrock farm (23° 04' 15" S, 30° 11' 17" E), a position north-east of Albasini Dam.

Ha-Mashau (*c* 23° 09' S, 30° 11' E; alt. 1 113 m a.s.l.) forms the northern termination of obvious mountains of the Drakensberg escarpment. The escarpment mountains then form a continuation of mountains with Luonde (23° 04.5' S, 30° 07' E; alt. 1 426 m a.s.l.) of the geologically distinct Soutpansberg mountain range. This barrier, between Levubu and Louis Trichardt, forms a significant rainshadow causing rainfall to decrease to the west. As a result, a marked change in vegetation structure occurs (A. Bester, L. van Schaik pers. comm.). Any further movement of Greyheaded Parrots up the Levubu River, towards Louis Trichardt, is therefore restricted by this change.

The Cape Parrot occurs in the Woodbush/Wolkberg forests (*c* 23° 30' - 24° 30' S and 29° 30' - 30° 30' E) near Tzaneen and Haenertsberg, Northern Province (Wirminghaus 1997; Barnes & Tarboton 1998; Downs 2000; K. Newman, J-M Van den Berg pers. comm.). This relict population, approximately 700 km from the core population in the south, is thought to extend its range into the Soutpansberg where an estimated 50 - 120 birds are thought to remain (Wirminghaus 1997; Barnes & Tarboton 1998). In the recent Red Data Book (Barnes 2000) the separation between *P. robustus* and *P. fuscicollis* (not *P. suahelicus* as indicated) is obscure (Downs 2000). Quarter Degree Squares (QDS) 2330AA Ratombo, 2330AB Levubu, 2330CD Thohoyandou and 2330DC Gravelotte indicated as *P. robustus* are likely *P. fuscicollis suahelicus* (Downs 2001). In this study Greyheaded Parrots were recorded in the former three squares. Also, Cape Parrots were noted as absent from afromontane forests in these squares (Symes, Venter & Perrin 2000; A. Bester pers. comm.). *P. robustus* is indicated as occurring in QDS 2330DC Gravelotte where forest does not occur (Downs 2000). The Cape Parrot is therefore restricted to QDS 2330CA Duiwelskloof, 2330CC Tzaneen, 2430AA The Downs and 2329DD Haenertsburg where afromontane forests of the Drakensberg escarpment occur (K. Newman, J-M Van den Berg pers. comm.). Any appearance of an overlap is therefore superficial and a distinct separation occurs as a result of different habitat requirements (this study). Cape Parrots are reliant on yellowwoods *Podocarpus* spp., which are absent to scarce in forests of the eastern Soutpansberg

(Symes *et al.* 2000). The presence of 10 - 15 Cape Parrots in Soutpansberg is therefore questioned (Barnes & Tarboton 1998). However, the presence of Cape Parrots in the forests of the western Soutpansberg, where *Podocarpus* spp. are more common, remains to be investigated.

In Mozambique the Greyheaded Parrot has a scattered distribution, confined to the west and occurring extralimitally on the littoral (Clancey 1996; Parker 1999). It occurs in small parties in forest and thick *Brachystegia* woodland (Clancey 1996) and open woodland (Irwin 1956). It was recorded in 4.3 % of Atlas squares south of the Save River (Parker 1999). Here it is an uncommon resident of tall mixed woodland, especially where Baobabs *Adansonia digitata* are common (Parker 1999). Legal and illegal capture of parrots, especially Brownheaded Parrots *Poicephalus cryptoxanthus*, is high in Mozambique and is likely to impact wild populations (Parker 1999). In the south and south-east its distribution is possibly restricted by habitat (Parker 1999).

In Botswana the Greyheaded Parrot is a sparse to uncommon resident of the extreme north, occurring in mature and undisturbed *Baikiaea* woodlands (Penry 1994). In the Chobe it was recorded breeding during 2000 yet is very uncommon here (R. Randall pers. comm.). Its occurrence further south is limited by arid habitats in which it is not regularly found (Wirminghaus 1997). It may, however, wander into Okavango vegetation (Wirminghaus 1997). It occurs in the Caprivi (Koen 1988; Wirminghaus 1997) and small flocks (1 - 4) were recorded on the Kavango River (18° 15' S, 21° 45' E) in April 1999 (pers. obs.). It has also been recorded breeding in Kaudom Park, Namibia (18° 30' S, 20° 50' E) with flocks of up to seven birds drinking at a waterhole at the main camp (P. Lane pers. comm.). This is likely the southern limit of the Greyheaded Parrot in Namibia.

In Zimbabwe it is widespread, yet uncommon, in woodlands along major river courses and scarce above 1000 m a.s.l. (Irwin 1981). It is found outside the *Brachystegia* belt and within the belt is not confined to it (Benson & Irwin 1966). Throughout this woodland it is noted to wander widely (Smithers, Irwin & Paterson 1957). Swynnerton (1907) found it at Mount Selinda (20° 14' S, 32° 26' E), south-east Zimbabwe, in lowland forest, and Smith (1941) recorded it near the Inyanga Mountains, eastern Zimbabwe highlands. Greyheaded Parrots were observed leaving the forest in early morning, frequently flying "considerable distances", and returning at sunset to settle in the tallest lightning struck Khaya's *Khaya anthotheca* (Swynnerton in Priest 1934). Greyheaded Parrots were also recorded at Binge forest (*c* 20° 10' S, 32° 35' E), Chipinge, south-east Zimbabwe (Tree 1996). Although not strictly a forest bird this evidence suggests that in this region it utilizes forest, like that of its congeneric, the Cape Parrot. It also occurs in montane regions in Malawi (R. Dowsett pers. comm.).

In Zambia, where the Greyheaded Parrot is widely distributed (48 % of Atlas squares) (Aspinwall 1984), it is nowhere common (Winterbottom 1959; Benson, Brooke, Dowsett & Irwin 1971; Snow 1978; Leonard 1999). It is generally uncommon in woodlands up to about 2 000 m a.s.l. where woodland tree species provide seeds for food and cavities for nesting (Fry *et al.* 1988). Zambia is reported as one of its strongholds where it has a widespread distribution (Benson & Irwin 1967; D. Aspinwall pers. comm.). In the Leopardshill area (15° 30' S, 28° 30' E) of the Zambezi escarpment it is probably a visitor in the area in search of fruit, and is less common south in the escarpment (Tree 1962). Seasonal movements here are recorded and are noted as being more nomadic than those of other *Poicephalus* species (Aspinwall 1984). However, in the Isoka district of northern Zambia it is noted as "distinctly scarce" (Clay 1953).

In Malawi the Greyheaded Parrot is considered not uncommon, occurring singly or in pairs, in South Nyasa and Dedza districts (14° 30' S, 34° 00' E) at 500 - 700 m a.s.l. (Benson 1940; Benson & Benson 1977). It has been recorded at higher altitudes at Vipya (11° 55' S, 34° 00' E; 1 850 m a.s.l.) on the edge of open short grassland and Chinde (12° 00' S, 33° 30' E; 1 300 m a.s.l.), in Mzimba district where it is regarded as a wanderer (Benson 1942). Greyheaded Parrots were recorded there in March and April (Wood in Priest 1934) and breeding "probably falls at the end of the rains, in April and May", with cavities in baobabs being used (Priest 1934). In the low country south of Lake Malawi (Nyasa) it is noted as a resident with breeding occurring in January (Wilkes 1928).

In Angola it is widespread up to 1 500 m a.s.l. and occurs locally in small groups (du Bocage 1881; Traylor 1963; Pinto 1983). It has a scattered distribution from southern Huila (16° 20' S, 13° 40' E), Cuando, Cubango and Cunene (southern Angola), north to Benguela, northern Bie (12° 21' S, 16 ° 57' E), upper Cuango River and Cuanza Norte, where it is an uncommon resident in closed miombo woodland, riverine woodland and forest patches (Traylor 1963; Dean 1999). At Uige town (07° 36' S, 15° 02' E) and Dala Tando (09° 18' S, 14 ° 54' E) it is present in evergreen forest in August (Dean, Huntley, Huntley & Vernon 1988; Dean 1999). In the north its distribution is patchy (Dean 1999). Movements occur in response to fruit availability and it is found on forest edges to open areas of *Brachystegia* (Pinto 1983). However, the distribution of the Greyheaded Parrot in Angola is obscure and the validity of a separate population, as indicated by Juniper & Parr (1998), is questioned. Previous authors have recognized two subspecies within the population distributed from southern to south-central Africa (Reichnow 1898; Clancey 1965); *P. robustus angolensis* (Type from Quindumbo, Angola), confined to Angola and west of the range, and *P. robustus suahelicus*, occurring to the east (Reichnow 1898; Clancey 1965). This separation may be based on geographical variations and warrants further investigation.

In East Africa it is an uncommon resident of woodlands being patchily distributed in some regions (Britton 1980). It is not recorded in Kenya (Lewis & Pomeroy 1989) and in Tanzania it has a patchy distribution (Britton 1980) with 144 (0.04 %) Atlas records for the region (N. Baker pers. comm.). It is generally uncommon and localised in the southern half of Tanzania, being absent from the northern and north-central Masai/Somali biome of *Acacia-Commiphora* woodland (N. Baker pers. comm.). Huge losses (10 000 birds in five years) to the bird trade via South Africa as documented by TRAFFIC may have caused significant declines in wild populations (N. Baker pers. comm.).

Distribution data on the Greyheaded Parrot in the southern and south-eastern DRC are scarce. Here, the northern extension of the distributional range is likely restricted by tropical evergreen forest of the Congo basin, where *P. gulielmi gulielmi* is found (Snow 1978; Forshaw 1989). In the highlands of south-eastern Democratic Republic of Congo (DRC) it occurs in montane forest up to 2 200 - 4 000 m a.s.l. (Swynnerton 1907; Vincent 1934; Chapin 1939; Lippens & Wille 1976; Britton 1980). It has been recorded at Kibumba (01° 29' 13" S, 29° 20' 15" E), Kivu Province, between Lake Edward and Lake Kivu (T. Pederson pers. comm.) and has been collected from the highland near Baraka (*c* 04° S, 29° E) (Chapin 1939). Northwest of Baraka in the Kivu district (02° S, 27° E) it frequents the mountain forest, and was seen flying over at altitudes between 2 200 m a.s.l. and 4 000 m a.s.l. (Chapin 1939). This northern extension of its range occurs between the montane and temperate forest zones of East Africa where *P. gulielmi massaicus* occurs, and the evergreen tropical forests of central and west Africa where *P. gulielmi fantiensis* and *P. gulielmi gulielmi* occur (Snow 1978; Forshaw 1989). It was also seen in downtown Kinshasa (*c* 04° 15' S, 15° 20' E) in February 1995 (T. Pederson pers. comm.). However, these were possibly escapees.

In Uganda it has been collected at Kanungu in Kigezi (00° 54' S, 29° 47' E) (Britton 1980). It is found to be common in Bwindi Impenetrable Forest (*c* 00° 40' S, 29° 30' E; 2 300 m a.s.l.) (Rossouw & Sacchi 1998; Carswell *et al.* In press). It has not been recorded feeding in forest and possibly moves into surrounding woodland, savanna and more open forest of adjacent DRC to feed (Carswell *et al* In press).

Distribution of *P. f. fuscicollis*

The Brown-necked Parrot *P. f. fuscicollis* is confined to drier parts of west Africa, from Senegal to northern Nigeria, but is rare and local in the east of its range (Bannerman 1953, Elgood 1982; Forshaw 1989). It is more numerous in Gambia and Guinea Bissau where it keeps more to habitat where mangroves are abundant (Bannerman 1953). Cawkell & Moreau (1962) note that it is rarely seen in the Gambia and that numbers have decreased since it was recorded there. Large flocks gathering may also occur with a flock of 24 recorded in one tree in Dankunku, Gambia, in September (Cawkell 1965). Gore (1981) notes the Brown-necked Parrot as being a scarce local resident, found mainly in the belt of high mangrove *Rhizophora*, and rarely in high open woodland far from the river. It is a seasonal visitor to the northern regions of Ghana where it was observed during daily feeding movements in Mole National Park (D. Moyer pers. comm.).

In Ivory Coast it is mainly restricted to *Borassus* Palm, southern Guinea savanna, from Sipilou to Lamto (near Ndouli) and Bougouanou, being scarce in northern savannas (Thiollay 1985). It is also recorded in Togo and Northern Territories of Ghana (Chapin 1939; Mackwort-Praed & Grant 1970; D. Moyer pers. comm.). It is considered rare and local in savanna woodlands, possibly a casual visitor to Plateau Province in April and May and to Jos (09° 56' N, 08° 53' E) and Aliya (11° 10' N, 10° 55' E), central Nigeria, in November and December (Elgood 1982). It was collected in Gunnal (12° 38' N, 09° 21' E), Nigeria, in 1910 (C.T. Downs unpubl. data.). Presently, very little data exist for these regions on the distribution of *P. f. fuscicollis*.

In west Central Africa the Brown-necked Parrot is thought to occur to Cabinda (*c* 05° S, 03° E) where it is an uncommon resident in forest (Chapin 1939; Pinto 1983; Dean 1999). From here it occurs north to Gabon and lower Congo (White 1965). This relict population, identified as *P. fuscicollis fuscicollis* is questioned and birds along the lower Congo River, in north-western Angola may be intermediate between *P. f. fuscicollis* and *P. f. suahelicus* (White 1945; Dean 1999). This southern limit of *P. f. fuscicollis* therefore appears doubtful (Chapin 1939).

The taxonomic status of the Greyheaded Parrot is obscure and requires further investigation with regards distribution at the sub-species level.

Vegetation

At Makuya, vegetation was dominated by Mopane *Calophospermum mopane*, whereas at Levubu this species did not occur (Table 1). At Levubu, although Mabola Plum *Parinari curatellifolia* was not dominant overall, it was dominant at one site i.e. Joubert's. It was found to occur in moister areas north of the Levubu river and west of Levubu town (pers. obs.). This included at higher altitudes in the Soutpansberg where it was found, but was not fruiting. *P. curatellifolia* was the predominant food source in the area and observations indicate a patchy distribution (Chapt. 5). Baobabs *Adansonia digitata* were not common in Makuya yet were important in providing nesting sites for Greyheaded Parrots in the area (Chapt. 6). Baobabs were not observed in Levubu except for two garden trees (both DBH < 100 cm) (Chapt. 6).

Table 1. Abundance of respective tree species at different localities at Levubu and Makuya study sites. Three most abundant species at each locality and at each site are highlighted. (* indicates tree species recorded in diet of the Greyheaded Parrot) (see Fig. 3 for associated dendrogram).

Scientific name	Common name	T'kuyu	H'shoe	Bileni	**Makuya**	Prinsloo	Joubert	**Levubu**
Calophospermum mopane	Mopane	48.9	57.3	46.3	**52.2**	-	-	-
Androstachys johnsonii	Lebombo Ironwood	1.5	-	10.8	**2.3**	-	-	-
Combretum spp. *	combretum species	17.8	14.0	12.8	**15.4**	12.5	-	**10.4**
Commiphora spp. *	corkwood species	3.8	1.4	6.9	**3.2**	5.1	-	**4.2**
-	other species	18.0	19.5	15.8	**18.3**	13.4	18.6	**14.3**
Acacia spp.	acacia species	2.7	1.8	-	**1.9**	4.9	3.2	**4.7**
-	creeper/climber	0.2	-	-	**0.1**	-	18.6	**3.1**
-	snag	0.6	1.1	1.5	**0.7**	0.3	2.6	**0.6**
Sclerocarya birrea *	Marula	1.9	-	1.5	**1.0**	0.4	-	**0.3**
Dichrostachys cinerea	Sickle Bush	4.0	-	2.0	**1.9**	20.3	-	**16.9**
Terminalia prunioides *	Lowveld Cluster-leaf	0.8	4.6	1.5	**2.5**	-	-	-
Adansonia digitata *	Baobab	-	0.4	1.0	**0.3**	-	-	-
Terminalia sericea	Silver Cluster-leaf	-	-	-	-	26.4	-	**22.0**
Crossopteryx febrifuga	Sand Crown-berry	-	-	-	-	6.1	-	**5.1**
Pseudostachnostylis maprouneifolia *	Kudu Berry	-	-	-	-	2.6	-	**2.2**
Burkea africana	Wild Seringa	-	-	-	-	4.7	-	**3.9**
Pterocarpus spp.	teak species	-	-	-	-	2.6	-	**2.2**
Diospyros mespilliformis *	Jackal Berry	-	-	-	-	0.5	-	**0.4**
Ficus spp. *	wild fig species	-	-	-	-	0.1	3.8	**0.8**
Celtis africana	White Stinkwood	-	-	-	-	-	11.5	**1.9**
Bridelia micrantha	Mitseeri	-	-	-	-	-	9.0	**1.5**
Paranari curatellifolia *	Mabola Plum	-	-	-	-	-	32.7	**5.5**

Similarity of localities, using Euclidean Distances Complete Linkage Analysis (StatSoft, Inc.

1995), based on tree species abundance (Table 1) are represented in Figure 3.

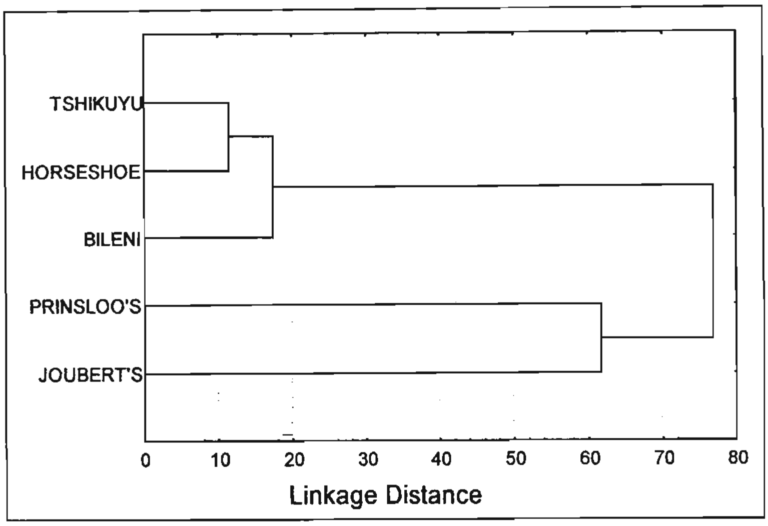

Figure 3. Complete linkage dendrogram (Euclidean distances) reflecting similarity of respective study sites based on abundance of plant species present.

Two clear vegetation groupings were identified with the breeding area vegetation separated from the non-breeding area vegetation based on abundance of tree species identified at each locality (Fig. 3). Less similarity between Prinsloo's and Joubert's may be biased by the inclusion and weighting of "other species" which were quite different between localities (pers. obs.). At both sites "other species" formed a major component of the tree species identified. At Levubu "other species" identified include Quinine tree *Rauvolfia caffra*, Natal Forest Cabbage tree *Cussonia sphaerocephala*, raisin/cross-berry species *Grewia* spp., *Entada spicata*, Syringa *Melia azaderach* (exotic) and Guava *Psidium guajava* (exotic) at Joubert's, whereas at Prinsloo's other species identified included *Grewia* spp., Common Bush-cherry *Maerua cafra*, Cork bush *Mundelea sericea*, Forest Num-num *Carissa bispinosa*, Magic Guarri *Euclea divinorum*, Common Wild Pear *Dombeya rotundifolia*, Apple-leaf *Lonchocarpus capassa* and *Cordia* spp. These were similar to "other species" identified at Makuya. At Tshikuyu "other species" included Common Star-chestnut *Sterculia rogersi*, *Grewia* spp., *Rhigozum* spp., False Marula *Lannea schweinfurthii* and sourplum species *Ximenia* spp., and at Horseshoe other species identified include *Grewia* spp., *Boscia* spp. (*albitrunca*, *foetida* and *angustifolia)*, *Rhigozum* spp., gardenia species *Rothmania* spp. and bitterberry species *Strychnos* spp. At Bileni "other species" identified include *Grewia* spp., *Rhigozum* spp., Sausage tree *Kigelia africana* and *Lannea schweinfurthii*.

Vegetation height differed between localities (Table 2; ANOVA, df = 4, F = 90.963, P

< 0.05) and between localities at each site (Table 2; ANOVA, Makuya: df = 2, $F = 60.778$, $P <$ 0.05; Levubu: df = 1, $F = 238.42$, $P < 0.05$). However, overall vegetation height between Levubu and Makuya did not differ significantly (Table 2; ANOVA, df = 1, $F = 0.0012$, $P > 0.05$).

DBH of trees > 2 m differed between localities (Table 2; ANOVA, df = 4, $F = 40.840$, $P < 0.05$) as well as between localities at each site (Table 2; ANOVA, Makuya: df = 2, $F =$ 18.359, $P < 0.05$; Levubu: df = 1 $F = 139.77$, $P < 0.05$). Also, overall DBH of trees between sites differed significantly (Table 2; ANOVA, df = 1, $F = 16.617$, $P < 0.05$).

Similarity of sites based on height classes (Fig. 4a) and DBH classes (Fig. 4b) for trees > 2 m recorded in vegetation transects were calculated using Euclidean Distances Complete Linkage Analyses (StatSoft, Inc. 1995). The differences between localities based on height and DBH classes are reflected in the resultant dendrograms (Figs. 4a & 4b).

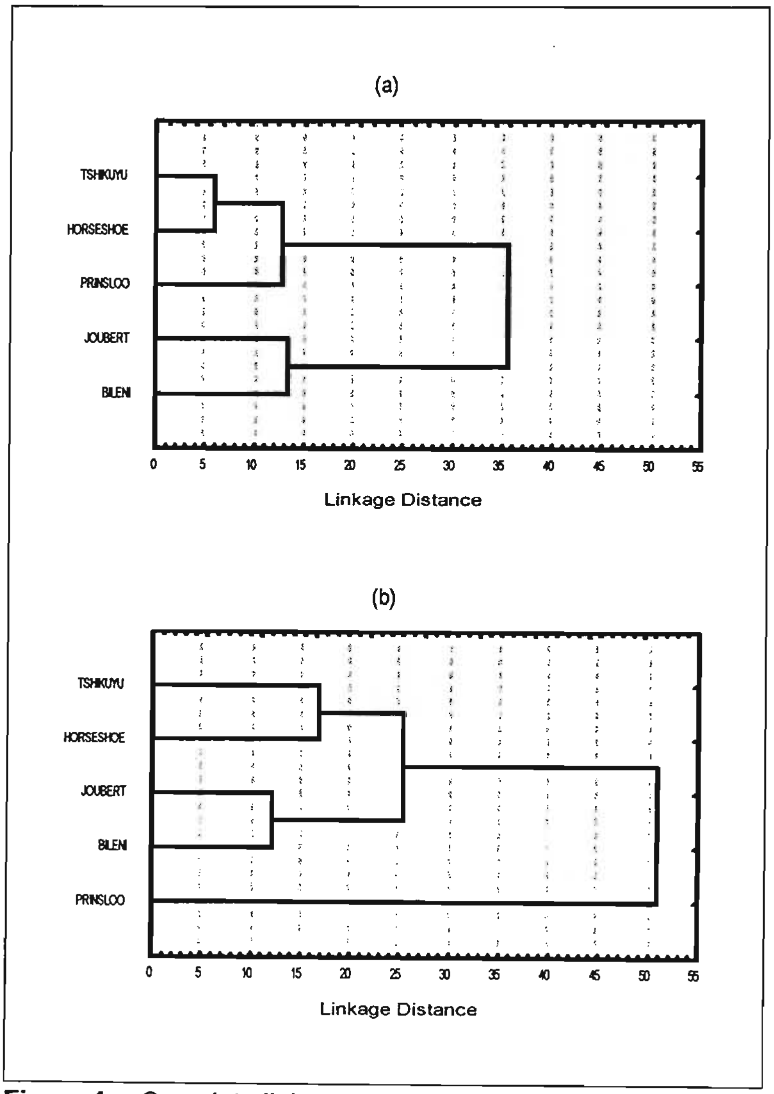

Figure 4 a. Complete linkage dendrogram (Euclidean distances) reflecting similarity of respective study sites based on proportion of trees represented in each height class (2 m height classes beginning at 2 m), and, **b.** proportion of trees sampled in each

Table 2. Summary of vegetation recorded at different localities at Levubu and Makuya. Figures given as mean ± S.E. Percentage trees with multistemming present given in parentheses.

	Site	Trees sampled	Area sampled (ha)	Density (trees. ha^{-1})	Mean ht (m ± s.e.)		Mean DBH (cm ± s.e.)		No. of multistemming trees	
Makuya	Tshikuyu	528	0.60	880	4.3 ± 0.1		8.2 ± 0.3		213 (40.3)	
	Horseshoe	565	0.60	942	4.0 ± 0.1	**4.4 ± 0.1**	9.0 ± 0.3	**9.4 ± 0.3**	250 (44.2)	**505 (39.0)**
	Bileni	203	0.25	812	5.9 ± 0.2		13.5 ± 1.5		42 (20.7)	
Levubu	Prinsloo	768	0.50	1 536	3.9 ± 0.1	**4.4 ± 0.1**	6.2 ± 0.2	**7.7 ± 0.3**	214 (27.9)	**220 (23.8)**
	Joubert	156	0.15	1 040	6.9 ± 0.3		14.7 ± 1.1		6 (3.8)	
		2220	2.10	1 057	4.4 ± 0.1		8.6 ± 0.2		725 (32.7%)	

Although the Greyheaded Parrot is generally a woodland species (Snow 1978) the difference in vegetation types sampled in the study reflects the difference in types of habitat used by Greyheaded Parrots. Seasonal occurrence in different habitats reflect seasonal food availability (Chapt. 3).

In this study Greyheaded Parrots were seen feeding in Mopane woodland, mixed broadleafed woodland, disturbed secondary growth forest and gardens. The predominant species identified in vegetation transects was mopane, yet Greyheaded Parrots were seldom seen in mopane trees. In Levubu the Greyheaded Parrot is reliant on *P. curatellifolia*, and despite major anthropogenic alteration to habitat through agricultural development still occurs in the area. Feeding on other fruit in the area does occur (Chapt. 4). When land clearing occurs, large *P. curatellifolia* are often left standing. The fruit is fed on by humans and the wood is difficult to cut (van Wyk & van Wyk 1997). In Makuya, wood removal outside of protected areas may have affected Greyheaded Parrot distribution and movements by the removal of large tree species.

In Zimbabwe, the Greyheaded Parrot has been described as using woodland and occurs in woodland following major river courses (Benson & Irwin 1966; Irwin 1981). In Zambia it is a bird of *Brachystegia* woodland, although is not confined to it (Benson & Irwin 1966). In South Africa, Bird Atlas records reflect habitat in which sightings were made (Wirminghaus 1997). Highest vegetation types reported include Mopane (6.9 %), Miombo (5.6 %), Valley Bushveld (2.4 %) and Moist Woodland (Wirminghaus 1997). In Mozambique it was not encountered in

Mopane and association with this habitat may have arisen from its occurrence in woodland types overlapping with Mopane (Parker 1999). Also, it may have been recorded in vegetation types that it was seen flying over on long distance, early morning feeding forays and late afternoon returns to roosts (Chapt. 3). Additional references to habitat throughout the range of the Greyheaded Parrot are suggested previously. Greyheaded Parrots therefore make use of a variety of defined habitat types within the woodland-savanna biome region of southern, south Central and East Africa (Snow 1978; Forshaw 1989). The range of the Greyheaded Parrot overlaps with several general habitat types of open woodland with mopane and baobab, *Brachystegia* woodland on Kalahari sand, open woodland with *Brachystegia*, *Acacia* and *Isoberlinia*, forest savanna mosaic, *Baikiaea* dry forest and moist woodland (Cooke 1962). Its exclusion from moist evergreen forest of tropical Africa, when observing distribution maps, is noted, and it is in this habitat that Jardine's Parrot occurs (Snow 1978; Forshaw 1989).

The number of stems on multistemming trees differed significantly between localities (Table 2; ANOVA, df = 4, $F = 17.396$, $P < 0.05$) and between localities at Makuya (Table 2; ANOVA, df = 2, $F = 12.055$, $P < 0.05$). However, there was no difference in the number of stems per multistemming tree between localities at Levubu (Table 2; ANOVA, df = 1, $F = 0.161$, $P > 0.05$). Between sites the number of stems per multistemming tree differed significantly (Table 2; ANOVA, df = 1, $F = 39.453$, $P < 0.05$).

Multistemming is likely a response to disturbance conferring advantages to trees exposed to damage, e.g. coppicing as a result of tree felling (Johnston & Lacey 1983). At Horseshoe this response is possibly a result of large herbivore damage, i.e. African elephant *Loxodonta africana*, and at Tshikuyu a response to tree felling by local communities. At Levubu, multistemming was significantly lower, a response to lower levels of recent disturbance. Tree felling may in turn affect tree height and overall community structure and composition. These effects may have consequences on the distribution of Greyheaded Parrots in the region, because Greyheaded Parrots prefer large trees for socializing and feeding.

Bird communities

Two hundred bird species were identified at both study sites with 63 species (31.5 %) common to both sites (Appendix 1). Including bird species identified out of transects, 97, 103, 113 (20 migrants) and 90 (14 migrants) were recorded at Horseshoe, Tshikuyu, Prinsloo's and Joubert's respectively. Many more species were recorded at Makuya despite sampling occurring here when migrants were absent. Twenty-four migrant species were observed at Levubu and none at Makuya during the study period. Klaas's Cuckoo *Chrysococcyx klaas*, a species considered a migrant species further south was observed at Makuya (Kemp 1974). Species lists are given in Appendix 1 and include species recorded at each site when not walking transects for a particular month. Relative abundance of each species is represented by the number of transects the respective species were recorded in each month at each locality (Appendix 1). Bird species recorded while not conducting transects are also presented. At Horseshoe, Tshikuyu, Prinsloo's and Joubert's, 11, 10, 16 (1 migrant species) and 17 species respectively were recorded in more than 50 % of transects at each locality (Appendix 1). Twenty-three species (Hamerkop, African Goshawk, Redeyed Dove, Greenspotted Dove, Green Pigeon, Greyheaded Parrot, Purplecrested Lourie, Burchell's Coucal, Redfaced Mousebird, Brownhooded Kingfisher, Striped Kingfisher, Blackcollared Barbet, Goldentailed Woodpecker, Blackheaded Oriole, Blackeyed Bulbul, Yellowbellied Bulbul, Puffback, Kurrichane Thrush, Whitebrowed Robin, Yellowbreasted Apalis, Orangebreasted Bush Shrike, Whitebellied Sunbird and Yelloweyed Canary) were recorded at all localities. Seventy eight, 70 and 31 species were identified at one, two and three localities respectively (Appendix 1).

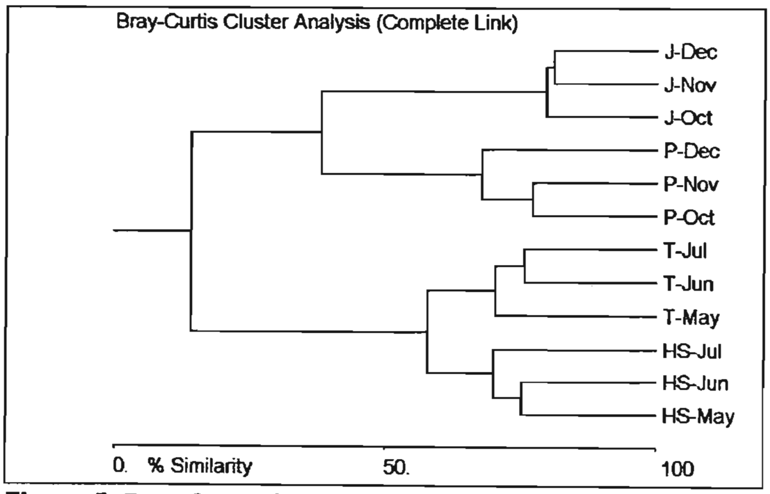

Figure 5. Bray-Curtis Complete Link Cluster analysis reflecting similarity of respective study sites based on relative abundance of all bird species recorded each month. Abundance indices calculated as a proportion of transects in which each species was recorded each month. J - Joubert's, P - Prinsloo's, T - Tshikuyu and HS - Horseshoe.

Intersite similarity based on relative abundance indices for each site per month for the period of sampling is represented in Figure 5 using Bray-Curtis Complete Link Cluster Analysis (McAleece 1997). There was a significant difference between all localities when comparisons were made comparing relative abundance indices of bird species recorded in transects (2-way ANOVA; df = 3, $F = 7.105$, $P < 0.05$). However, at each site there was no overall difference between localities in birds species recorded (2-way ANOVA; Levubu: df = 1, $F = 1.138$, $P > 0.05$; Makuya: df = 1, $F = 0.002$, $P > 0.05$). At each site there was also no difference between months for bird species recorded (2-way ANOVA; Levubu: df = 2, $F = 1.934$, $P > 0.05$; Makuya: df = 2, $F = 0.621$, $P > 0.05$). Differences in bird species composition are a function of the different habitats and different seasons and are not corrected for here.

Bird species are good indicators of habitat type and condition (Capen 1981). Bird species communities occurring with Greyheaded Parrots differed at each study site. These communities reflect vegetation structure and composition. Large cavity nesting species were absent from Levubu, indicating poorer breeding habitat for Greyheaded Parrots there (Appendix 1; Chapt. 7). Species recorded at all localities are generally common species with widespread distributional ranges, with those confined to fewer localities indicating habitat preference or greater rarity. Both study sites are regions of sympatry for a number of related species. For example Greenbacked Warbler *Camaroptera brachyura* was recorded at Levubu, where it was more common in thicker forest vegetation at Joubert's than woodland at Prinsloo's, and Greybacked Warbler *Camaroptera brevicaudata* at Makuya. Barred Warbler *Camaroptera fasciolata* and Stierlings Barred Warbler *Camaroptera stierlingi* were recorded in sympatry at Levubu while only Barred Warbler was recorded at Makuya. Similarly the Southern Boubou *Laniarius ferrigineus* was recorded at Levubu while the Tropical Boubou *Laniarius aethiopicus* was recorded at Makuya.

The 23 species identified common to both sites are indicative of habitat type and not necessarily habitat condition (Parker 1999). However, Levubu was depauperate of large cavity nesting species, indicating poor breeding habitat for Greyheaded Parrots. Therefore, in establishing the likelihood of Greyheaded Parrots breeding in an area, censussing bird species can be used to assess habitat quality.

The study region appears as a transition zone for species falling out in a southerly direction, with the Limpopo River described as a barrier for the distribution of a number of woodland species extending their ranges from the north (Clancey 1994). Also, this region forms the northern distributional limits for a number of species utilizing forest (Clancey 1994; Symes, Venter & Perrin 2000). The Limpopo has been described as an area where the south-eastern range of Meyer's Parrot *P. meyeri* terminates (Clancey 1994). The Brownheaded Parrot *P. cryptoxanthus* occurs on the eastern littoral with a transition zone between *P. meyeri* and *P. cryptoxanthus* where hybrids are known to occur (Clancey 1977). In this study these species were recorded at localities contrary to where they were expected to occur (Appendix 1). This region may therefore be an area of sympatry where hybrids occur, as suggested by Clancey (1977). Hybrids between *P. robustus* and *P. fuscicollis* are known to occur in captivity (W. Horsfield pers. comm.) but are unlikely in the wild because of different habitat requirements for each species.

Species misidentification may have occurred with certain bird species but the data are supported by bird ringing at each site that helped positively identify the presence of specific species, and record species not detected audibly.

Similar species, with densities >10 birds/100 ha., as recorded by Parker (1999) for *Acacia*, Miombo, Mopane and other broadleaved woodland were recorded in this study. These species include Blue Waxbill, Rattling Cisticola Blackeyed Bulbul, White Helmetshrike, Cape Turtle Dove, Forktailed Drongo, Puffback Shrike, Blackheaded Oriole, Whitebrowed Robin and Greenspotted Dove (see Parker 1999, pp. xix for detailed list of density estimates). A decline in density estimates was recorded in late winter (Jul - Aug) with a peak coinciding with breeding (Sep - Oct) (Parker 1999). In this study abundance indices similarly reflected an increase in activity during the spring and summer, and breeding months for most species at Levubu (Benson 1963; Dean 1971).

Abundance

At Levubu a maximum number of 50 Greyheaded Parrots was accounted for in an estimated area of 18 000 ha. At Makuya a maximum number of 20 birds was estimated for a study area of 14 300 ha. This gives density estimates of 0.28 and 0.14 birds/100 ha. for Levubu and Makuya respectively. These figures reflect differences in flocking behaviour (Chapt. 4). This flocking and the seasonal occurrence of birds in particular areas makes populations estimates difficult.

Various techniques have been used to estimate parrot population size (Gnam & Burchsted 1991; Casagrande & Beissinger 1997; Marsden 1999). Parrot populations are difficult to estimate because birds may fly long distances between nesting, roosting and feeding areas, inhabit dense forests where visibility is poor and are difficult to locate when perched because of cryptic colouration (Chapman, Chapman & Wrangham 1993; Casagrande & Beissinger 1997; Gilardi & Munn 1998). Also, monitoring nests high in trees, and catching and marking techniques are difficult (Chapman *et al.* 1993; Casagrande & Beissinger 1997). Estimation of Cape Parrot population size has proved difficult using traditional methods because birds are found in a naturally fragmented landscape, move between forest patches and have a strict bimodal activity pattern, flock at unpredictable times of the year and population numbers are low (Downs & Symes 1998; Wirminghaus, Downs, Perrin & Symes 2001; C.J. Skead pers. comm.). However, Greyheaded Parrots almost always call in flight and are vocal, especially in the early morning and late afternoon (Chapt. 4). This was used advantageously in the study to locate Greyheaded Parrots. As a result, attempts were made to cover as large an area as possible during a single day, and count all individuals (Downs & Symes 1998; Downs 2001).

Evolutionary implications

The Ethiopian region is depauperate of parrot species. Eighteen species are endemic to Africa, of which ten belong to the genus *Poicephalus* (Forshaw 1989; Wirminghaus *et al.* In press). Five of these are large, being closely related, with a recent ancestor possibly within the last 20 000 years (Massa 1998). The Greyheaded Parrot can generally be described as a woodland species while the Cape Parrot, its closest relative is confined to Afromontane forests in South Africa (Wirminghaus, Downs, Symes & Perrin 2000; Wirminghaus *et al.* In press). Their separation is thought to have occurred as a result of speciation events associated with periods of aridity and fragmentation of forest or savanna habitats (Massa 1998). A major shift in vegetation occurred between 9 500 - 12 500 BP resulting in an advancement of forest vegetation (Hamilton 1974; Livingstone 1975). During the last dry period, when grasslands were more extensive, woodland habitat would have effectively been reduced north with an encroachment of desert and sub-desert and grassland from the south (Livingstone 1975; Diamond & Hamilton 1980; Crowe & Crowe 1982). This reduction in woodland and forest through Africa would have confined relict populations of the *Poicephalus robustus* super-species ancestral group to relict forest in the south-east of South Africa (Cooke 1962). During this period the Cape Parrot may have evolved as a separate species, becoming a habitat specialist in a reduced forest habitat. With wetter conditions prevailing, and expansion of woodland habitat, the Greyheaded Parrot would have been able to extend its range to its present status. *P. gulielmi* is primarily a forest species and only occurs in sympatry with *P. fuscicollis* where transitions between tropical forest and woodland/savanna occur (Snow 1978; Forshaw 1989). *P. gulielmi* is more distant from *P. fuscicollis* with a divergence estimated earlier. This divergence is also estimated to have occurred at the same time as that of the Yellowfronted Parrot *P. flavifrons*, a species now confined to the forests of the Ethiopian highlands. This suggestion, however, needs further investigation. DNA studies may reveal more details concerning time scales and speciation events.

CONCLUSION

Many of the distribution records presented are dated and recent local extinctions have likely occurred. The distribution map presented is based on a generalization of references in the literature. The distribution is therefore an extrapolation to where the Greyheaded Parrot is likely to occur. The map therefore differs significantly from published guides on parrots of the world and Africa (Mackworth-Praed & Grant 1970; Fry, Keith & Urban 1988; Forshaw 1989; Juniper & Parr 1998). Museum specimens were collected at Inhambane, Mozambique in 1971, an area where it is now possibly extinct (C.T. Downs unpubl. data.). Although the distribution of *P. fuscicollis suahelicus* is widespread, threats such as trapping for the illegal bird trade and habitat destruction may threaten local populations. It is also likely that where heavy logging has occurred, local populations have been affected. Concessions offered to logging companies in Mozambique destroy prime habitat of Greyheaded Parrots by removing large trees (various pers. comm.). Tall *Brachystegia* woodlands in southern Mozambique are one of the most threatened avian habitats in southern Mozambique and are being depleted by slash-and-burn agricultural practices (Parker 1999). These trees would provide natural cavities for nests and are no longer available. Also, large areas of land are being cleared to satisfy the energy requirements (e.g. charcoal) of Maputo and other large towns (Parker 1999). This habitat will take decades to recover and eventually sustain parrot populations once again. A similar scenario exists in north-east South Africa. Areas where large trees are found, outside protected areas, are vulnerable to utilization. Felling of these trees and removal of standing dead trees (snags) have implications for the conservation of Greyheaded Parrots and other secondary cavity nesting species.

Because of its widespread distribution, the conservation status of the Greyheaded Parrot is likely to vary from region to region. However, as with all other parrots threatened by excessive illegal capture, populations need to be monitored.

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REFERENCES

ASPINWALL, D. 1984. Movement analysis chart: comments on Brown-necked Parrot. *Newsletter Zambian Orn. Soc.*: **14**: 146-148.

BANNERMAN, D.A. 1953. *The birds of west and equatorial Africa.* Oliver & Boyd, Edinburgh.

BARNES, K.N. & TARBOTON, W.R. 1998. Important bird areas of the Northern Province. In: *The important bird areas of southern Africa*, (ed) K.N.Barnes. BirdLife South Africa, Johannesburg.

BARNES, K.N. 2000. (Ed). *The Eskom Red Data Book of birds of South Africa, Lesotho and*

Swaziland. BirdLife South Africa, Johannesburg.

BENSON, C.W. 1940. Further notes on Nyasaland birds (with particular reference to those of the Northern Province). - Part 2. *Ibis* **4**(3):385-433.

BENSON, C.W. 1942. Additional notes on Nyasaland birds. *Ibis* **6**(2):197-224.

BENSON, C.W. 1963. The breeding seasons of birds in the Rhodesias and Nyasaland. *The Proceedings XIIIth International Ornithological Conference.* pp. 623-639.

BENSON, C.W. & IRWIN, M.P.S. 1966.The Brachystegia avifauna. *Ostrich* Suppl. **6**:297-321.

BENSON,C.W. & IRWIN, M.P.S. 1967. A contribution to the ornithology of Zambia. *Zambia Museum Papers 1.* OVP. Zambia.

BENSON, C.W. & BENSON, F.M. 1977. *The birds of Malawi.* Mountfort Press, Limbe.

BENSON, C.W., BROOKE, R.R., DOWSETT, R.J & IRWIN, M.P.S. 1971. *The birds of Zambia.* Collins, London.

BRITTON, P.L. (Ed) .1980. *Birds of east Africa: Their habitat, status and distribution.* East Africa Natural History Society, Nairobi.

CARSWELL, M., POMEROY, D., REYNOLDS, J. & TUSHUBE, H. In press. *Bird atlas of Uganda.*

CAPEN, D.E. (ed). 1981. *The use of multivariate statistics in studies of wildlife habitat.* USDA Forest Service General Technical Report RM-87. Colorado State University, Fort Collins.

CASAGRANDE, D.G. & BEISSINGER, S.R. 1997. Evaluation of four methods for estimating parrot population size. *Condor* **99**:445-457.

CAWKELL, E.M. & MOREAU, R.E. 1963. Notes on birds in the Gambia. *Ibis* **105**:156-178.

CAWKELL, E.M. 1965. Notes on Gambian birds. *Ibis* **107**:535-540.

CHAPIN, J.P. 1939. The birds of the Belgian Congo, Part II. *Bull. Am. Mus. nat. Hist.* **75**:1-632.

CHAPMAN, C.A., CHAPMAN, L.J. & WRANGHAM, R. 1993. Observations on the feeding biology and population ecology of the Grey Parrot *Psittacus erithacus. Scopus* **16**: 89-93.

CLANCEY, P.A. 1965. A catalogue of birds of the South African subregion. Part 2, Glareolidae - Pittidae. *Durban Museum Novitates* 7(10):305-633.

CLANCEY, P.A. 1977. Variation in and the the relationships of the Brownheaded Parrot of the Eastern African Lowlands. *Bonner Zool. Beitrage* **28**:279-291.

CLANCEY, P.A. 1994. Combined biogeographic role of river valleys and aridity in southern African bird distribution. *Durban Museum Novitates* **19**:13-29.

CLANCEY, P.A. 1996. *The birds of southern Mozambique.* African Bird Book Publishing, Westville.

CLAY, G. 1953. Some notes on the birds of the Isoka district of Northern Province of Northern Rhodesia. *Ostrich* **24**(2):76-97.

COOKE, H.B.S. 1962. The pleistocene environment in Southern Africa. Hypothetical vegetation in Southern Africa during the pleistocene. *Ann. Cape. Prov. Mus.* **2**:11-15

CROWE, T.M. & CROWE, A.A. 1982. Patterns of distribution, diversity and endemism in Afrotropical birds. *J. Zool., Lond.* **198**:417-442.

DEAN W.R.J. 1971. Breeding data for birds of Natal and Zululand. *Durban Museum Novitates* 9(6):59-91.

DEAN, W.R.J., HUNTLEY, M.A., HUNTLEY, B.J. & VERNON, C.J. 1988. Notes on some birds of Angola. *Durban Museum Novitates* **14**(4):43-92.

DEAN, W.R.J. 1999. *The birds of Angola.* BOU Checklist No. 17. British Ornithologists Union. Tring.

DIAMOND, A.W. & HAMILTON, A.C. 1980. The distribution of forest passerine birds and Quaternary climatic change in tropical Africa. *J. Zool. Lond.* **191**:379-402.

DOWNS, C.T & SYMES, C.T. 1998. Cape Parrots. Report on the second Cape Parrot big birding day, (25 April 1998). *Psittascene* **10**(3):5-7.

DOWNS, C.T. 2000. Cape Parrot *Poicephalus robustus*. In: *The Eskom Red Data Book of birds of South Africa, Lesotho and Swaziland.* (ed) K.N. Barnes. BirdLife South Africa, Johannesburg.

DOWNS, C.T. 2001. Cape Parrot Big Birding Day 2000. *Psittascene* **13**(1):14.

DU BOCAGE, J.V.B. 1881. *Ornithologie D'Angola.* Imprimerie Nationale, Lisbonne.

ELGOOD, J.H. 1982. *The birds of Nigeria.* B.O.U. Checklist No. 4. British Ornithologists' Union, London.

FORSHAW, J.M. 1989. *Parrots of the world.* Lansdowne Books, Willoughby.

FRY, C.H., KEITH, S. & URBAN, E.K. 1988. *The birds of Africa. Vol. III.* Academic Press, London.

GILARDI, J.D. & MUNN, C.A. 1998. Patterns of activity, flocking behaviour and habitat use in parrots of the Peruvian Amazon. *The Condor* **100**:641-653.

GNAM, R.S. & BURCHSTED, A. 1991. Population estimates for the Bahama Parrot on Abaco Island, Bahamas. *J. Field. Ornithol.* **62**:139-146.

GORE, M.E.J. 1981. *Birds of The Gambia: an annotated checklist.* B.O.U. Checklist No. 3.

British Ornithologists Union, London.

HAMILTON, A.C. 1974. The history of the vegetation of East Africa. Pages 188-209. In: *East African vegetation.* (eds) E.M. Lind & M.E.S. Morrison. Longmans, London.

IRWIN, M.P.S. 1956. Field notes on a collection from Mozambique. *Ostrich* **26**(1):28-39.

IRWIN, M.P.S. 1981. *The birds of Zimbabwe.* Quest, Salisbury.

JOHNSTON, R.D. & LACEY, C.J. 1983. Multi-stemmed trees in rainforest. *Aust. J. Bot.* **31**:189-195

JUNIPER, T. & PARR, M. 1998. Parrots: a guide to the parrots of the world. Pica Press, Sussex.

KEMP, A. C. 1974. The distribution and status of birds of Kruger National Park. *Koedoe* monogr. **2**:1-352.

KOEN, J.H. 1988. Birds of the eastern Caprivi. *Southern Birds* **15**: 1-73. Witwatersrand Bird Club, Benmore.

LEWIS, A. & POMEROY, D. 1989. *A bird Atlas of Kenya.* A.A. Balkema, Rotterdam.

LIPPENS, L. & WILLE, H. 1976. *Les oiseaux du Zaïre.* Lanoo a Tielt, Brussels.

LIVINGSTONE, D.A. 1975. Late quaternary climatic change in Africa. *Annual Review of Ecological Systems* **6**: 249-280.

LEONARD, P. 1999. Afrotropical bird movements in Zambia - Part 1: grebes to nightjars. *Zambia Bird Report* 1998. pp. 15-73.

MACKWORTH-PRAED, C.W & GRANT, C.H.B. 1970. *Birds of west central and western Africa. Vol. 1, Series 3.* Longman, London & New York.

MARSDEN, S.J. 1999. Patterns of diurnal flight activity in three Indonesian parrot species. Papageienkunde **3** (S):1-8.

MASSA, R. 1998. A molecular approach to the taxonomy and biogeography of African parrots. In: N.J. Adams & R.H. Slotow. (eds). Proc.22 Int. Ornithol. Congr., Durban. *Ostrich* **69**:406.

MCALEECE, N., LAMBSHEAD, P.J.D., PATERSON, G.L.J. & GAGE, J.D. 1997. *BioDiversity Professional Beta.* The Natural History Museum & The Scottish Association for Marine Science.

PARKER, V. 1999. *The atlas of the birds of Sul do Save, southern Mozambique.* Avian Demography Unit and Endangered Wildlife Trust, Cape Town and Johannesburg.

PENRY, H. 1994. *Bird Atlas of Botswana.* University of Natal Press, Pietermaritzburg.

PINTO, A.A. DA ROSA. 1983. *Ornitologia de Angola.* Instituto de Investgacâo Científica

Tropicale, Lisboa.

PRIEST, C.D.1934. *The birds of Southern Rhodesia.* Vol 2. William Clowes and Sons Ltd., London.

REICHNOW, A.N.T. 1898. Bericht uber die Februar-Sitzung. *Journal fur Ornithologie* 46:314.

ROSSOUW, J. & SACCHI, M. 1998. *Where to watch birds in Uganda.* Uganda Tourist Board, Kampala.

SCHOLES, R.J. 1997. Savanna. In: *Vegetation of southern Africa.* (eds) R.M. Cowling, D.M. Richardson. & S.M.Pierce. Cambridge University Press, Cambridge.

SMITH, K.D. 1941. Notes on the birds of Mashonaland, Southern Rhodesia. *Ibis* **5**(2):296-301.

SMITHERS, R.H.N., IRWIN, M.P.S. & PATERSON, M.L. 1957. *Checklist of the birds of Southern Rhodesia.* Rhodesian Ornithological Society.

SNOW, D.W. (Ed.). 1978. *An atlas of speciation of African non-passerine birds.* British Museum (Natural History), London.

STATSOFT, Inc. 1995. *STATISTICA for windows.*(Computer program manual). StatSoft Inc.,Tulsa, OK.

SWYNNERTON, C.F.M. 1907. On the birds of Gazaland, Southern Rhodesia. Part II. *Ibis* **9**: 279-311.

SYMES, C.T., VENTER, S.M. & PERRIN, M.R. 2000. Afromontane avifauna of the eastern Soutpansberg, Northern province, South Africa. *S. Af. J. For. Res.* **189**:71-80.

THIOLLAY, J-M. 1985. The birds of Ivory Coast: status and distribution. *Malimbus* 7(1):1-59.

TRAYLOR, M.A, 1963. *Checklist of Angolan birds.* Publicações Culturais, Lisbon.

TREE, A.J. 1962. The birds of the Leopardshill area of the Zambesi escarpment. *Ostrich* **33**(4):3-23.

TREE, A.J. 1996. Recent reports. *Honeyguide* **42**(2):112-122.

VAN WYK, B. & VAN WYK, P. 1997. *Field guide to trees of southern Africa.* Struik Publishers, Cape Town.

VINCENT, A.W. 1934. On the birds of northern Portuguese East Africa. *Ibis* **4**(4):757-799.

WHITE, C. M. N. 1945. The ornithology of the Kaonde-Luanda Province, Northern Rhodesia. - Part III. - Systematic List (*cont.*). *Ibis* **87**:309-345.

WHITE, C.M.N. 1965. *A revised checklist of African non-passerine birds.* pp.1-299. Govt Printer. Lusaka.

WILKES, A.H. Paget. 1928. The birds of the region south of Lake Nyasa - Part 1. Non-passerine birds. *Ibis* **4**:690-748.

WINTERBOTTOM, J.M. 1959. Notes on the status of some birds in Northern Rhodesia. *Ostrich* **30**(1):1-12.

WIRMINGHAUS, J.O. 1997. Cape Parrot *Poicephalus robustus*. In: *The atlas of southern African birds - Vol 1.*, (eds) J.A. Harrison, D.G. Allan, L.L. Underhill, M. Herremans, A.J. Tree, V. Parker & C.J. Brown. Birdlife - South Africa, Johannesburg.

WIRMINGHAUS, J.O., DOWNS, C.T., SYMES, C.T. & PERRIN, M.R. 1999. Conservation of the Cape parrot. *Poicephalus r. robustus* in southern Africa. *S. Afr. J. Wildl. Res.* **29**(4):118-129.

WIRMINGHAUS, J.O., DOWNS, C.T., SYMES, C.T. & PERRIN, M.R. 2000. Abundance of the Cape parrot in South Africa. *S. Afr. J. Wildl. Res.* **30**(1):43-52.

WIRMINGHAUS, J.O., DOWNS, C.T., PERRIN, M.R. & SYMES, C.T. 2001. Abundance and activity of the Cape Parrot *Poicephalus robustus* in afromontane forests in southern Africa. *African Zoology* **36**(1):71-77.

WIRMINGHAUS, J.O., DOWNS, C.T., SYMES, C.T. & PERRIN, M.R. In press. Taxonomic relationships of the subspecies of the Cape Parrot *Poicephalus robustus* (Gmelin). *J. Nat. Hist.*

APPENDIX 1. Relative abundance of birds species at two localities at Levubu (Prinsloo's and Joubert's) covering months of the non-breeding season (Oct - Dec) of the Greyheaded Parrot, and two localities at Makuya (Horseshoe and Tshikuyu) covering months of the breeding season (May - Jul) of the Greyheaded Parrot. Relative abundance figure represents the number of transects each bird species was recorded either visually or audibly. (Sixteen transects walked per month; Zero represents species recorded out of transect times for each month, not used in analysis; * represents intra-African or Palaearctic migrants in the region (total = 24).

English name	Scientific name	P'loo's			J'bert's			H'shoe			T'kuyu		
		O	N	D	O	N	D	M	J	J	M	J	J
ARDEIDAE													
Grey Heron	*Ardea cinerea*	1											
Blackheaded Heron	*Ardea melanocephala*			1									
Cattle Egret	*Bubulcus ibis*	0	2	2	0								
SCOPIDAE													
Hamerkop	*Scopus umbretta*			0		0			1		1	3	5
CICONIIDAE													
Black Stork *	*Ciconia nigra*								1				0
PLATALEIDAE													
Hadeda Ibis	*Bostrychia hagedash*	0	2		0	1	0						
ACCIPITRIDAE													
Whitebacked Vulture	*Gyps africanus*		1						1			1	
Lappetfaced Vulture	*Torgos tracheliotus*								0				
Yellowbilled Kite *	*Milvus parasitus*	1	0	1		1							
Blackshouldered Kite	*Elanus caeruleus*	1	1										
Cuckoo Hawk	*Aviceda cuculoides*	1	0										
Black Eagle	*Aquila verreauxii*							1				0	
Wahlberg's Eagle	*Aquila wahlbergi*			1									
African Hawk Eagle	*Hieraaetus spilogaster*								1				1
Martial Eagle	*Polemaetus bellicosus*							0		3			
Crowned Eagle	*Stephanoaetus coronatus*				0	0	1						
Blackbreasted Snake Eagle	*Circaetus pectoralis*	2		2							1		
Bateleur	*Terathopius ecaudatus*							3	3	2	1		
African Fish Eagle	*Haliaeetus vocifer*		0					1					
Steppe Buzzard *	*Buteo buteo*		1			1							
Jackal Buzzard	*Buteo rufofuscus*						1						
Lizard Buzzard	*Kaupifalco monogrammicus*	0	0	0								1	
Little Sparrowhawk	*Accipiter minullus*												1
Little Banded Goshawk	*Accipiter badius*											1	
African Goshawk	*Accipiter tachiro*		2		0	2	1		0	0		0	
Gabar Goshawk	*Micronisus gabar*										1		
Dark Chanting Goshawk	*Melierax metabates*											1	
Gymnogene	*Polyboroides typus*							1			0		
FALCONIDAE													
Dickinson's Kestrel	*Falco dickinsoni*							0					
PHASIANIDAE													

English name	Scientific name	P'loo's			J'bert's			H'shoe			T'kuyu		
		O	N	D	O	N	D	M	J	J	M	J	J
Crested Francolin	*Francolinus sephaena*							8	11	4	2	2	3
Natal Francolin	*Francolinus natalensis*					1	0	10	5	7	6	5	6
Swainson's Francolin	*Francolinus swainsonii*				0		1					1	
NUMIDIDAE													
Helmeted Guineafowl	*Numida meleagris*	4	1	2	0		1				0	0	
Crested Guineafowl	*Guttera pucherani*				5	8	1		1		3		
TURNICIDAE													
Kurrichane Buttonquail	*Turnix sylvatica*											2	
RALLIDAE													
Buffspotted Flufftail	*Sarothrura elegans*		0		1	7	2						
OTIDIDAE													
Blackbellied Korhaan	*Eupodotis melanogaster*	0											
CHARADRIIDAE													
Crowned Plover	*Vanellus coronatus*										1	1	1
GLAREOLIDAE													
Doublebanded Courser	*Smutsornis africanus*											0	
PTEROCLIDAE													
Doublebanded Sandgrouse	*Pterocles bicinctus*							1	2	1	0	1	0
COLUMBIDAE													
Rameron Pigeon	*Columba arquatrix*					1							
Redeyed Dove	*Streptopelia semitorquata*	7	8	11	7	6	5	2	0	2	2	3	3
Cape Turtle Dove	*Streptopelia capicola*	10	9	12				16	14	14	16	15	15
Laughing Dove	*Streptopelia senegalensis*		0	1					1		3	2	2
Greenspotted Dove	*Turtur chalcospilos*	11	11	15			2	2	2	4	11	12	11
Tambourine Dove	*Turtur tympanistria*			1	10	11	12				1		
Green Pigeon	*Treron calva*	2	4	7		1	1	1	4	2	2	1	
PSITTACIDAE													
Greyheaded Parrot	*Poicephalus fuscicollis*	1	2		9	5		7	4	4	3	2	2
Brownheaded Parrot	*Poicephalus cryptoxanthus*											1	
Meyer's Parrot	*Poicephalus meyeri*							0	1				
MUSOPHAGIDAE													
Purplecrested Lourie	*Tauraco porphyreolophus*	13	16	15	15	16	15		0	15			0
Grey Loerie	*Corythaixoides concolor*							5	6	11	1	0	3
CUCULIDAE													
African Cuckoo *	*Cuculus gularis*	2	3	3									
Redchested Cuckoo *	*Cuculus solitarius*	9	9	11	3	5	7						
Black Cuckoo *	*Cuculus clamosus*	2	2	5			1						
Jacobin Cuckoo *	*Clamator jacobinus*	0											
Klaas's Cuckoo	*Chrysococcyx klaas*	0	2	2	0					0			
Diederik Cuckoo *	*Chrysococcyx caprius*		3	4		3	2						
Burchell's Coucal	*Centropus burchellii*		0	1	3	5	3	2	2	5	0	2	3
STRIGIDAE													
African Scops Owl	*Otus senegalensis*								0	0			0
Pearlspotted Owl	*Glaucidium perlatum*								0	0		1	0
Spotted Eagle Owl	*Bubo africanus*	0											

English name	Scientific name	P'loo's			J'bert's			H'shoe			T'kuyu		
		O	N	D	O	N	D	M	J	J	M	J	J
CAPRIMULGIDAE													
Fierynecked Nightjar	*Caprimulgus pectoralis*	0											
APODIDAE													
Whiterumped Swift *	*Apus caffer*			0									
Little Swift *	*Apus affinis*	2											
Alpine Swift *	*Apus melba*	1			2	1							
Palm Swift	*Cypsiurus parvus*	2	2	2		2							
COLIIDAE													
Speckled Mousebird	*Colius striatus*	3	3	1	14	8	13		1				
Redfaced Mousebird	*Urocolius indicus*	8	12	2	0			6	3		6	1	
TROGONIDAE													
Narina Trogon	*Apaloderma narina*	0			2	6	0						
ALCEDINIDAE													
Pied Kingfisher	*Ceryle rudis*											0	
Giant Kingfisher	*Ceryle maxima*								1				1
Pygmy Kingfisher *	*Ispidina picta*		2	2		0							
Brownhooded Kingfisher	*Halcyon albiventris*	9	10	4	8	3	5	2	2	6	2	3	6
Striped Kingfisher	*Halcyon chelicuti*		0	3		1				3			2
MEROPIDAE													
European Bee-eater *	*Merops apiaster*	7	7	4	3	3	0						
Whitefronted Bee-eater	*Merops bullockoides*							1	3	5	1		
Little Bee-eater	*Merops pusillus*							1			1	1	
CORACIIDAE													
Lilacbreasted Roller	*Coracias caudata*							8	3	2	2	1	0
Purple Roller	*Coracias naevia*							3	6	2			
UPUPIDAE													
Hoopoe	*Upupa epops*	1	1							1			
PHOENICULIDAE													
Redbilled Woodhoopoe	*Phoeniculus purpureus*							6	3	8	4	8	
Scimitarbilled Woodhoopoe	*Phoeniculus cyanomelas*											1	
BUCEROTIDAE													
Trumpeter Hornbill	*Bycanistes bucinator*										2	4	4
Grey Hornbill	*Tockus nasutus*							8	9	4	6	13	8
Redbilled Hornbill	*Tockus erythrorhynchus*							6	3	5	11	7	8
Southern Yellowbilled Hornbill	*Tockus leucomelas*	1						13	11	10	8	7	11
Crowned Hornbill	*Tockus alboterminatus*							1					
Southern Ground Hornbill	*Bucorvus leadbeateri*							1	1	1			0
LYBIIDAE													
Blackcollared Barbet	*Lybius torquatus*	15	14	14	9	11	9	2	7	4	4	8	3
Pied Barbet	*Tricholaema leucomelas*								1				
Yellowfronted Tinker Barbet	*Pogoniulus chrysoconus*	1			1	5	3						
Crested Barbet	*Trachyphonus vaillantii*	3						8	6	6	2	6	5
INDICATORIDAE													
Greater Honeyguide	*Indicator indicator*							1	1	0	2	1	0
Scalythroated Honeyguide	*Indicator variegatus*				0	2	0						

English name	Scientific name	P'loo's			J'bert's			H'shoe			T'kuyu		
		O	N	D	O	N	D	M	J	J	M	J	J
Lesser Honeyguide	*Indicator minor*				4	5	3			0		0	
Sharpbilled Honeyguide	*Prodotiscus regulus*	1	1				1						
PICIDAE													
Goldentailed Woodpecker	*Campethera abingoni*	3	5	5	2	3	4	5	1	4		1	1
Cardinal Woodpecker	*Dendropicos fuscescens*	5		1	2	0	1				1		
Bearded Woodpecker	*Thripias namaquus*	2	1					1	0		2	5	
Olive Woodpecker	*Mesopicos griseocephalus*				0	3	1						
EURYLAIMIDAE													
African Broadbill	*Smithornis capensis*				1		0						
HIRUNDINIDAE													
European Swallow *	*Hirundo rustica*	5	5	12	1	2	2						
Wiretailed Swallow *	*Hirundo smithii*			1									
Mosque Swallow	*Hirundo senegalensis*								2	3		1	
Greater Striped Swallow *	*Hirundo cucullata*				2	0	0						
Lesser Striped Swallow *	*Hirundo abyssinica*		1	1	0	4	4						
CAMPEPHAGIDAE													
Black Cuckooshrike	*Campephaga flava*	2	5	7								0	
DICRURIDAE													
Forktailed Drongo	*Dicrurus adsimilis*	4	3	3				8	7	9	13	10	16
ORIOLIDAE													
Blackheaded Oriole	*Oriolus larvatus*	6		3	1			13	10	11	13	12	15
CORVIDAE													
Pied Crow	*Corvus albus*	0	1	0			1						
PARIDAE													
Southern Black Tit	*Parus niger*	3	2	2				3	2	3	4	3	5
TIMALIIDAE													
Arrowmarked Babbler	*Turdoides jardineii*							2	3	5			
PYCNONOTIDAE													
Blackeyed Bulbul	*Pycnonotus barbatus*	16	16	16	16	16	15	16	16	16	14	12	15
Terrestrial Bulbul	*Phyllastrephus terrestris*				9	4	10						
Sombre Bulbul	*Andropadus importunus*			1	16	16	16						
Yellowbellied Bulbul	*Chlorocichla flaviventris*	4	3	12	12	16	13	1	11	11	6	5	4
TURDIDAE													
Kurrichane Thrush	*Turdus libonyana*	10	11	9		1		4	6	3		5	
Chorister Robin	*Cossypha dichroa*				3	5							
Heuglin's Robin	*Cossypha heuglini*				3	4	2			2			1
Natal Robin	*Cossypha natalensis*				1	9	10						
Whitethroated Robin	*Cossypha humeralis*	2				1							
Whitebrowed Robin	*Erythropygia leucophrys*	10	13	13			3	12	12	12	7	7	5
Bearded Robin	*Erythropygia quadrivirgata*				1								
SYLVIIDAE													
Titbabbler	*Parisoma subcaeruleum*	0											
Willow Warbler *	*Phylloscopus trochilus*	3	6	9									
Barthroated Apalis	*Apalis thoracica*				9	14	16						
Yellowbreasted Apalis	*Apalis flavida*	10	11	9	5	8	6			4			1

English name	Scientific name	P'loo's			J'bert's			H'shoe			T'kuyu		
		O	N	D	O	N	D	M	J	J	M	J	J
Longbilled Crombec	*Sylvietta rufescens*							1	5	2		2	2
Yellowbellied Eremomela	*Eremomela icteropygialis*	2	3	1									
Greenbacked Warbler	*Camaroptera brachyura*		0		13	12	11						
Greybacked Warbler	*Camaroptera brevicaudata*							10	11	8	3	3	4
Barred Warbler	*Camaroptera fasciolata*		1	6									
Stierling's Barred Warbler	*Camaroptera stierlingi*		9	7						1			2
Grassbird	*Sphenoeacus afer*						1						
Rattling Cisticola	*Cisticola chiniana*	8	11	11				8	7			3	3
Croaking Cisticola	*Cisticola natalensis*							1					
Neddicky	*Cisticola fulvicapilla*	1											
Tawnyflanked Prinia	*Prinia subflava*	6	10	4	14	10	14			3			
Blackchested Prinia	*Prinia flavicans*								2				
MUSCICAPIDAE													
Spotted Flycatcher *	*Muscicapa striata*		1	9									
Bluegrey Flycatcher	*Muscicapa caerulescens*				1				0				
Fantailed Flycatcher	*Myioparus plumbeus*				0								
Black Flycatcher	*Melaenornis pammelaina*	6	3	1									0
Pallid Flycatcher	*Melaenornis pallidus*		3	4				1					
Cape Batis	*Batis capensis*				12	11	7						
Chinspot Batis	*Batis molitor*	5	7	6				1	6	5	5	7	4
Wattle-eyed Flycatcher	*Platysteira peltata*								0				
Bluemantled Flycatcher	*Trochocercus cyanomelas*				2	6	5						
Paradise Flycatcher *	*Terpsiphone viridis*	0	12	12	1		2						
LANIIDAE													
Fiscal Shrike	*Lanius collaris*				0								
Redbacked Shrike *	*Lanius collurio*						2						
Southern Boubou	*Laniarius ferrugineus*	3	2	3	14	16	16						
Tropical Boubou	*Laniarius aethiopicus*							3	7	8	1	2	6
Puffback	*Dryoscopus cubla*	15	15	11	16	16	16	8	13	10	7	10	9
Brubru	*Nilaus afer*	6	3	2									
Threestreaked Tchagra	*Tchagra australis*	4	7	6				6	14	6	2	3	
Blackcrowned Tchagra	*Tchagra senegala*			5	2	6	4						
MALACONOTIDAE													
Gorgeous Bush Shrike	*Telophorus quadricolor*	6	7	7	11	12	12						
Orangebreasted Bush Shrike	*Telophorus sulfureopectus*	2					1	3	3	2	1		
Olive Bush Shrike	*Telophorus olivaceus*				11	11	8						
Greyheaded Bush Shrike	*Malaconotus blanchoti*		1					1	4	8	3	3	3
PRIONOPIDAE													
White Helmetshrike	*Prionops plumatus*	1						5	2	4	6	9	11
Redbilled Helmetshrike	*Prionops retzii*								3	2		4	3
Whitecrowned Shrike	*Eurocephalus anguitimens*											0	0
STURNIDAE													
Plumcoloured Starling *	*Cinnyricinclus leucogaster*	2	5	4					0		1		
Longtailed Starling	*Lamprotornis mevesii*							10	12	15	1		
Glossy Starling	*Lamprotornis nitens*	0		2				6	4	1		1	

English name	Scientific name	P'loo's O	P'loo's N	P'loo's D	J'bert's O	J'bert's N	J'bert's D	H'shoe M	H'shoe J	H'shoe J	T'kuyu M	T'kuyu J	T'kuyu J
Redwinged Starling	*Onychognathus morio*		1										
BUPHAGIDAE													
Redbilled Oxpecker	*Buphagus erythrorhynchus*								0	0	1		
NECTARINIIDAE													
Lesser Doublecollared Sunbird	*Nectarinia chalybea*				0	1							
Whitebellied Sunbird	*Nectarinia talatala*			0		1		2	6	5	1	4	5
Scarletchested Sunbird	*Nectarinia senegalensis*	14	14	13	5	4	4						
Collared Sunbird	*Anthreptes collaris*				7	11	10						
ZOSTEROPIDAE													
Cape White-eye	*Zosterops pallidus*	10	12	10	15	16	14						
PLOCEIDAE													
Redbilled Buffalo Weaver	*Bubalornis niger*								1				
House Sparrow	*Passer domesticus*											1	
Greyheaded Sparrow	*Passer griseus*	0	0					10	13	14	3	8	12
Thickbilled Weaver	*Amblyospiza albifrons*			2	7	7	5						
Spectacled Weaver	*Ploceus ocularis*				0	2	7	0	1	1			1
Masked Weaver	*Ploceus velatus*	1	1	1									
Redheaded Weaver	*Anaplectes rubriceps*	1						2	1	0	4	2	1
Redbilled Quelea *	*Quelea quelea*								1	2	0	4	6
Yellowrumped Widow	*Euplectes capensis*	3	6	14	2	2	6						
Whitewinged Widow	*Euplectes albonotatus*												1
Redcollared Widow	*Euplectes ardens*					1	1						1
ESTRILDIDAE													
Melba Finch	*Pytilia melba*							4	5	2	4	5	2
Bluebilled Firefinch	*Lagonosticta rubricata*	2	3	1	2	1	1						
Jameson's Firefinch	*Lagonosticta rhodopareia*							4	3	7	4	1	2
Redbilled Firefinch	*Lagonosticta senegala*							3	4	3	3	3	1
Blue Waxbill	*Uraeginthus angolensis*		1	9				6	5	12	9	6	7
Common Waxbill	*Estrilda astrild*		4	4	8	4	5						
Bronze Mannikin	*Spermestes cucullatus*	1											
VIDUIDAE													
Pintailed Whydah	*Vidua macroura*			1									
Shafttailed Whydah	*Vidua regia*		4										
Paradise Whydah	*Vidua paradisaea*										0		
FRINGILLIDAE													
Yelloweyed Canary	*Serinus mozambicus*	10	7	11	6	7	6	3	2	3		1	1
Streakyheaded Canary	*Serinus gularis*		1	4			1						
Goldenbreasted Bunting	*Emberiza flaviventris*	5	3	6				1	4	1	4	4	8
Rock Bunting	*Emberiza tahapisi*										3	2	3
Total number of species	**201**	**80**	**80**	**78**	**66**	**68**	**68**	**66**	**80**	**70**	**63**	**75**	**65**
Species recorded in transects	**185**	**66**	**70**	**73**	**51**	**63**	**61**	**62**	**69**	**62**	**57**	**66**	**55**

CHAPTER 3

Seasonal occurrence and local movements of the Greyheaded Parrot *Poicephalus fuscicollis suahelicus* in southern and south Central Africa

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Seasonal movements of Greyheaded Parrots are recorded in various parts of its range and are likely a response to breeding and availability of specific food sources. Breeding occurs in the northern Kruger National Park and lowveld near the Mutale-Levhuvhu river confluence, and possibly along the Limpopo river into Mozambique. Aggregations and movements of birds occur during the post-breeding season in response to seasonally abundant food sources. In north-eastern South Africa Greyheaded Parrots occur at Levubu in months succeeding the breeding season. Their arrival in the area corresponds with the fruiting of Mabola Plum *Parinari curatellifolia*. Similar movement patterns in Zimbabwe involve post-breeding movements onto the central plateau. Also, in Zambia and the Nyika Plateau (Malawi/Zambian border), the occurrence of birds following the breeding season, during the latter quarter of the year, is evident. The occurrence of birds in the Caprivi is also recorded in the latter half of the year. During these movements larger flocks of up to 50 individuals are observed whilst during breeding months singletons and pairs are more frequently seen. Further movements of the Greyheaded Parrot, in response to food availability and breeding, are likely throughout its range.

INTRODUCTION

The Greyheaded Parrot *Poicephalus fuscicollis suahelicus* (Reichnow) has recently been described as a separate species from the Cape Parrot *Poicephalus robustus* Gmelin, based on morphometric measurements, plumage colouration, distribution and habitat requirements (Clancey 1997, Wirminghaus 1997, Wirminghaus, Downs, Symes & Perrin In press). DNA findings support this separation (Solms, Berruti, Perrin, Downs & Bloomer 2000). The distribution of the Greyheaded Parrot *Poicephalus fuscicollis suahelicus* extends north from the Northern Province, South Africa to southern Uganda and south-eastern Democratic Republic of Congo (Snow 1978; Fry, Keith & Urban 1988; Forshaw 1989; Chapt. 2). Seasonal movements of Greyheaded Parrots into the Levubu area of Northern Province have been reported in Spring (Aug - Sept) and members of the local farming community relate the timed arrival of Greyheaded Parrots in the area with the fruiting of Mabola Plum *Parinari curatellifolia* (various pers. comm.). Also, breeding of Greyheaded Parrots has been reported in the Makuya region but not in the Levubu region (various pers. comm.; Chapt. 7). The occurrence of Greyheaded Parrots has also been reported further south near Pietersberg, corresponding with the movements of birds into the Levubu area (various pers. comm.). Also, movements of Greyheaded Parrots throughout their range have been reported and attributed to the seasonal availability of food sources and breeding (Fynn 1991; M.P.S. Irwin pers comm.).

In this study, part of a broader study on the biology of the Greyheaded Parrot, seasonal occurrence and local movements of birds in north-eastern South Africa, and other parts of its range, were investigated. It was hypothesized that annual seasonal movements in the southern limit of the range of the Greyheaded Parrot were a response to food availability and breeding requirements. It was predicted that similar movements of Greyheaded Parrots in other parts of the southern African sub-region were likely to occur. These movements were similarly predicted to be correlated with breeding and food availability.

METHODS

Field work was carried out in the Levubu district (23° 00' - 23° 15' S, and 30° 05' - 30° 30' E) from August 1999 to December 1999 (Fig. 1). This study period covered the non-breeding season of the Greyheaded Parrot and included months of the year when Greyheaded Parrots occur seasonally in the area (various pers. comm.). Field work continued in the region of the Luvhuvhu-Mutale river confluence (22° 26' - 22° 32' S and 30° 50' - 31° 05' E), from April 2000 to September 2000 (Fig. 1). This season covered the breeding season of the Greyheaded Parrot. Exceptionally high rains during January 2000 to March 2000 throughout the southern African sub-region, and flood damage in the study areas prevented access to field sites during these months.

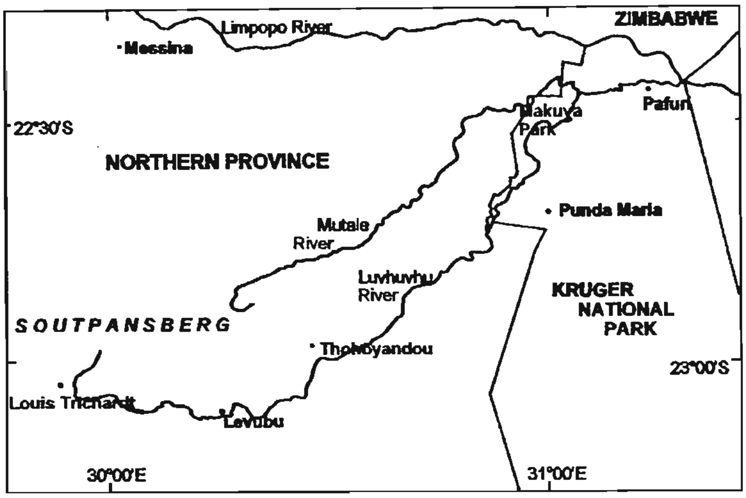

Figure 1. Study sites.

All sightings of Greyheaded Parrots were noted by recording location, date, time, flock size and activity (Chapt. 4). Attempts were made to cover as wide an area of each study site as possible. The maximum number of Greyheaded Parrots accounted for per day was recorded, and correlated with bi-monthly food availability in the area. Breeding activity of Greyheaded Parrots was also recorded (Chapt. 7). Observations were made bi-monthly at Levubu after Greyheaded Parrots had departed the area in December 1999. Various bird watchers in Levubu and Makuya were requested to report sightings of Greyheaded Parrots in the study areas.

At Levubu, food availability of the preferred food tree species (*P. curatellifolia*) was determined (Chapt. 5). Relative abundance of fruit was determined by quantifying the proportion of 37 selected *P. curatellifolia* with unripe fruit. Data were recorded bi-monthly when birds were present and monthly when birds were absent from the area. Monthly recordings of fruit stage of potential and known food tree species (20 species) were made at Makuya. A subjective interpretation of fruit ripeness was determined while working in the field for each particular month.

A request was made in *Honeyguide* (Journal of the Zimbabwe Ornithological Society) for information on Greyheaded Parrots, and in particular, long term records of this species (Symes 2000). This was done in order to identify regions where seasonal movements may occur.

RESULTS AND DISCUSSION

In 1999 Greyheaded Parrots were first observed in Levubu on 16 August. The maximum daily number of Greyheaded Parrots accounted for in a week varied at Levubu (mean ± S.E = 14.9 ± 3.7, n = 16; ANOVA, $F(15,15) = 5.18$, $P < 0.05$) and Makuya (mean ± S.E = 4.7 ± 1.1, n = 17; ANOVA, $F(15,30) = 3.22$, $P < 0.05$) (Chapt. 4).

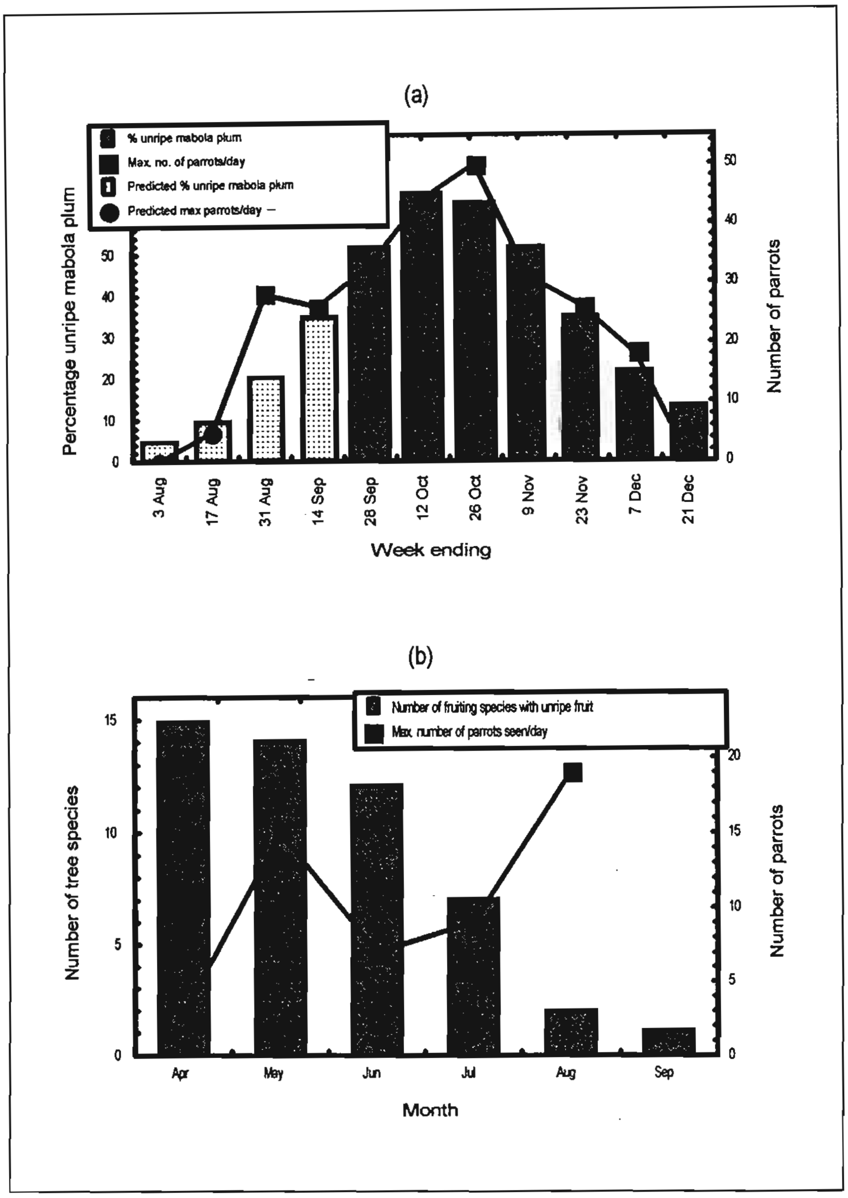

Figure 2a. Maximum number of Greyheaded Parrots seen per day each fortnight at Levubu, and abundance of food available as measured by the proportion of Mabola Plum bearing unripe fruit.

b. Maximun daily number of Greyheaded Parrots seen per week at Makuya, and abundance of food available for Greyheaded Parrots as measured by the number of potential food tree species for Greyheaded Parrots with unripe fruit.

Numbers at Levubu peaked at 50 birds per day during weeks ending 17 and 24 October 1999, and at Makuya peaked (19 birds) at the end of the study period in week ending 13 August 2000 (Fig. 2). The dip in flock size is likely a result of absent incubating females, a factor effectively halving the number of active birds if all adult pairs are breeding (Fig. 2b, 3a).

The last sightings of Greyheaded Parrots in Levubu were made on 9 December 1999. Sightings of arrivals in the Levubu occurred on 27 July (4 birds) the previous year (1998), with larger groups sighted on 4 August (T. Prinsloo pers. comm.). In 2000 a flock of *c.* 8 was observed in Levubu on *c.* 10 July (H. Barkhuysen pers. comm.), and then larger flocks again on 22 August 2000 (T. Prinsloo pers. comm.). Between these two dates no Greyheaded Parrots were seen. There was a correlation between the daily maximum number of Greyheaded Parrots seen per week and the availability of unripe *P. curatellifolia* in the area (Fig. 2a; Spearman's r = 0.9153, $n = 11$, $P < 0.05$; analysis includes predicted values) (Chapt. 5)

There were no Greyheaded Parrots present in Levubu (nor have they been recorded regularly) during months that Greyheaded Parrots are known to breed. (various pers. comm.; Chapt. 7).

The arrival of birds in Levubu is directly correlated with the setting of *P. curatellifolia* fruit in the area (Fig. 2a). The total number of birds occurring annually varies and has been attributed to variations in rainfall and resultant changes in food production (A. Muller, T. Prinsloo, H. Barkhuysen, A. Bester pers. comm.). Similarly, in the Trelawney-Darwenvale-Banket area of Zimbabwe numbers of Greyheaded Parrots recorded annually varied (A. Tree unpubl. data). This occurrence was common following the breeding season (May - Aug) and involved post-breeding dispersal movements (Chapt. 7). Fledging occurs in August and is related to a decrease in food availability in the breeding area (Chapt. 5). Similarly, the appearance of birds in the Trelawney district, Zimbabwe, occurs, where arriving flocks feed predominantly on *P. curatellifolia* from late-August to mid-November (Fynn 1991; A Tree pers. comm.). Similar patterns are observed in other parts of the range of the Greyheaded Parrot. Greyheaded Parrots are absent from the Kariba basin from September to November (Donnelly & Donnelly 1983) with a similar absence of birds from Mlibizi during September and October (Table 1). It is likely that birds occurring on the central plateau are from this population (Fynn 1991). Movements may therefore occur on an annual basis, involving long distance movements in search of food sources during the dry season (Fynn 1991).

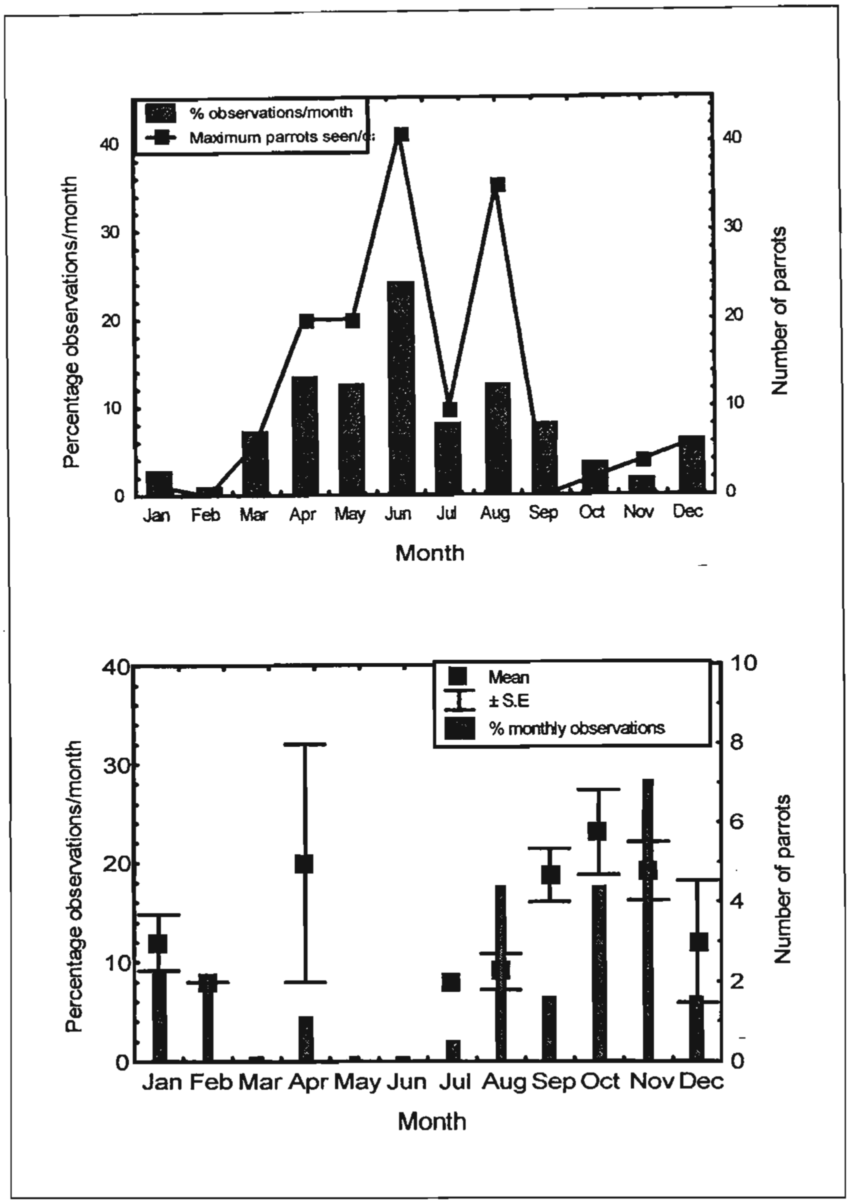

Figure 3 a. Percentage reporting rate for Greyheaded Parrots and maximum flock size as recorded in Zimbabwe by *Recent Reports* returns (I. Riddel pers. comm.).

b. Mean monthly flock size and proportion of monthly sightings of Greyheaded Parrots as observed by A. Tree north-west of the Middle Zambezi from South Kafue Flats to Mpika, Zambia.

(Observation effort was not recorded hence not allowing times series analysis to be conducted further).

In Zimbabwe the breeding range of the Greyheaded Parrot is possibly concentrated in the lowveld in the Middle Zambezi Valley (Kazangula - Luangwa), in the Save Valley and south-east lowveld, in the Limpopo River Valley and the heavily wooded country of north-west Matabeleland (M.P.S. Irwin pers. comm.). When they are not breeding, they possibly move onto the central plateau in search of fruiting trees (Fynn 1991; M.P.S. Irwin pers. comm.). In the middle Zambezi valley the occurrence of Greyheaded Parrots is most common during December to May. At Mlibizi (17° 56' S, 27° 08' E), Kariba (observation period from May 1998 - August 1999), Greyheaded Parrots were most common from January to March, months preceding the breeding season (S. Long pers. comm.; Table 1). No sightings were made in September and October (Table 1). Data from Recent Reports in *Honeyguide* (1986 - 1999; sightings by quarter-degree-squares) show a greater number of observations per month from March to August with a significant positive correlation between the maximum number of parrots seen per day each month and the number of monthly records reported (Fig. 3a; Spearman's $r = 0.8148$, $n = 12$, $P < 0.05$) (I. Riddel pers. comm.). Similarly at Victoria Falls, observations were most common from February to April (C. Pollard pers. comm.) and in Livingstone from September to February (Table 1). From January to April they are thought to breed in the dead palm trunks along the Zambezi Valley (C. Pollard pers. comm.). In light of the data presented, this is questioned. Breeding may, however, begin later here, possibly in May.

In the Trelwaney district, 100 km north-west of Harare in *Brachystegia* (miombo) woodland, the earliest arrival of birds was 4 August (Fynn 1991), and in the Trelawney/Darwenvale/Banket area arrivals were noted as occurring from August to October (A. Tree pers. comm.). Departures here occurred in December with birds lingering into January one year (A Tree pers. comm.). This correlates with the earliest sighting of birds in the Levubu where flocks of 1 - 5 birds arrive predictably in August each year. The arrival of juveniles in the Trelawney district was first seen on 17 - 20 October 1985 (Fynn 1991). From these data, egg laying is placed in mid-July (Fynn 1991). However, movement time is not accounted for and egg laying is therefore possibly earlier (Chapt. 7). In Levubu, juveniles were observed with the first large flock in late August, soon after fledging was observed in Makuya (Chapt. 7). These data suggest a predictable post-breeding movement into areas where food sources are seasonally abundant.

In the Leopardshill area (15° 30' S, 28° 30' E) of the Zambezi escarpment the Greyheaded Parrot is probably a visitor in the area in search of fruit, and is less common south in the escarpment (Tree 1962). It is absent in May and first noticed in July in Nyabasanga where birds are still present in good numbers in December (Tree 1962). No birds were observed in January (A. Tree unpubl. data). In the Chongwe area (15° 20' S, 28° 40' E), north of Leopardshill, larger flocks were more apparent from October to December, suggesting post-breeding flocking and seasonal movements during this time of the year (A. Tree unpubl. data). Also, seasonal data reflected in the South African Bird Atlas Project (SABAP) indicate a peak reporting rate in July/August for this area (Wirminghaus 1997). This may, however, be an indication of increased conspicuousness during post-breeding flocking, at a time when juvenile flocks and movements are more obvious (Chapt. 4). Similar trends are observed in Recent Reports data (various *Honeyguide* publications) where a peak is realized in total flock size and number of reportings from April to August (January peak) (I. Riddel pers. comm.). In the region south-east of Lusaka in Zambia, an increase in flock size and number of sightings during post-breeding months (Aug - Dec) is evident (Fig. 3b). These records are from the Leopardshill, Chongwe east, Mpika (11° 30' S, 31° 00' E) Kariba, South Kafue Flats, Kabwe, Zambezi-Luangwa confluence and Chiawa area, a region running parallel with the Zambezi river in a north-east direction (A. Tree unpubl. data). Data collected show a significant positive correlation between the mean number of parrots observed per sighting each month and the total number of sightings per month (Fig. 3b; Spearman's $r = 0.7496$, $n = 12$, $P < 0.05$). Observations of flocks in this area, on the Zambian side of the Zambezi show an increase in flock size and flock sightings during post-breeding months from August to December (A. Tree unpubl. data; Fig. 3b). During these months the occurrence of larger family groups is possibly more conspicuous as they become involved in long distance forays in search of seasonally abundant food sources.

In south-east Zimbabwe breeding has been recorded with chicks in the nest in July (Chapt. 7). An absence of birds in the region succeeding the breeding season from August to December possibly involves a movement of birds into the eastern highlands or Save Valley lowveld. In south-eastern Zimbabwe Greyheaded Parrots were recorded at Chirinda forest (20° 14' S, 32° 26' E) from which they would make daily feeding forays (Swynnerton 1907), and at Inyanga, eastern Zimbabwe highlands, it was recorded in October (Smith 1941). It was also recorded at Chipinge (20° 10' S, 32° 35' E), Zimbabwe eastern highlands, in July (Tree 1996). Very little is known of birds in this area. Records from central Zimbabwe are distinctly scarce, indicating a possible distributional gap between a population in the middle Zambezi valley and a population in the south-east Zimbabwe/Mozambique lowveld.

At Mkuyu Spring, Zimbabwe a flock of 40 was seen heading to roost (Tree 1996). This is in accordance with post breeding flocking in which larger aggregations of birds are more common after the breeding season (P. Leonard pers. comm.; Chapt. 4)

In the Caprivi Strip Atlas records are confined to the period February to June

(Wirminghaus 1997). An absence during the non-breeding season months (Aug - Jan) suggests a movement out of this area after breeding. The Botswana Atlas (Penry 1994) records Greyheaded Parrots in March (2 records), April (2 records) and June (1 record) suggesting a movement of birds into northern Botswana to breed during the second quarter of the year.

Table 1. Records of seasonal occurrence of Greyheaded Parrots at Victoria Falls and in the Victoria Falls region (C. Pollard pers. comm.), weeks in which Greyheaded Parrots were observed at Mlibizi, Kariba (S. Long pers. comm.), "Movement Analysis Charts" (MAC) showing weeks in which Greyheaded Parrots were recorded by Zambia Ornithological Society (ZOS) members (Aspinwall 1984), monthly records of Greyheaded Parrots in the Lusaka area (D Aspinwall pers. comm.; records of D.L. Berkvens gathered over 15 yrs, with records for 9 years only), percentage of bird-watching days in which Greyheaded Parrots were observed in the Mongu (15° S, 23 ° E, 1 100 m a.s.l.) and Livingstone area (18° S, 26 ° E, 1 000 m a.s.l.) (Winterbottom 1959), and Atlas records each month as recorded in the Tanzania Atlas. Conspicuous months in which Greyheaded Parrots are absent or present are highlighted and relate to the discussion.

Locality	J	F	M	A	M	J	J	A	S	O	N	D
Victoria Falls (irregular obs 1996-99)	2	5	2	3	2	0	1	2	1	1	1	2
Victoria Falls region (1978-)	3	4	4	4	2	1	0	2	2	1	1	2
Mlibizi (May 1998 - May 1999)	5	4	4	3	4	2	4	2	0	0	1	3
MAC (Jan 1981 - Jan 1988)	7	1	2	3	3	2	6	3	10	15	9	12
Lusaka area	3	0	1	0	1	1	0	1	1	3	15	5
Mongu	29	9	6	3	11	2	9	3	3	0	3	38
Livingstone	17	13	6	6	1	8	5	6	11	8	7	13
Tanzania Atlas	18	11	26	6	9	10	13	7	12	14	11	7

In Zambia Greyheaded Parrots appear and remain temporarily on the Nyika Plateau (Greenberg 1977a) with birds arriving at the end of November and being regularly seen in December (Dowsett, Colebrook-Robjent & Osborne 1974; Taylor 1979, 1980; Aspinwall 1981). Summaries of data recording sightings in Lusaka, Zambia record an influx of birds in the latter quarter of the year, and an increase in sighting during the same period (Table 1).Additional records reflecting seasonal occurrence are also shown in Table 1. At the Resources Development College in Lusaka birds arrive from September to October in different years (D.L. Berkvens to D. Aspinwall pers. comm.). In October and November up to 15 birds were evident and fed on Mabola Plum *Paranari curatellifolia* in two successive years (de Pury 1980 a, b). At the Lusaka Golf Course a flock of Greyheaded Parrots tends to gather in September and October (Williams

2000). At Protea Hills (Lusaka), from October to November large numbers of parrots, with flocks of up to 30, gathered to feed on *P. curatellifolia* (Bingham 2000). Further records for Lusaka, indicative of seasonal occurrence, are for November (Fosbrook 1968) and July to December (Tree 1962). It is likely that the origin of these birds is the Middle Zambezi Valley, where they are noted as locally common (White & Winterbottom 1949), but absent from September to November (Donnelly & Donnelly 1983; D. Aspinwall, S. Long pers. comm.). It would also seem likely that the birds visiting Lusaka are ones that have recently completed breeding and are no longer tied to the vicinity of the nest site (D. Aspinwall pers. comm.).

Reports of Greyheaded Parrots in Choma (16° 50' S, 26° 55' E) within the period September to February (Greenberg 1977a, b; Hayward 1979) may be compared with those of Lusaka. Present data include the occasional appearance of small flocks (2 - 4 birds) during the wandering season (August to December) (P. Leonard pers. comm.). These birds may originate in the Middle Zambezi Valley and may also account for the minor influx into Livingstone in December to February (Winterbottom 1959; L. Warburton pers. comm.; Table 1). Similarly, at Mongu (15° S, 23° E), in *Baikiaea* woodland near the edge of the Barotse Plain (seasonally flooded grassland) a peak is realized from December to February (Winterbottom 1959). Along the border of Southern and Western Province, large flocks of up to 30 birds were more common in May and June (L. Warburton pers. comm.). This correlates with the reduction in sightings in the Victoria Falls region during these months and these may be breeding birds.

In Malawi, Benson (1942) considers the Greyheaded Parrot a wanderer with sightings recorded at higher altitudes at Vipya (1 850 m a.s.l.; 11° 55' S, 34° 00' E; 40 km east of Chinteche) in January, and in Mzimba district (1 300 m a.s.l.) in October (Greenberg 1977c). At Chiromo, southern Malawi, they were recorded in March and April (Wood in Long 1961) and in the Port Herald (16° 55' S, 35° 16' E) they were observed eighteen times in January, May, June, September and December (Long 1961).

Tanzania Atlas sightings do not indicate or support any trends in seasonal occurrence and possibly need to be analyzed in greater depth to identify regions where movements occur (Table 1; N. Baker pers. comm.). Studies of the Greyheaded Parrot in the north of its range may indicate similar patterns of movement. However, the timing of these movements may differ if food species are different.

Cape Parrots are similarly involved in local daily movements where they move between naturally fragmented forest patches (Wirminghaus, Downs, Symes & Perrin 2000). These movements possibly occur in response to food and water availability (Wirminghaus, Downs, Symes & Perrin 2001). Daily movements of up to 90 km are known to occur, yet it is not known whether local seasonal movements occur (Skead 1964, 1971, Wirminghaus *et al.* 2001). Radio-collar tracking has proved unsuccessful in Cape Parrots as they destroy and chew any tag or collar attached to them (C.T. Downs unpubl. data). However, seasonal fluctuations of numbers at large forests where Cape Parrots occur indicate that some local movements occur (Wirminghaus *et al.* 2001).

The Brown-necked Parrot *Poicephalus fuscicollis fuscicollis* has a local distribution in the east of its range, being a visitor to the Plateau Province of Nigeria in April and May (Bannerman 1953). It is a visitor to the Jos (09° 56' N, 08° 53' W) and Aliya (11° 10' N, 10° 55' E) region, central Nigeria, in November and December, yet has not been recorded breeding (Elgood 1982). The causative factors of any movements here needs to be investigated.

CONCLUSION

The data presented support the hypothesis of seasonal movements of the Greyheaded Parrots in response to food availability and breeding. As a result of these movements they may move away from protected areas where they are vulnerable to capture for the avicultural market, and persecution. Tree removal in areas where Greyheaded Parrots are involved in long distance movements may make populations vulnerable by affecting local food supply. In areas where bush clearance occurs large Mabola Plum trees are usually left standing (various pers. comm.). The fruit is favoured by humans, and similarly benefits parrots. However, large areas of land cleared for agriculture threatens populations of Greyheaded Parrots reliant on seasonally available food sources. Today Greyheaded Parrots are nowhere common, and 50 years ago they were recorded flying over Zimbabwe's capital, Harare (M.P.S. Irwin pers. comm.). At Levubu, flocks of 100+ birds were recorded up to 20 years ago (various pers. comm.). Local farmers attribute this recent decline to trapping by the local Venda population. It seems more likely that population declines are a result of habitat destruction and a removal of birds from the wild for the illegal trade (Chapt. 7). Pressures on seasonally available food sources such as indicated for Levubu (RSA) and Trelawney (Zimbabwe) may have implications for the survival of the Greyheaded Parrot in certain regions. The conservation concern of this species outside of protected areas is also highlighted.

This is one of the first accounts investigating and reviewing the occurrence and seasonal movements in an African Parrot. Throughout the range of the Greyheaded Parrot there are possibly areas where only seasonal occurrences occur. Very little is known on the movements of this and other African parrots where the reliance on seasonally abundant food sources and nest site availability may play an important part in the biology of each species. Further research may therefore indicate similar movement patterns.

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REFERENCES

Aspinwall, D.R. 1981. Newsletter Zambian Orn. Soc. 11: 127.

Aspinwall, D.R. 1984. Movement analysis chart: comments on Brown-necked Parrot. Newsletter Zambian Orn. Soc.: 14: 146-148.

Bannerman, D.A. 1953. The birds of west and equatorial Africa. Edinburgh: Oliver & Boyd.

Benson, C.W. 1942. Additional notes on Nyasaland birds. Ibis 6(2): 197-224.

Bingham, M. 2000. Protea Hills notes. Zambian Ornithological Society Newsletter 30(2): 2.

Clancey, P.A. 1997. The Cape Parrot: an additional valid species. Honeyguide 43:61-62.

de Pury, R.J. Casalis. 1980a, Newsletter Zambian Orn. Soc. 10: 176.

de Pury, R.J. Casalis. 1980b, Newsletter Zambian Orn. Soc. 10: 193.

Donnelly, B.G. & Donnelly, A. 1983. The birds of the Lake Kariba basin, Zimbabwe. Honeyguide 114/115: 27-42.

Dowsett, R.J., Colebrook-Robjent, J.F.R. & Osborne, T.O. 1974. Further additions to the Nyika Plateau avifauna. Bull. Zambian Orn. Soc. 6: 42.

Elgood, J.H. 1982. The birds of Nigeria. London: British Ornithologists' Union.

Forshaw, J.M. 1989. Parrots of the world. Lansdowne Books. Willoughby.

Fosbrook, H.A. 1968. Brown-necked Parrot. Black Lechwe 7(1): 24-25.

Fry, C.H., Keith, S. & Urban, E.K. 1988. The birds of Africa. Vol. III. Academic Press. London.

Fynn, A.R. 1991. Feeding and movements of the Brown-necked Parrot in the Trelawney district. Honeyguide 37(1): 5-8.

Gmelin. 1788. *Syst. Nat.*, vol. i, part1, p. 344.

Greenberg, D.A. 1977a. Newsletter Zambian Orn. Soc. 7: 75.

Greenberg, D.A. 1977b. Newsletter Zambian Orn. Soc. 7: 102.

Greenberg, D.A. 1977c. Newsletter Zambian Orn. Soc. 7: 115.

Hayward, R.J. 1979. Newsletter Zambian Orn. Soc. 9: 29.

Long, R.C. 1961. The birds of the Port Herald district. (Part 2). Ostrich 32(1): 23-35.

Penry, H. 1994. Bird Atlas of Botswana. University of Natal Press. Pietermaritzburg.

Reichnow, A.N.T. 1898. Bericht uber die Februar-Sitzung. *Journal fur Ornithologie* 46:314.

Skead, C.J. 1964. The overland flights and the feeding habits of the Cape Parrot, *Poicephalus robustus* (Gmelin) in the eastern Cape Province. Ostrich 25(1):202-223.

Skead, C.J. 1971. The Cape Parrot in the Transkei and Natal. Ostrich Supplement 9: 165-178.

Smith, K.D. 1941. Notes on the birds of Mashonaland, Southern Rhodesia. Ibis 5(2): 296-301.

Snow, D.W. (ed).1978. An atlas of speciation in African non-passerine birds. London: Trustees of the British Museum (Natural History).

Solms, L., Berruti, A., Perrin, M., Downs, C. & Bloomer, P. 2000. Phylogenetic relationships of the three subspecies of the Cape Parrot *Poicephalus robustus*. 17^{th} Congress of the South African Genetics Congress. June 2000. Pretoria.

Swynnerton, C.F.M. 1907. On the birds of Gazaland, Southern Rhodesia. Part II. Ibis 9:279-311.

Symes, C.T. 2000. The status, biology and conservation of the Grey-headed Parrot in southern

Africa. Honeyguide 45(1):10-12.

Taylor, P.B. 1979. Newsletter Zambian Orn. Soc. 9: 163.

Taylor, P.B. 1980. Newsletter Zambian Orn. Soc. 10: 32.

Tree, A.J. 1962. The birds of the Leopardshill area of the Zambesi escarpment. Ostrich 33(4): 3-23.

Tree, A.J. 1996. Recent reports. Honeyguide 42(2): 112-122.

White, C.M.N. & Winterbottom, J.W. 1949. A checklist of the birds of Northern Rhodesia. Lusaka: Government Printer.

Williams, S. 2000. Birds of the Lusaka Golf Course. Zambian Ornithological Society Newsletter 30(3): 4-5.

Winterbotton, J.M. 1959. Notes on the status of some birds in Northern Rhodesia. Ostrich 30(1): 1-12.

Wirminghaus, J.O. 1997. Cape Parrot *Poicephalus robustus*. In: Harrison, J.A., Allan, D.G., Underhill, L.L., Herremans, M., Tree, A.J., Parker, V. & Brown, C.J. (eds). The atlas of southern African birds - Vol 1. Johannesburg: Birdlife - South Africa.

Wirminghaus, J.O., Downs, C.T., Symes, C.T. & Perrin, M.R. 2000. Abundance of the Cape parrot in South Africa. S. Afr. J. Wildl. Res. 30(1):43-52.

Wirminghaus, J.O., Downs, C.T., Perrin, M.R. & Symes, C.T. 2001. Abundance and activity of the Cape Parrot *Poicephalus robustus* in afromontane forests in southern Africa. African Zoology 36(1):71-77.

Wirminghaus, J.O., Downs, C.T., Symes, C.T. & Perrin, M.R. In press. Taxonomic relationships of the subspecies of the Cape Parrot *Poicephalus robustus* (Gmelin). J. Nat. Hist.

CHAPTER 4

DAILY ACTIVITY AND FLOCKING BEHAVIOUR PATTERNS OF THE GREYHEADED PARROT *POICEPHALUS FUSCICOLLIS SUAHELICUS* IN NORTHERN PROVINCE, SOUTH AFRICA

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Abstract. Daily activity and flocking behaviour patterns of the Greyheaded Parrot *Poicephalus fuscicollis suahelicus* were studied during the non-breeding (Aug - Dec) and breeding (Mar - Aug) season in Northern Province, South Africa. Greyheaded Parrots were active in the early morning and late afternoon. Activity at two study sites (Levubu: non-breeding season; Makuya: breeding season) began at first light and continued until after sunset. Correcting for sunrise and sunset between winter and summer, results in similar patterns of peak activity at each site. Flock size of Greyheaded Parrots in flight differed significantly between the breeding season (Makuya: 2.1 ± 0.1) and non-breeding season (Levubu: 4.7 ± 0.2). For different flight activities, flock size differed between the non-breeding and breeding season study sites, yet was the same during each season. Daily activities changed through the day for each season. Early morning activity was characterized by overland flights to predictable morning activity centres where birds fed, and drank when water was available. These centres varied between seasons. Intra-specific socialisation also occurred. Thereafter, birds moved to alternate feeding trees where they rested quietly during the heat of the day. Late afternoon movements were characterized by the return of birds to roost sites. The maximum number of Greyheaded Parrots accounted for in a day was different between weeks at each study site, and also between study sites. Maximum daily total numbers peaked in mid-October at Levubu and in mid-

August (end of the breeding season) at Makuya. Mean daily flock size did not differ between weeks at each site but differed between sites.

Key words: Greyheaded Parrot, Poicephalus, *flocking behaviour, South Africa, flock size.*

INTRODUCTION

Flocking behaviour and temporal changes in bird flock size and composition have been recognized in birds and the implications discussed (Weathered 1983; Caccamise, Lyon & Fischl 1983; Hogstad 1984; Caccamise & Morrison 1986; Westcott & Cockburn 1988; Chapman, Chapman & Lefebvre 1989; Hampe 1998, Marsden 1999). The general foraging literature predicts that daytime foraging flocks will be small when food resources are rare and clumped (Bradbury & Vehrencamp 1976; Krebs & Davies 1999). The Information Centre (IC) hypothesis suggests that the congregation of birds in roosts at night facilitates the exchange of information regarding food site localities, and that flock size will be largest when information concerning location of food sites is most valuable (Ward & Zahavi 1972). Alternatively, Caccamise & Morrison (1986) suggest that birds only roost communally when the benefit more than compensates for the cost of travelling to the roost. This hypothesis similarly predicts that roost size will increase as food resources become more clumped (Caccamise & Morrison 1986). However, neither of these hypotheses are correlated with the breeding season of birds.

The Greyheaded Parrot *Poicephalus fuscicollis suahelicus* has recently been identified as a separate species from the Cape Parrot *Poicephalus robustus*, based on morphological differences, colour variation, allopatric distributions and different habitat requirements (Clancey 1997; Wirminghaus, Downs, Symes & Perrin In press). Furthermore, DNA evidence supports separate species status (Solms, Berruti, Perrin, Downs & Bloomer, 2000).

Parrot populations are difficult to estimate because birds may fly long distances between nesting, roosting and feeding areas, inhabit dense forests where visibility is poor and are difficult to locate when perched because of cryptic colouration (Chapman, Chapman & Wrangham 1993; Casagrande & Beissinger 1997). Various techniques have been used to estimate parrot population size (Gnam & Burchsted 1991; Casagrande & Beissinger 1997; Marsden 1999). Estimation of Cape Parrot population size has proved difficult using traditional methods because birds are found in a naturally fragmented landscape, move between forest patches and have a strict bimodal activity pattern, flock at unpredictable times of the year and population numbers are low (Downs & Symes 1998; Wirminghaus *et al.* 2001; C.J. Skead pers. comm.). Throughout most of their range Greyheaded Parrots are uncommon, so flocking and the seasonal occurrence of birds in particular areas makes populations estimates difficult (Wirminghaus 1997; M.P.S. Irwin pers. comm.).

Movements and daily activity patterns of the Greyheaded Parrot in Northern Province, South Africa are not known and a study was conducted to investigate the biology of this species in the wild. The study was carried out at two sites, Levubu and Makuya, during the non-breeding and breeding seasons of the Greyheaded Parrot respectively. The objectives of this aspect of the study were to document the daily activity patterns in the wild and investigate the ecological and behavioural implications of these findings. Most African parrots belong to the genus *Poicephalus*. It was hypothesized that patterns of daily activity would be similar to other African parrots, and in particular the Cape Parrot. Activity was expected to vary between study sites, because of vegetational differences between sites and the occurrence of breeding at one site (Chapt. 2 & 7).

Greyheaded Parrots are possibly involved in local movements in response to food availability and breeding (Fynn 1991). Greyheaded Parrots are feeding specialists accessing the kernel of unripe fruit (Chapt. 5). In many instances flock size of birds is dependent on resource distribution, with flock size smaller when resources are scattered (Krebs & Davies 1999). It was hypothesized that flock size was correlated with breeding and food availability. Flock size was expected to vary between the non-breeding and breeding seasons because of local movements. As flight activity through the day changed, so flock size was expected to vary. Also, the maximum number of birds seen per day was expected to vary with time. Movements and activity patterns were expected to have implications on the conservation of Greyheaded Parrots.

STUDY SITES & METHODS

Field work began in the Levubu district (23° 00' - 23° 15' S, and 30° 05' - 30° 30' E) from August

1999 to December 1999 (16 weeks). This study period covered the non-breeding season of the Greyheaded Parrot and included months of seasonal occurrence in the area (various pers. comm.). A mosaic of habitats occur with habitat types dominated by mixed woodland and bushveld habitats, and intensive agriculture practised in particular regions e.g. banana, macadamia, mango and tropical crops (Chapt. 2). A well developed road network in the region allowed easy access to most sites to locate parrots (Fig. 1).

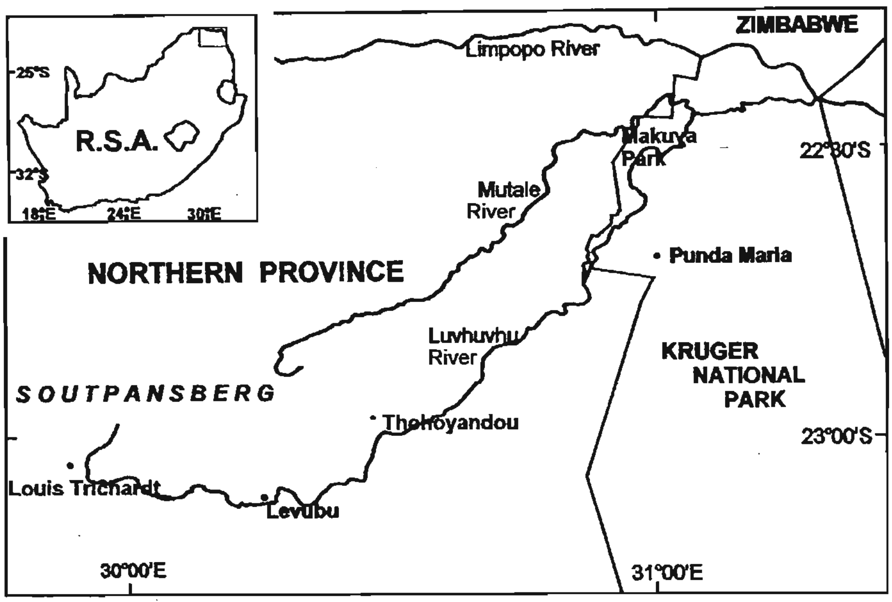

FIGURE 1. Location of study sites in north-east South Africa.

Exceptionally high rains from January 2000 to mid-March 2000 throughout the southern African sub-region, and flood damage in the study areas prevented fieldwork during these months (Fig. 1).

Field work continued in the region of the Luvhuvhu-Mutale river confluence (22° 26' - 22° 32' S, and 30° 50' - 31° 05' E) from April 2000 to September 2000 (19 weeks) which included the breeding season of the Greyheaded Parrot. Although a rudimentary network of roads is found in the area, access to find parrots was through rough terrain, requiring the use of 4x4 transport. Very few sightings were made of parrots where human population density was highest and observations were concentrated in less disturbed and least accessible areas. Additional observations were made from a vehicle in the Punda Maria campsite vicinity, Kruger National Park.

Two transects were walked at each site, in woodland and bushveld, where parrots were known to occur (various pers. comm.). A 300 m transect at each locality was walked 16 times, on separate days, each month. Each day was divided into four time periods (before 09h00, 09h01 - 12h00, 12h01 - 15h00, after 15h00) and four transects walked at random times during each time period. The same time period was walked only once in a day. Transects lasted 30 min and were surveyed in both directions for each sampling period. Presence of Greyheaded Parrots was recorded visually (number recorded) and audibly.

During each week attempts were made to cover as wide an area of the study site as possible, including areas where parrots were known to be active and where parrots were likely to occur. This was done in order to record the maximum number of individual parrots in the study area. One week allowed enough time for each study area to be covered almost entirely. Greyheaded Parrot are strong fliers but localised and it was assumed that the recounting of the same individual on successive days would occur. The maximum number of parrots at each site was therefore estimated by counting early morning or late afternoon flocks arriving at a feeding site or activity centre, or the total number of parrots flying over an observation point in one direction. Morning counts were not added to afternoon flock counts as the same birds could have been counted more than once. Variation in number of parrots seen per day, each week, was calculated.

Active behaviour was determined by recording all sightings of parrot flocks. Observations began at first light and continued until after the last active parrots were recorded after sunset. The following data were recorded while observing Greyheaded Parrots in flight in the wild: locality, date, time and flock size. Because of their colouration, Greyheaded Parrots are difficult to locate in foliated trees, especially when the birds are quiet and feeding (Chapman *et al.* 1993; pers. obs.). Counts of flocks in flight were therefore more reliable than those of perched flocks. Although the same individual may have been counted more than once each flock in flight was regarded as a separate behavioural unit. Flocks were categorized, depending on locality, flight direction of the flock and time recorded. This categorization was subjective and based on field experience studying Cape Parrots in the wild (Wirminghaus, Downs, Symes, Dempster & Perrin 2000a; Wirminghaus *et al.* 2001). Flight categories were defined as follows:

1. early morning movement from roost to activity centre(s) and/or feeding site(s) (departing flocks in Chapman *et al.* (1989); similar to flocks arriving at or departing forest in Wirminghaus *et al.* (2001));
2. arrival at activity centre;
3. departure from activity centre;

4. late afternoon return from feeding sites to roosts (similar to late afternoon inter-forest movement flocks in Wirminghaus *et al.* (2001));
5. roosts;
6. daily movements between feeding sites and activity centres (daytime foraging flocks in Chapman *et al.* (1989); similar to daytime flock movement in forests in Wirminghaus *et al.* (2001));
7. daily movement within feeding sites, and;
8. daily movement within activity centres (daytime activity and socialising).

Activity centres were defined as any locality where Greyheaded Parrots congregated in the early morning (usually before 09h00), with flocks arriving from different directions at different times, socializing and/or feeding and drinking, and then moving off to alternate locations. Activities 1 - 3 were grouped as post-dawn socialising flocks and activities 6 - 8 as day-time socialising flocks (Table 1).

Familiarity with the area and movement patterns of the Greyheaded Parrots enabled birds to be located and improved data collection. Total number of parrots accounted for in a day was determined. Greyheaded Parrots in flight were used as indices for levels of active behaviour (Pizo & Samão 1997; Marsden 1999). The proportion of flocks seen per hourly time period as a fraction of the total flocks seen at each site was calculated to indicate the level of activity for each time period.

Statistical analyses were conducted using STATISTICA (Statsoft, Inc. 1995).

RESULTS

ABUNDANCE

Greyheaded Parrots were not common but were recorded during 16.7 % and 22.9 % of transects walked at Levubu and Makuya respectively. Most observations occurred in the early morning (before 09h00) (52.6 % of observations) and late afternoon (after 15h00) (36.8 % of observations) (Fig. 2). Greyheaded Parrots were sighted on 5 transects (31.3 % of observations made) and 12 transects (54.5 % of observations made) at Levubu and Makuya respectively, and were of birds flying over the transect. Flock size of parrots ranged from 1 - 6 (mean ± s.e. = 2.4 ± 0.4, n = 17).

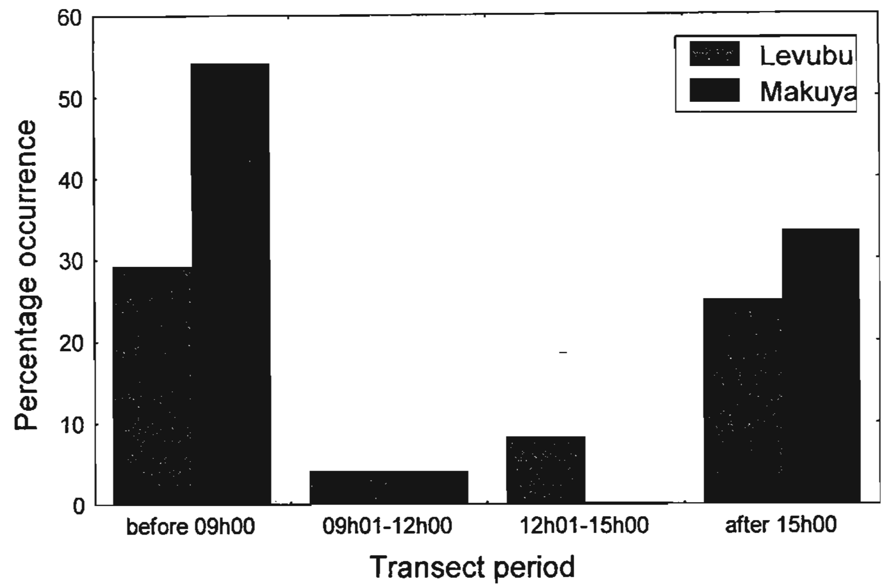

FIGURE 2. Frequency of occurrence of Greyheaded Parrots during transects at Levubu and Makuya.

The maximum daily number of Greyheaded Parrots accounted for in a week varied significantly at Levubu (mean ± s.e., 14.9 ± 3.7, n = 16; ANOVA, $F(15, 15) = 5.18$, $P < 0.05$) and Makuya (mean ± s.e., 4.7 ± 1.1, n = 17; ANOVA, $F(15, 30) = 3.22$, $P < 0.05$). At Levubu the daily maximum peaked at 50 birds per day during late October 1999, and at Makuya at 19 birds in mid-August (Fig. 3).Although there was little variation in flock size through a day, and from week to week at each study site, large flocks were observed (Fig. 6). Large flocks (44) were observed at Levubu during post-breeding flocking in late-October 1999, and a flock of 10 at Makuya late in the breeding season in mid-August (Fig. 7). These flocks were observed in the morning and accounted for a small proportion of total flocks sighted (Fig. 6).

DAILY ACTIVITY PATTERNS

At Levubu flight activity and behaviour patterns were clearly identifiable because of the vocal nature of parrots and an observer's ability to locate birds in flight. The dispersed nature of parrots and difficult accessibility at Makuya made parrots difficult to locate. However, patterns recorded at Makuya are similar to those observed at Levubu. Greyheaded Parrots were most active in the early morning and late afternoon (Fig. 4). Flight activity at both sites began at first light and continued until after sunset. Flight activity at Levubu began at *c* 05:00 and peaked from 06:00 to 06:59. Flight activity decreased to a minimum around midday, peaking again from 17:00 to 17:59. Activity continued after sunset until *c* 18:30. Flight activity at Makuya began at *c* 06:00, peaking from 07:00 to 07:59. After a midday decrease, activity increased from 16:00 to16:59 and continued until *c* 17:45. Times of active behaviour in relation to sunrise and sunset time were similar when seasonal variation in sunrise and sunset times are accounted for ($n = 12$, $r = 0.922$, $P < 0.05$) (Fig. 4).

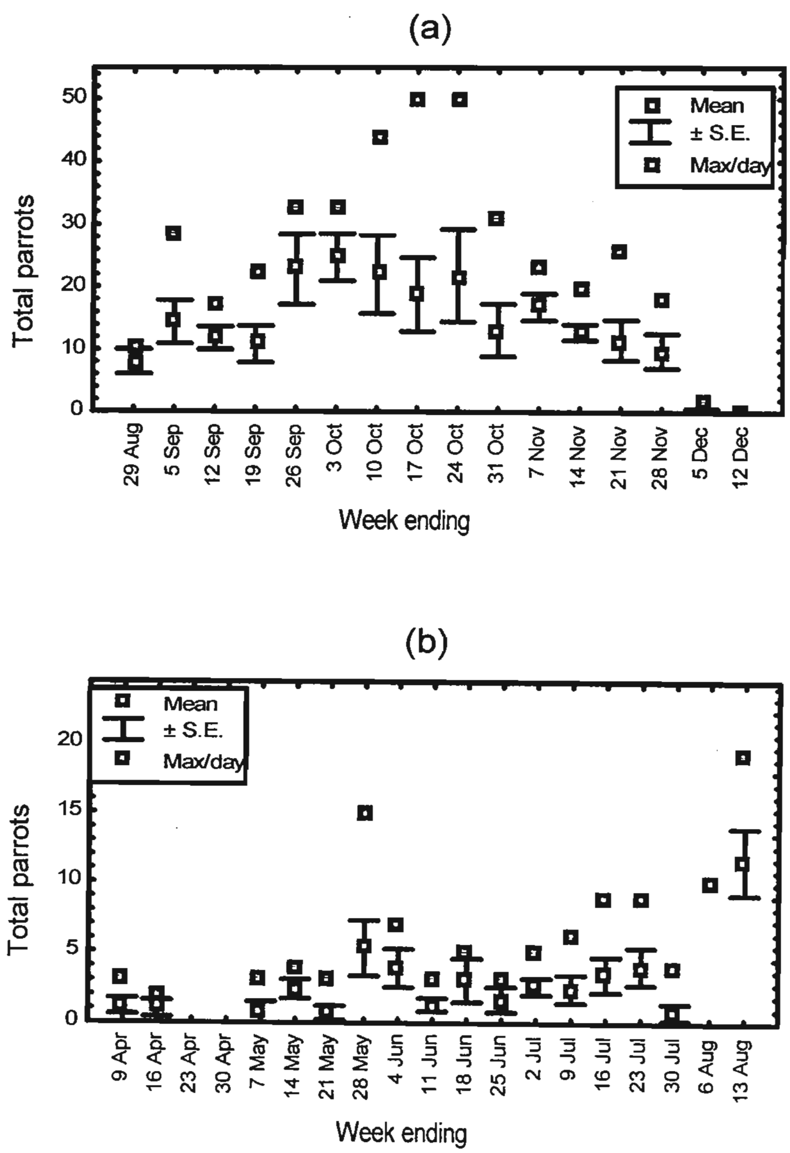

FIGURE 3. Average daily number of Greyheaded Parrots estimated per week at, a). Levubu and, b). Makuya (note different y-axis scales).

TABLE 1. Mean flock size (mean ± s.e.) during various flight activities of Greyheaded Parrots (sample size in parentheses).

	Activity	Levubu		Makuya	
Post-dawn flocking	1. Early morning flights to food site or activity centre	5.2 ± 0.8 (47)	**4.5 ± 0.4 (199)**	2.0 ± 0.2 (37)	**2.1 ± 0.2 (80)**
	2. Arrival at activity centre	2.6 ± 0.3 (84)		2.0 ± 0.2 (23)	
	3. Departure from activity centre	5.8 ± 0.8 (68)		2.3 ± 0.4 (20)	
	4. Late afternoon return flocks	3.9 ± 0.4 (111)		2.0 ± 0.2 (76)	
	5. Roost	3.4 ± 1.0 (8)		1.0 (1)	
Day-time socialising flocks	6. Movements between feeding sites and activity centres	5.4 ± 0.3 (266)	**4.9 ± 0.3 (558)**	2.1 ± 0.2 (66)	**2.1 ± 0.1 (297)**
	7. Daily movement within feeding site	4.2 ± 0.4 (199)		2.4 ± 0.2 (95)	
	8. Movement within activity centre	5.1 ± 0.9 (93)		1.8 ± 0.1 (136)	
		4.7 ± 0.2 (876)		**2.1 ± 0.1 (454)**	

EARLY MORNING ACTIVITIES

Activity began at dawn with long distance flights (estimated at up to 20 km) to early morning drinking, feeding, or socialising sites. Continuous calling announced the arrival of flocks at activity centres (Table 1; Fig. 6). During early morning activities birds were conspicuous when socialising and calling at activity centres. Socializing activities involved preening, allo-preening and mutual-preening, flying in small flocks and "playing". These activities were accompanied by high levels of vocalizing (Chapt. 6). Here birds called often, circling the area in small flocks, with high levels of intra-specific interacting. Snags and the uppermost branches of trees served as perches during early morning gatherings. Socialising, preening, allopreening, and feeding and drinking when food and water were present, occurred at these sites (Chapt. 6). A maximum of

50 birds gathered at one activity centre in October at Levubu (Fig. 3).

The use of activity centres was seasonal with the presence of food sources and/or water acting as cues for gathering birds. A food source and/or a drinking site was present at all activity centres. At an activity centre in Levubu prominent leafless white teak *Gmelina arborea* trees served as frequent snag like perches at early morning gatherings. At leaf flushing and the appearance of fruit feeding at this site occurred more often (Chapt. 5 & 6).

At Makuya lower average flock size and dispersion of birds caused lower flock sizes than at Levubu (Fig. 7). Early in the breeding season flocks comprised mostly male birds. On 03 June 2000 a flock of 8 birds (4 male and 4 female) was observed feeding at an activity centre. Prior to this, sightings of female birds were scarce and it was assumed they were incubating eggs (Chapt. 7). Later in the breeding season, as chicks likely became less dependent on adults for thermoregulation in the nest, females were sighted more often, and flock size increased (Fig. 7b). Thereafter, birds moved off in groups, usually in similar directions, to feeding sites. At Makuya birds possibly returned to nests. At an artificial drinking site near Punda Maria, similar gatherings occurred with up to 15 birds recorded in a morning.

Activity at a specific DAC identified in Levubu changed during the study (Chapt. 6). When birds were first seen there they were observed socializing, e.g. preening, allo-preening and mutual-preening, and drinking at an artificial drinking trough. As birds began to feed on a *G. arborea* more often, a fruit high in water content, so drinking occurred less often.

MID-MORNING TO LATE-AFTERNOON ACTIVITIES

Mid-morning activities involved feeding and social interaction, followed by a period of rest in hot weather, or continued socialising and active behaviour in cooler weather (Fig. 4). Feeding sites were generally more difficult to locate later in the day when vocal behaviour and flight activity from early morning to late afternoon declined (Fig. 4). Birds feeding and resting could only be located by disturbance. They would then fly off to a nearby tree, remaining quiet while continuing to rest.

LATE AFTERNOON ACTIVITIES

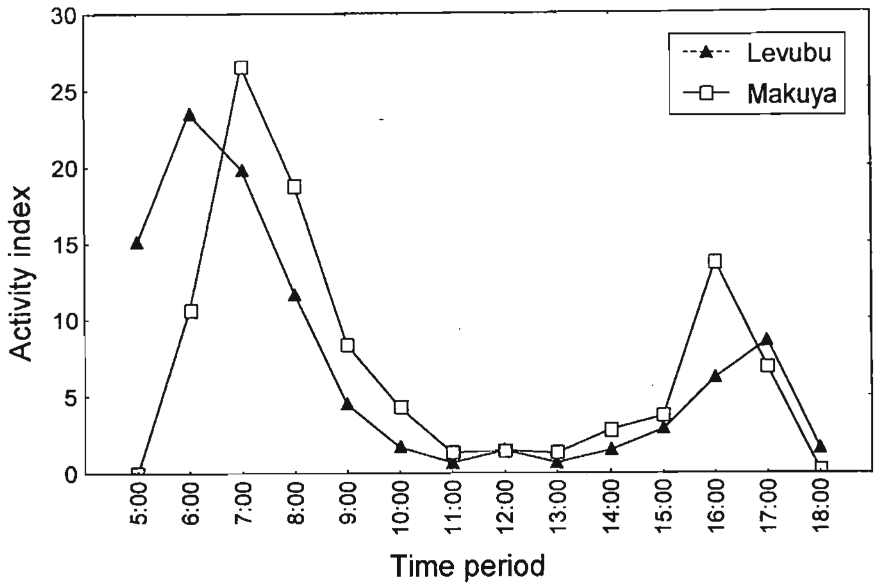

FIGURE 4. Activity of Greyheaded Parrot at Levubu and Makuya expressed a percentage flying flocks observed per hour.

Late afternoon movements involved the return of feeding flocks to roosts. These flocks were also observed gathering at the same early morning activity centres, on route to roost sites but not as often or as regularly as morning activities. Some birds roosted nearby in *Eucalyptus* sp. trees while others flew to distant roost sites estimated at up to 10 km away (Chapt. 6).

Late afternoon intra-specific avoidance was recorded once when a pair of birds were located preparing to roost in a stand of *Eucalyptus* sp. The pair had arrived at the roost site relatively early in the afternoon (*c*17:15) and remained quiet, climbing down the tree into the denser foliage of the canopy. Later in the afternoon another bird flew over, calling intensely, apparently attempting to locate other birds. The roost birds remained quite and the singleton passed over.

ROOSTS

Roosts were difficult to find. Some birds roosted in *Eucalyptus* sp. trees near an activity centre and were always the first birds to become vocal there. They were always joined by other birds at the activity centre. Other roosts were located in mixed broadleaved woodland (Chapt. 6). Greyheaded Parrots were once reported calling at *c* 03h00 at Levubu (D. Hlungwane pers. comm.).

FLIGHT ACTIVITY FLOCK SIZE VARIATION

Flock sizes of 1 - 4 parrots accounted for 68.3 % and 91.9 % of flocks observed at Levubu and Makuya respectively (Fig. 5). No flocks of > 10 birds were observed at Makuya whilst flocks of > 10 birds accounted for 10.3 % of flocks observed at Levubu (Fig. 5). Mean flock size of the breeding and non-breeding seasons combined was 3.8 ± 0.1 (median = 2, n = 1 330). Flock size of Greyheaded Parrots in flight differed significantly between Levubu (mean = 4.7 ± 0.2, median = 3, n = 876) and Makuya (mean = 2.1 ± 0.1, median = 2, n = 454) (Mann-Whitney U-test, Z = 10.767, $P < 0.05$) (Table 1).

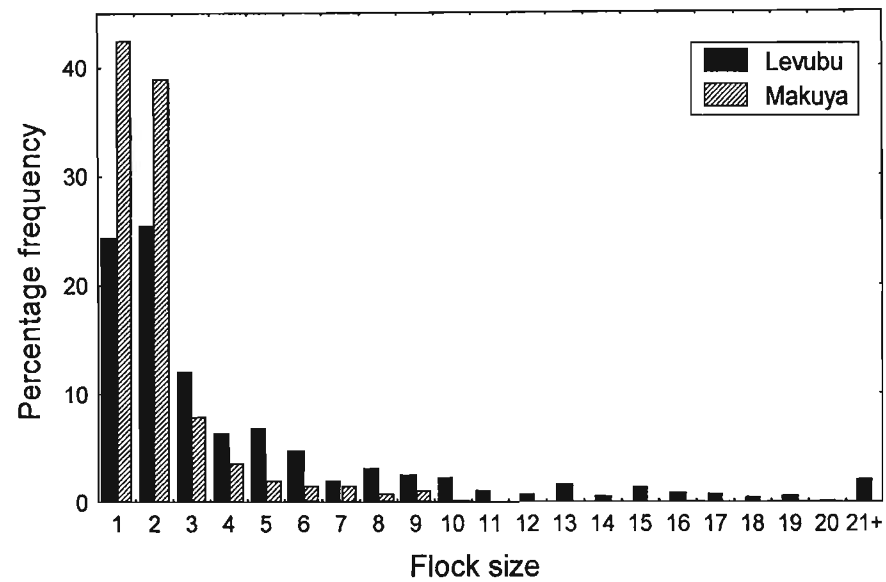

FIGURE 5. Frequency of flock sizes at Levubu and Makuya.

Flock size of Greyheaded Parrots showing different flight activities differed between study sites (Mann-Whitney U-tests, $P < 0.05$). However, roost flock size and flocks arriving at activity centres that did not differ between sites (Mann-Whitney U-tests, $P > 0.05$) (Table 1). At Levubu flocks arriving at activity centres were smaller than flocks departing activity centres (Mann-Whitney U-test, Z = - 2.780, $P < 0.05$) (Table 1). Flocks arriving at activity centres were also smaller than flocks flying to activity centres or feeding sites (Mann-Whitney U-test, Z = 2.407, $P < 0.05$) and day flocks moving between feeding sites and activity centres (Mann-Whitney U-test, Z = - 3.319, $P < 0.05$) (Table 1). Flocks departing activity centres were larger than late afternoon return flocks (Mann-Whitney U-test, Z = 2.320, $P < 0.05$) (Table 1). Day movement between feeding site and activity centre flocks were larger than late afternoon return flocks (Mann-Whitney U-test, Z = - 2.835, $P < 0.05$) and daily movement within feeding site flocks (Mann-Whitney U-test, Z = - 2.805, $P < 0.05$) (Table 1). There was no difference in flock size for different flight activities at Makuya (Mann-Whitney U-test, $P > 0.05$) except flocks moving within day feeding sites that were larger than flocks moving within activity centres (Mann-Whitney U-test, $Z = 2.682$, $P < 0.05$).

HOURLY FLOCK SIZE VARIATION

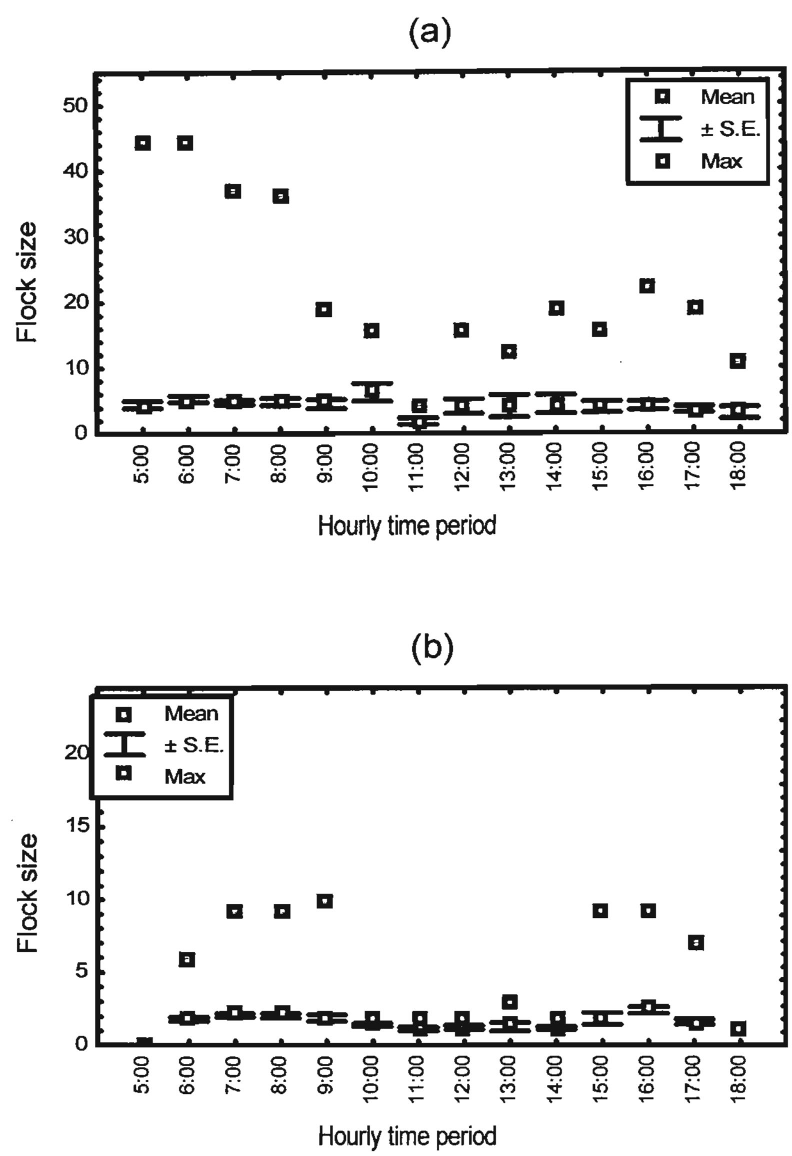

FIGURE 6. Mean and maximum hourly flock size at Levubu and Makuya (note different y-axis scales).

Hourly flock size of Greyheaded Parrots differed between sites for all day hours where parrots were observed (Mann-Whitney U-test, $P < 0.05$) except hourly time periods from 11h00-13h00

(Mann-Whitney U-test, $P > 0.05$). At Levubu, hourly flock sizes in the morning and in the afternoon were similar (Kruskal-Wallis ANOVA, a.m. $\chi^2 = 6.580$, p.m. $\chi^2 = 0.722$, $P < 0.05$). However, maximum flock size peaked in the early morning and late afternoon (Fig. 6a). Hourly flock size at Makuya did not differ (Kruskal-Wallis ANOVA, a.m.: $\chi^2 = 10.209$, df = 6, $P > 0.05$; p.m.: $\chi^2 = 6.848$, df = 5, $P > 0.05$, df = 5), yet maximum flock size peaked in the early morning and late afternoon (Fig. 6b).

WEEKLY FLOCK SIZE VARIATION

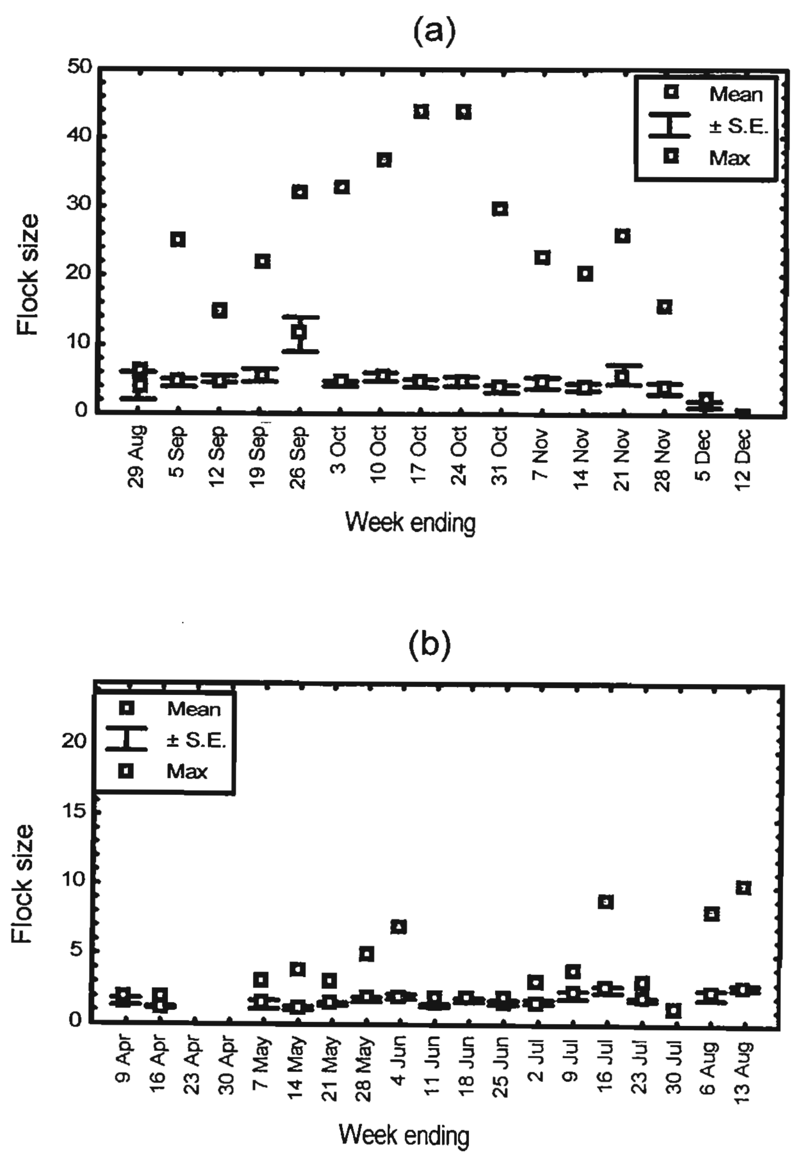

FIGURE 7. Mean and maximum weekly flock size at Levubu and Makuya (note different y-axis scales).

Flock size at Levubu was different between weeks and peaked in October (ANOVA, $F(14; 14) = 2.52$, $P < 0.05$) (Fig. 7a). Maximum flock sizes of 44 were recorded during week's ending 17 and 24 October. Although there was no significant difference between mean weekly flock size at Makuya (ANOVA, $F(15; 60) = 0.93$, $P > 0.05$), maximum flock size increased towards the end of the study period in August (Fig. 7b). At Makuya, maximum flock size began to increase once chicks began to fledge (Chapt. 7).

DISCUSSION

ABUNDANCE

Censussing Greyheaded Parrots is difficult because of the bimodal pattern of active behaviour each day, clumped distribution and flocking behaviour at certain times of the year, and long distance movements at particular times of the day (pers. obs.). Low numbers of parrots detected during transects where parrots are known to occur and counts of larger numbers at congregations may bias population estimates. Variation in flock size differs between seasons and techniques employed (Casagrande & Beissinger 1997). The concentration of birds at activity centres may account for birds from a large area and the count of 50 birds at Levubu was possibly an accurate population figure for that study site. Although Greyheaded Parrots were recorded less often during transects at Levubu than Makuya, density of parrots during the non-breeding season was higher (Chapt. 2). The difference between different sampling methods is thus reflected.

The origin of birds in the Levubu area is unknown but it is suspected they may be participating in post-breeding dispersal from their breeding range (Chapt. 3). Nests are only located in natural cavities of Baobabs *Adansonia digitata* and breeding is therefore restricted to them (Chapt. 7). Understanding the dispersion of activity centres, seasonal and daily flocking behaviour patterns, and the distances travelled during seasonal movements may lead to more accurate population estimates.

Seasonal variation in Greyheaded Parrot numbers is similar to Cape Parrots (Wirminghaus *et al.* 2001). The mean monthly number of Cape Parrots observed daily varied seasonally (mean: 21.8 ± 2.5, $n = 45$) and ranged from zero to 80 in April - May 1995 (Wirminghaus *et al.* 2001).

Fewer birds were observed at Hlabeni forest in spring and early summer, and random visits to forests were only reliable in determining presence or absence of birds (Marsden 1999; Wirminghaus *et al.* 2001). This variation is therefore likely to influence abundance estimates. Understanding these variations and patterns may therefore assist in accurate abundance estimates.

DAILY ACTIVITIES

Very little has been documented on the biology and behaviour of the Greyheaded Parrot (Holyoak & Holyoak 1972). Activities recorded in this study are similar to activities of other African parrots including African Grey *Psittacus erithacus*, Cape Parrot *Poicephalus robustus*, Jardine's Parrot *Poicephalus gulielmi*, Ruppell's Parrot *Poicephalus rueppelli*, Yellowfronted Parrot *Poicephalus flavifrons* and the Brownheaded Parrot *Poicephalus cryptoxanthus*, in which flocks are observed flying to feeding sites at sunrise (Swynnerton 1907; Skead 1964; Chapman *et al.* 1993; Wirminghaus *et al.* 2001).

A classic pattern of activity, with few flights during the day, was exhibited by the Greyheaded Parrot (Robbins 1981). This has been shown in other Australasian and neotropical parrots such as the Orangefronted Conure *Aratinga canicularis* (Hardy 1965), Puerto Rican Parrot *Amazona vitatta* (Snyder, Wiley & Kepler 1987), Redfronted Macaw *Ara rubrogenys* (Pitter & Christianson 1995), Maroon-bellied Parakeet *Pyrrhura frontalis*, Plain Parakeet *Brotogeris tirica* (Piza & Simão 1997) and Eclectus Parrot *Eclectus rorartus* (Marsden 1999).

A study of the Cape Parrot *Poicephalus robustus* at two forests in KwaZulu-Natal, South Africa showed bimodal daily activity patterns (Wirminghaus *et al.* 2001). Activity commenced around sunrise, was followed by inactivity through the mid-day, and recommenced a few hours before sunset, continuing until dusk (Wirminghaus *et al.* 2001). Early morning activity was characterised by overland flights between forest patches (Wirminghaus *et al.* 2001). Flock size arriving at Hlabeni forest ranged from singletons to 17 (mean 2.8 ± 0.7) and did not differ between months (Wirminghaus *et al.* 2001). However, total number of birds arriving at Hlabeni forest in the early morning differed between months (Wirminghaus *et al.* 2001). Birds moved to feeding sites and early morning social gatherings were at predictable sites, usually near or in forest. Intra-specific socialisation occurred with allo-, and mutual-preening. Thereafter, birds moved to feed and rest quietly in the forest canopy during the heat of the day. Late afternoon movements were characterized by flocks returning to roost sites. Daily activity patterns were, however, not compared between months (Wirminghaus *et al.* 2001).

Similarly, in the Greyheaded Parrot mid-morning activities involved feeding and social interaction, followed by a period of rest in hot weather, or continued socialising and active behaviour in cooler weather. During cool and cloudy weather, Greyheaded Parrots remained active throughout the day and, although not investigated, a strong correlation between ambient temperature and activity probably exists. Activity patterns were similar between sites even though birds at Makuya were breeding and might have been expected to behave differently. Early morning activity began earlier in summer (Levubu) than in winter/spring (Makuya) and afternoon activity continued later at Levubu than Makuya, reflecting seasonal variation in day length. Timing of activity of the Cape Parrot also changed seasonally and reflected seasonal changes in sunrise and sunset (Wirminghaus *et al.* 2001).

Activity of Greyheaded Parrots at early socialising points appears to support the hypothesis of Caccamise & Morrison (1986) in which birds return regularly to a Diurnal Activity Centre (DAC). Benefits of a DAC include; foraging within familiar surroundings thereby increasing efficiency (Tinbergen 1981), the presence of stable food resources (Davies 1976), and additional foraging and anti-predatory benefits obtained by flocking (Pulliam & Caraco 1984). The accumulation of Greyheaded Parrots at early morning activity centres at Levubu ended when birds moved off to alternative daytime feeding sites further away. Arriving flocks were smaller than departing flocks and increased the overall bird presence at activity centres. A high degree of intra-specific interaction, socialising and calling characterized the early morning social behaviour of birds (Chapt. 6). Such activity would be advantageous to newly fledged juveniles where learning the presence of seasonally available food sources is required for successful foraging and where anti-predatory benefits are obtained.

Greyheaded Parrots likely drink daily. If food is high in water content they may not need to do so daily (Chapt. 6). Relative abundance of food and water probably dictate local migrations of Greyheaded Parrots. These movements also have implications on the conservation of Greyheaded Parrots, because birds at activity centres are vulnerable to trapping. Similarly, in Cape Parrots, temporal availability of suitable roosts, food sources and drinking sites may explain daily movements (Wirminghaus *et al.* 2001). Numbers of Cape Parrots at forests where drinking sites were located were lower in summer than winter, and Cape Parrots are probably more dispersed when less free water is available (Wirminghaus *et al.* 2001). However, their flocking response is more likely related to breeding during spring and summer. They have been observed drinking from water collected in trees and if water is accessible above the ground then it is utilized (Wirminghaus, Downs, Symes & Perrin 2000b). This water source may even be preferred (pers. obs.).

Flight paths of late afternoon birds to roosts followed the converse of flight paths of early morning flights. Late afternoon returning flock size and roost flock sizes are similar. This suggests that roosting flock size may have already become established before returning to roost, and that roost flock size is maintained prior to roosting. The incidence of intra-specific avoidance behaviour, in which perched birds avoid flock flying over and calling, causes the maintenance of small flocks.

Ward & Zahavi (1972) have interpreted roost assemblages as "information centres" where the exchange of information between individual birds regarding the location of feeding sites is facilitated. In such cases, the assumption rarely questioned, and much less tested, is that of the roost being the individuals base of operation. In most studies, explanations of communal roosting have focussed on the conditions of the roost. Caccamise and Morrison (1986) demonstrated that European Starlings *Sturnus vulgaris* are more faithful to feeding sites and daily activity centres (DAC's) than roost sites. They suggested that such centres are probably not unique only to starlings. In the present study, the possibility of finding Greyheaded Parrots at a feeding site was greater than finding them at roosts. The movement of flocks to and from roosts was observed in near darkness therefore finding the exact locality of roost sites was difficult (Chapt. 6). Advertizing roost sites may increase risks of predation (Krebs & Davies 1999). Roost sites were not advertized by Greyheaded Parrots as in other flocking species. Aggregations of individuals have been described for numerous parrot species including the African Grey *Psittacus erithacus* where flocks at traditional roosts numbered hundreds of birds (Serle 1965; Snyder *et al.* 1987; Chapman *et al.* 1989; Gnam & Burchsted 1991; Johnson & Gilardi 1996; Mabb 1997; Gilardi & Munn 1998; Rasmussen 1999). This was not observed in the study but may occur at certain times of the year (S. Taylor pers. comm.). Flock size at roosts were smaller than at activity centres suggesting dispersion prior to roosting.

Calling at night has been recorded in diurnal species such as Redchested Cuckoo *Cuculus solitarius*, Cape Turtle Dove *Turtur capensis*, Helmeted Guineafowl *Numida meleagris* and Hadeda Ibis *Hagedashia hagedash* (pers.obs.). Calling of the Greyheaded Parrot at night may have been in response to disturbance, and may not occur often as it was only heard once by an observer who stayed nearby where parrots were recorded roosting (D. Hlungwane pers. comm.).

FLOCK SIZE VARIATION

Flocks of 1 - 4 Greyheaded Parrots were most common with larger flocks being observed at activity centres. Although large flocks (> 10 birds) were observed at Levubu they were not observed often (Fig. 5). Mean size of all Cape Parrot flocks observed at two study sites from March 1993 - December 1996 was 3.97 ± 0.07 (median = 2, n = 5 019) (Wirminghaus *et al.* 2001). This agrees with a Greyheaded Parrot mean flock size of 3.78 ± 0.13 (median = 2, n = 1 330) for the breeding season and non-breeding season combined.

Similarly, in a study of the Hawk-headed Parrot *Deroptyus accipitrinus* in Venezuela, groups of 2 - 4 birds were observed most frequently with 75 % of all sightings of three or less individuals (Strahl, Desenne, Jiminez & Goldstein 1991). Flocks of 1 - 3 individuals accounted for 86.2 % of flock observations in the Red Shining Parrot *Prosopeia tabuensis* (Rinke 1988). In a study of Peruvian Amazon parrot species, most Macaw and amazons occurred in pairs with occassionally 3 - 5 in a flock (Gilardi & Munn 1998). Smaller species generally occurred in larger flocks (Gilardi & Munn 1998). Groups of 1 - 4 Cape Parrots were observed most often at two study sites, and flocks rarely comprised > 10 individuals (Wirminghaus *et al.* 2001). Larger flocks of Cape Parrots, representing aggregations of several smaller groups, were concentrated at roost sites, water points and fruiting trees (Wirminghaus *et al.* 2001).

At Levubu and Makuya, although activity changed through the day, flock size per hourly time period was constant. Maximum flock size did, however, peak in the early morning and late afternoon, and is attributed to early morning gathering at activity centres and late afternoon pre-roosting flocks. This was similar in Santa Rosa National Park, Costa Rica, where parrot/parakeet flock size at different hours of the day was highly variable (Chapman *et al.* 1989).

DAILY VARIATION

It has been shown that parrot flocks departing roosts left in small groups, in a dispersive fashion (Chapman *et al.* 1989). This suggests roosts may therefore serve to facilitate dispersion and reduce competition for food sources (Chapman *et al.* 1989). Similarly, in the Greyheaded Parrot, activity centres may serve to facilitate dispersion where separate flocks fly to different feeding sites each morning. At Levubu, flocks departing activity centres were larger than arriving flocks, yet smaller than the total number of birds at the activity centre. At Makuya flocks arriving and departing were similar in size, yet departing flocks were smaller than the total number of birds seen at the activity centre. It is suggested that flocks departing Levubu attempt to increase flock size, and that small flocks attempt to "draw" remaining birds into a departing flock, by circling the activity centre and calling continuously. Such interpretations are speculative but support the Foraging Dispersion (FD) Hypothesis (Chapman *et al.* 1989) in which successive flocks departing a roost (in the case of the Greyheaded Parrot, an activity centre) avoid the preceding flocks departure route. The Information Centre (IC) Hypothesis, however, suggests that unsuccessful foragers follow successful feeders to feeding sites when they leave the roost. Unsuccessful foragers are likely juveniles, where feeding juveniles are recognized by inexperienced and uncoordinated feeding techniques (pers. obs.). In the Greyheaded Parrot activity centres would have the same function as Information Centre roosts. Daytime flocks generally remained small suggesting that flocks retained their small size, and were able to avoid one another through a day. This is reflected in the low numbers observed during the day.

The IC Hypothesis and FD Hypothesis are not mutually exclusive. Greyheaded Parrots are very social at activity centres, yet groups avoid one another when leaving activity centres. This may improve foraging efficiency yet reduced predator avoidance. However, if food sources are abundant, intra-specific competition will be low in these specialist seed predators. Avoidance will therefore be unnecessary if food availability is the cause (Chapt. 5).

SEASONAL VARIATION

An average flock size of 4.7 during the non-breeding season at Levubu, and of 2.1 during the breeding season at Makuya suggests that the social unit structure of the Greyheaded Parrot is the family group. During the breeding season this comprised a mated couple. Once chicks have fledged, the flock comprises an adult pair and two to four dependent juveniles (Chapt. 7). Non-breeding, unpaired and sub-adult individuals may associate with family groups. Clutch size ranges from 2 - 4 chicks and post-fledging dependence is estimated to last for 4 - 6 months in the wild (Chapt. 7). Therefore, during the non-breeding season flocks comprise a mated pair with 2 - 4 dependent juveniles. Also, aggregation of these family groups out of the breeding season is more common and larger flocks are recorded. Once juveniles became independent they separate and disperse, possibly forming loose mixed sex flocks where pair bonding occurs. The mated pair are then able to breed again.

Ecological theory predicts that group size of animals feeding on depleting resources will be largest when resources are abundant and uniformly distributed (Bradbury & Vehrencamp 1976; Krebs & Davies 1999). Both the IC and DAC Hypotheses suggest that roosting flock size would be greatest when resources are rare and clumped (Ward & Zahavi 1972; Caccamise and Morrison 1986). Cannon (1984) suggested that flock size was probably a response to temporary and localised resources that provide benefits to juveniles through local enhancement and social learning. Maximum flock size at Levubu showed a clear peak in mid-October during the non-breeding season. Greyheaded Parrots are strong fliers and learning the location of temporal feeding grounds may be an important component of socialization. Flock size, therefore, may not be a response to available food sources, but rather a behavioural response in the life history of these birds. In Australia, flock size in birds has been attributed to aridity (Brereton 1971; Cannon 1984) and predation (Westcott & Cockburn 1988). Flocking is more likely to occur in an avifauna with many predators (Pulliam & Millikan 1982) and is more likely to occur in smaller species (Gilardi & Munn 1998). In this study flocking is not attributed to predators as there were a greater number of species and higher abundance of predators where flocking was less obvious (Chapt. 7). Flocking of Red Shining Parrots is higher in Fiji than Tonga and is attributed to the presence of three diurnal avian predators at the former site and none at the latter (Rinke 1988). Newly fledged young that are more vulnerable to avian predators obtain anti-predatory benefits through flocking and congregating with adults when they are active (Rinke 1988). During hours when birds are less active, flock sizes are small and anti-predatory flocking benefits are reduced.

Flocking of Cape Parrots peaks during dry months (May - Aug), when *Podocarpus falcatus* trees are in fruit and generally when they are not breeding (Wirminghaus *et al.* 2001). Numbers are low when birds nest and aggregations of juveniles follow the breeding season (Wirminghaus *et al.* 2001). This seasonal change has also been noted in introduced *Amazona* parrots in the San Gabriel Valley, California (Frocke 1981; Mabb 1997), and has been attributed to breeding biology. Flock size of introduced Mitred Parakeets *Aratinga mitrata* in Long Beach, California, also varies seasonally (Collins & Kares 1997). Studies of African parrots show that large flocks are found when food is plentiful at a particular site, while pairs are more common during the breeding season (Chapman *et al.* 1993).The Orange-fronted Parakeet *Aratinga canicularis* is highly social out of the breeding season but disperses in pairs when nesting (Hardy 1966). In Tonga, Red Shining Parrots live in pairs and are accompanied by their offspring after the breeding season (Rinke 1988). Flocking does not appear to occur and a maximum of 10 birds congregate in feeding trees (Rinke 1988). During the breeding season female Red Shining Parrots *Prosopeia tabuensis* spend most of time in the nest and frequency of single birds during this time was common (Rinke 1988). This seasonal flock size variation is similar to Cape Parrots. Arrival and departure flocks differed between months and departure flock size ranged from singletons to 26 birds (Wirminghaus *et al.* 2001). These departure flocks are synonymous with late afternoon return flocks of this study (Table 1). At Hlabeni, Cape Parrot departure flocks also differed between seasons (Wirminghaus *et al.* 2001).

CONCLUSION

Greyheaded Parrots are not common and presence in an area is dependent on the availability of food and water. Flocking occurs seasonally with aggregations of birds in flocks during the post-breeding period. These flocks likely comprise individuals from a wide area that may cause misinterpretations of estimates of wild population numbers. Post-breeding flocking and the predictable occurrence at activity centres for extended periods makes birds vulnerable to natural predation and illegal capture. Their strict activity patterns may facilitate easy illegal capture and have negative implications on the conservation of the species in certain parts of their range.

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LITERATURE CITED

BRADBURY, J.W. & VEHRENCAMP, S. 1976. Social organization and foraging in emballonurid bats. II. A model for the determination of group size. Behav. Ecol. Sociobiol. 1:383-404.

BRERETON, J. L. 1971. Interanimal control of space. In Esser, A.H. (Ed). Behaviour and the environment. pp. 69-91. Plenum Press. New York.

CACCAMISE, D.F., LYON, L.A. & FISCHL. J. 1983. Seasonal patterns in roosting associations composed of starlings and common grackles. Condor 84:474-481.

CACCAMISE, D.F. & MORRISON, D.W. 1986. Avian communal roosting: implications of diurnal activity centers. Am. Nat. 128(2):191-198.

CANNON, C.E. 1984. Flock size of feeding eastern and pale-headed rosellas. Aust. Wildl. Res. 11:349-355.

CASAGRANDE, D.G. & BEISSINGER, S.R. 1997. Evaluation of four methods for estimating parrot population size. Condor 99:445-457.

CHAPMAN, C.A., CHAPMAN, L.J. & LEFEBVRE, L. 1989. Variability in parrot flock size: possible functions of communal roosts. Condor 91:842-847.

CHAPMAN, C.A., CHAPMAN, L.J. & WRANGHAM, R. 1993. Observations on the feeding biology and population ecology of the Grey Parrot *Psittacus erithacus*. Scopus 16:89-93.

COLLINS, C.T. & KARES, L.M.. 1997. Seasonal flock sizes of naturalized Mitred Parakeets (*Aratinga mitrata*) in Long Beach, California. Western Birds 28:218-222.

CLANCEY, P.A. 1997. The Cape Parrot: an additional valid species. Honeyguide 43:61-62.

DAVIES, N.B. 1976. Food, flocking and territorial behaviour of the pied wagtail (*Motacilla alba yarrellii* Gould) in winter. J. Anim. Ecol. 45:235-253.

DOWNS, C.T & SYMES, C.T. 1998. Cape Parrots. Report on the second Cape Parrot Big Birding Day, (25 April 1998). Psittascene 10(3):5-7.

FROKE, J.B. 1981. Population movements, foraging and nesting feral *Amazona* parrots in southern California. M.S. Thesis, Humbolt State University, Arcata, California.

FYNN, A.R. 1991. Feeding and movements of the Brown-necked Parrot in the Trelawney district. Honeyguide 37(1):5-8.

GILARDI, J.D. & MUNN, C.A. 1998. Patterns of activity, flocking and habitat use in parrots of the Peruvian Amazon. Condor 100:641-653.

GNAM, R.S. & BURCHSTED, A. 1991. Population estimates for the Bahama Parrot on Abaco Island, Bahamas. J. Field. Ornithol. 62:139-146.

HAMPE, A. 1998. Field studies on the Black Parrot *Coracopsis nigra* in western Madagascar. Bull ABC 5(2):108-113.

HARDY, J.W. 1965. Flock social behaviour of the Orange-fronted Parakeet. Condor 67:140-156.

HARDY, J.W. 1966. Physical and behavioural factors in sociality and evolution of certain parrots (*Aratinga*). Auk 83:66-83.

HOGSTAD, O. 1984. Variation in numbers, territoriality and flock size of a Goldcrest *Regulus regulus* population in winter. Ibis 126:296-306.

HOLYOAK, D.M. & HOLYOAK, D.T. 1972. Notes on the behaviour of African parrots of the genus *Poicephalus*. Avicul. Mag. 78:88-95.

JOHNSON, M.D. & GILARDI, J.D. 1996. Communal roosting of the Crested Caracara in southern Guatemala. J. Field Ornithol. 67:44-47.

KREBS, J R. & DAVIES, N.B. 1999. An introduction to behavioural ecology (3rd Edition). Blackwell Science. Oxford.

MABB, K. 1997. Nesting behaviour of *Amazona* parrots and Rose-ringed Parakeets in the San Gabriel Valley, California. Western Birds 28:209-217.

MARSDEN, S.J. 1999. Patterns of diurnal flight activity in three Indonesian parrot species. Papageienkunde 3 (S):1-8.

PITTER, E. & CHRISTIANSON, M.B. 1995. Ecology, status and conservation of the Red-fronted Macaw *Ara rubrogenys*. Bird Conserv. Int. 5:61-78.

PIZO, M.A. & SIMÃO, I. 1997. Daily variation in activity and flock size of two parakeet species from south-eastern Brazil. Wilson Bulletin 109(2):343-348.

PULLIAM, H.R. & CARACO, T. 1984. Living in groups: is there an optimal group size? In: Krebs, J.R. & Davies, N.B. (Eds). Behavioural Ecology: an evolutionary approach. Blackwell. Oxford.

PULLIAM, H.R. & MILLIKAN. G.C. 1982. Social organization in the nonreproductive season. In: Karner, D.S., King, J.R. & Parkes, K.C. (Eds). Avian Biology, vol. VI, pp. 169-197.

Academic Press. New York & London.

RASMUSSEN, C. 1999. Flock sizes of parrots recorded in a *terre firme* lowland rainforest in Parque Nacional Yasuni, Ecuador. Papageienkunde 3: S. 141-145.

RINKE, D. 1988. Group sizes of Red Shining Parrots on'Eua, Kingdom of Tonga. Notornis 35:57-58.

ROBBINS, C.S. 1981. Effect of time of day on bird activity. Stud. Avian Biology 6:275-286.

SERLE, W. 1965. A third contribution to the ornithology of the British Cameroons. Ibis 107:60-94.

SKEAD, C.J. 1964. The overland flights and the feeding habits of the Cape Parrot, *Poicephalus robustus* (Gmelin) in the eastern Cape Province. Ostrich 25(1):202-223.

SNYDER, N.F.R., WILEY, J.W. & KEPLER, C.B. 1987. The parrots of Luquillo: natural history and conservation of the Puerto Rican Parrot. Western Foundation of Vertebrate Zoology. Los Angeles.

SOLMS, L., BERRUTI, A., PERRIN, M., DOWNS, C. & BLOOMER, P. 2000. Phylogenetic relationships of the three subspecies of the Cape Parrot *Poicephalus robustus*. 17th Congress of the South African Genetics Congress. June 2000. Pretoria.

STATSOFT, Inc. 1995. STATISTICA for windows.(Computer program manual). StatSoft Inc.,Tulsa, OK.

STRAHL, S.D., DESENNE, P.A., JIMINEZ, J.L. & GOLDSTEIN, I.R. 1991. Behaviour and biology of the Hawk-headed Parrot *Deroptyus accipitrinus*, in southern Venezuela. The Condor 93:177-180.

SWYNNERTON, C.F.M. 1907. On the birds of Gazaland, Southern Rhodesia. Part II. Ibis 9:279- 311.

SYMES, C.T & DOWNS, C.T. 1998. The role of nest sites in population declines of the Cape Parrot. Avizandum. Sept 1998: 32-33.

TINBERGEN, J.M. 1981. Foraging decisions in starlings (*Sturnus vulgaris* L.). Ardea 69:1-67.

WARD, P. & ZAHAVI, A. 1972. The importance of certain assemblages of birds as "information centres" for food finding. Ibis 115:517-534.

WEATHERHEAD, P.J. 1983. Two principal strategies in avian communal roosts. Am. Nat. 121(2):237-243.

WESTCOTT, D.A. & COCKBURN, A. 1988. Flock size and vigilance in parrots. Aust. J. Zool. 36:335-349.

WIRMINGHAUS, J.O. 1997. Cape Parrot *Poicephalus robustus*. In: Harrison, J.A., Allan, D.G., Underhill, L.L., Herremans, M., Tree, A.J., Parker, V. & Brown, C.J. (Eds). The atlas of southern African birds - Vol 1. Birdlife - South Africa. Johannesburg.

WIRMINGHAUS, J.O., DOWNS, C.T., SYMES, C.T., DEMPSTER, E. & PERRIN, M.R. 2000a. Vocalisations and behaviours of the Cape parrot *Poicephalus robustus* (Psittaciformes: Psittacidae). Durban Museum Novitates 25:12-17.

WIRMINGHAUS, J.O., DOWNS, C.T., SYMES, C.T. & PERRIN, M.R. 2000b. Abundance of the Cape parrot in South Africa. S. Afr. J. Wildl. Res. 30(1):43-52.

WIRMINGHAUS, J.O., DOWNS, C.T., PERRIN, M.R. & SYMES, C.T. 2001. Abundance and activity of the Cape Parrot *Poicephalus robustus* in afromontane forests in southern Africa. African Zoology 37(1):71-77.

WIRMINGHAUS, J.O., DOWNS, C.T., PERRIN, M.R. & SYMES, C.T. In press. Taxonomic relationships of the subspecies of the Cape Parrot *Poicephalus robustus* (Gmelin). J. Nat. Hist.

CHAPTER 5

Feeding Biology of the Greyheaded Parrot *Poicephalus fuscicollis suahelicus* (Reichnow) in Northern Province, South Africa

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Summary: The Greyheaded Parrot *Poicephalus fuscicollis suahelicus* feeds on at least 25 tree species through its range. In Northern Province, South Africa, it was recorded feeding on the fruit of six tree species during the non-breeding season (August - December) and eight species during the breeding season (April - August). It was also recorded feeding on the bark of three additional species during the breeding season. Competition with other avian frugivores was low as Greyheaded Parrots were specialist feeders, accessing the kernel of unripe fruit which other species are unable to do. Energy content of food species ranged from 15.72 $MJ.kg^{-1}$ (*Gmelina arborea,* an exotic) to 31.18 $MJ.kg^{-1}$ (*Sclerocarya birrea*), and protein from 8.75 % (*G. arborea*) to 39.81 % (*Melia azaderach,* an exotic). Feeding choice reflected seasonal fruit availability, and during any one month feeding occurred on few tree species.

The Greyheaded Parrot *Poicephalus fuscicollis suahelicus* has a broad range, extending from north-eastern South Africa, north through Zimbabwe, northern Botswana, the Caprivi of Namibia, Angola, Malawi, Mozambique, Tanzania, into south-western Uganda and southern and eastern Democratic Republic of Congo (Bannerman 1953; Smithers, Irwin & Paterson 1957; Traylor 1963; Mackworth-Praed & Grant 1970; Benson *et al.* 1971; Lippens & Wille 1976; Benson & Benson 1977; Snow 1978; Penry 1994; Wirminghaus 1997; Dean 1999; Parker 1999). It occurs in a variety of habitats yet is generally associated with woodland, woodland savannah and forest at higher altitudes (Swynnerton 1907; Benson & Irwin 1966; Wirminghaus 1997, Chapt. 2). It has been recorded feeding on a number of fruiting tree species throughout its range (Table 1). In Gambia *P. fuscicollis fuscicollis* has been reported feeding on mangrove fruit *Rhizophora* spp. and peanuts left out to dry (Hopkinson 1910). Captive birds are known to feed on a diet of groundnuts, rusks and bananas (Lang 1969), although this may be insufficient to support breeding nutritional requirements. They will also feed healthily, and breed, when fed sunflower seeds and a nutritionally supplemented mixture of various fruit and vegetables (W. Horsfield pers. comm.; pers. obs.).

Table 1. Food species recorded for the Greyheaded Parrot throughout its range. (* species also recorded in this study)

Scientific name	Common name	Fruit item	Reference
Adansonia digitata	Baobab	seed	Mackworth-Praed & Grant 1970
Aningeria adolfi-friedericii	Aningeria	fruit?	Fry *et al.* 1988
Celtis africana	White Stinkwood	unripe kernel	Rowan 1983
Chrysophyllum gorungosum	Brown-berry Fluted Milkwood	fruit?	Fry *et al.* 1988
Combretum apiculatum *	Red Bushwillow	kernel	W. Hlungwane pers. comm.
Commiphora edulis	Rough-leaved Commiphora	kernel	W. Hlungwane pers. comm.
Commiphora karibensis	Angular-stemmed Commiphora	fruit?	Jacobsen 1979
Commiphora mollis *	Velvet Commiphora	kernel	W. Hlungwane pers. comm.
Diospyros mespiliformis *	Jackal-berry	unripe kernel	Fynn 1991; T. Prinsloo pers. comm.
Erythrina abyssinica	Red-hot Poker Coral Tree	nectar	Fynn 1991
Euphorbia ingens	Common Tree Euphorbia	seed/flowers	H. Erwee pers. comm.
Ficus sur	Broom Cluster Fig	fruit	W. Hlungwane pers. comm.
Ficus sycomorus	Common Cluster Fig	fruit	Tarboton *et al.* 1987, H. Barkhuysen pers.comm.
Grewia hexamita	Giant Raisin	kernel	W. Hlungwane pers. comm.
Kirkia acuminata *	White Seringa	unripe/ripe kernel	H. Erwee pers. comm.
Lannea discolor	Live-long	unripe kernel	Fynn 1991
Monotes glaber	Pale-fruited Monotes	kernel	Fynn 1991

Scientific name	Common name	Fruit item	Reference
Olinia rochetiana	Rock Hard pear	fruit flesh	W. Hlungwane pers. comm.
Parinari curatellifolia *	Mabola Plum	unripe kernel	Fynn 1991; T. Prinsloo pers. comm.
Pseudostachnostylis maprouneifolia *	Kudu-berry	ripe/unripe kernel	Jacobsen 1979; C.T.Downs unpubl. data
Schinziophyton rautanenii	Manketti Tree	unripe kernel	Benson & White 1957
Sclerocarya birrea *	Marula	unripe kernel	various pers. comm.; C.T.Downs unpubl. data
Syzygium cordatum	Water Berry	ripe kernel	Fynn 1991
Syzygium guineense	Water Pear	ripe kernel	Fynn 1991
Terminalia prunioides *	Lowveld Cluster-leaf	unripe kernel	V. Crowther pers. comm.
Uapaca kirkiana	Mahobohobo	unripe kernel	Fynn 1991
Uapaca nitida	Narrow-leaved Mahobohobo	-	Benson & White 1957
Zea mays	corn	pips	Mackworth-Praed & Grant 1970
-	millet	seeds	Wilkes 1928
Sorghum	sorghum	seeds	Swynnerton 1907; Wilkes 1928

Very little is known about the feeding biology of the Greyheaded Parrot in the wild and available information includes anecdotal reports in the literature (Perrin, McGowan, Downs, Symes & Warburton 2000). Feeding ecology of African parrots is generally poorly known yet detailed information on the diet of the Cape Parrot *Poicephalus robustus* has been documented (Wirminghaus *et al.* In press a). The Cape Parrot, recently identified as a separate species to the Greyheaded Parrot, is a specialist feeder, accessing the kernel of unripe forest fruit, and most importantly the fruit of *Podocarpus* species (Wirminghaus *et al.* In press a).

This study sought to investigate the feeding biology of the Greyheaded Parrot in the south of its range. It was hypothesized that Greyheaded Parrots, like Cape Parrots, are specialist feeders, relying on specialist feeding techniques to access fruit kernels of high energy content. As a result, food competition from other frugivorous species would be low. The Cape Parrot is a predispersal seed predator (Wirminghaus *et al.* In press a), inactive in the dispersion of seeds. It was predicted that the Greyheaded Parrot would similarly prey on seeds, playing little role in seed dispersion. Male Greyheaded Parrots are significantly larger than females (Wirminghaus *et al.* In press b) and it was predicted that resource partitioning would be evident in feeding birds.

Materials and methods

Study sites and observational data

The study was conducted at two sites in the southern limit of the range of the Greyheaded Parrot (Fig. 1). Greyheaded Parrots occur seasonally in the Levubu district (23° 00' - 23° 15' S, and 30° 05' - 30° 30' E) from August to December and arrive to feed on certain fruiting trees in the area (Chapt. 3; various pers. comm.). Field work was conducted there from August 1999 to December 1999 during the non-breeding season of the Greyheaded Parrot. Habitat types were dominated by mixed woodland and bushveld habitats, with no particular tree species dominant (Chapt. 2). Baobabs *Adansonia digitata* are absent in this region (Chapt. 2 & 7). Intensive agriculture is practised in some regions e.g. banana, macadamia, mango and tropical crops (Chapt. 2), and bush encroachment has occurred where lands have been left fallow (various pers. comm.).

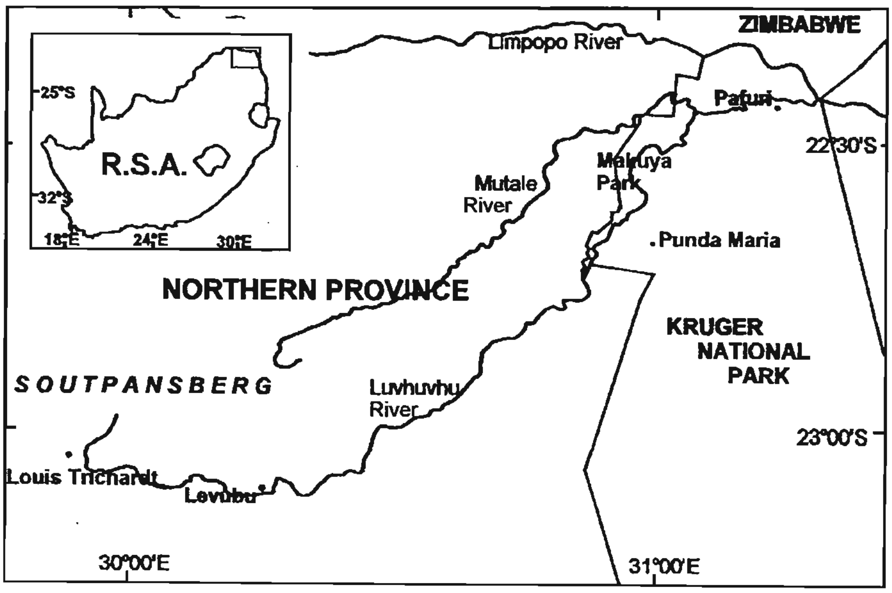

Figure 1. Map of the north-east South Africa showing locality of study sites.

Exceptionally high rains from January to mid-March 2000 throughout the southern African sub-region, and flood damage in the study areas prevented fieldwork during these months (Fig. 1). These rains destroyed most of the riverine vegetation along the Mutale and Luvhuvhu rivers and may have implications for the movements and feeding biology of Greyheaded Parrots in the region (Chapt. 2 & 3).

Field work recommenced in the region of the Luvhuvhu-Mutale river confluence (22° 26' - 22° 32' S, and 30° 50' - 31° 05' E), during April - September 2000. This period included several months of the breeding season of the Greyheaded Parrot. Habitat types were dominated by mixed woodland with mono-specific stands of Mopane *Calophospermum mopane*, *Combretum* spp., *Acacia* spp., Lebombo Ironwood *Androstachys johnsonii* and *Terminalia* spp. Baobabs are conspicuous yet uncommon in the region (Chapt. 2). Observations also occurred from a vehicle in the Punda Maria (22° 41' S, 31° 01' E) area of the Kruger National Park.

Diet of the Greyheaded Parrot was determined by direct observations in the field. A feeding observation was defined as an individual or flock feeding in a particular tree for up to 20 minutes duration. The following data were recorded: tree species, locality, sex and age of feeding bird(s), food item and fruit handling time. Feeding method and technique were also noted for each food species. Footedness was recorded in instances where parrots were observed using the foot to manouevre the food item while feeding. Observations were made using a Kowa TS-611 telescope supported on a tripod.

Individual trees of Mabola Plum *Paranari curatellifolia* (6 trees) and exotic White Teak *Gmelina arborea* (8 trees) in which parrots were regularly observed feeding were selected to determine fruit wastage of feeding birds. Fruit was collected from beneath each tree and the proportion of fruit eaten and fruit wasted or rejected determined. Rejected fruit was identified by a maxilla bite mark in the fruit, with no part of the kernel eaten. A blanket of shade-cloth was used to collect fallen fruit where dense vegetation was likely to hide fallen fruit. Once fruit began to ripen fruit-bats (species not identified) were observed feeding on fruit. Sampling fruit rejection then ceased.

Fruit abundance

Relative fruit abundance of the two main food species Greyheaded Parrots were observed feeding on in Levubu was determined by recording fruit development in randomly selected trees. Thirty-seven *P. curatellifolia* and eleven *G. arborea* used at a regular feeding site/early morning gathering centre in the Levubu area were selected. Fruit stage (none/absent, flowering, setting, unripe, ripe, moribund) was recorded bimonthly during the study period.

Monthly recordings of fruit stage of 12 known and eight potential food tree species were made at Makuya. A subjective interpretation of fruit stage of the majority of individual tree species seen was determined monthly while working in the field for each particular month.

Food quality

Fruit samples of food species were collected to determine energy and protein content in the diet of the Greyheaded Parrot. Wet weight of the whole fruit was obtained, after which the kernels were removed (or part of fruit determined to be eaten by parrots) for analysis. Samples were oven-dried at 60°C to constant mass and then reweighed. Seed parts eaten by parrots were milled for analysis procedures at Department of Animal Science, University of Natal. Energy was determined using an adiabatic bomb calorimeter (DDS CP 500) and protein analysis using the Dumas combustion method in a Leco FP 2000 combustion analyser. Additional fruit samples from trees where parrots were seen feeding were collected and measured to determined fruit size.

Results

Food trees and observational data

At Levubu, most feeding observations of Greyheaded Parrots were made in *P. curatellifolia* (56.0 %) and *G. arborea* (34.7 %), with observations in *G. arborea* made at one locality (Table 2). At Makuya, most observations were on Velvet Commiphora *Commiphora mollis* (30.4 %) and Kudu Berry *Pseudostachnostylis maprouneifolia* (19.6 %). Birds were often seen biting and chewing on branches of snags during early morning socializing activities (Chapt. 6). Careful observation was made of such activity and positive identifications of birds feeding on the bark of Leadwood *Combretum imberbe* and Baobab *Adansonia digitata* were made (Table 2). The ingestion of bark was supported by the presence of bark in the crops of nestlings (Chapt. 7). Greyheaded Parrots were once observed mandibulating a *P. curatellifolia* and a *Combretum* sp. leaf in the bill. All observations were of birds feeding in trees. Greyheaded Parrots were only seen on the ground when drinking, and no observations were made of feeding on commercial crops (e.g. pecan nuts or macadamia nuts which are common in Levubu) at either site.

Table 2. Food tree species of Greyheaded Parrot and proportion of feeding observations at each study site (* indicates exotic species).

Locality	Food tree	Food Item	A	S	O	N	D	M	J	J	A	Proportion	N
Levubu	*Parinari curatellifolia*	unripe kernel, (once on leaf?)	13	28	39	4						56.0	84
	Gmelina arborea *	unripe kernel			2	49	1					34.7	52
	Melia azaderach *	ripe kernel		2		7						6.0	9
	Eucalyptus sp. *	ripe kernel, bark				2						1.3	2
	Sclerocarya birrea	unripe kernel			2							1.3	2
	Erythrina caffra	ripe kernel			1							0.7	1
Makuya	*Commiphora mollis*	unripe kernel						6	6	1	1	30.4	14
	Pseudostachnostylis maprouneifolia	unripe & ripe kernel									9	19.6	9
	Terminalia sericea	ripe kernel						3		2	1	13.0	6
	Xanthocercis zambesiaca	unripe kernel									5	10.9	5
	Combretum imberbe	bark							1	1	1	6.5	3
	Terminalia prunioides	ripe kernel						1	1			4.3	2
	Adansonia digitata	bark						1	1			4.3	2
	other *Combretum* spp.	bark									2	4.3	2
	Diospyros mespilliformis	unripe kernel							1			2.2	1
	Afzelia quazensis	ripe seed									1	2.2	1
	Kirkia acuminata	ripe kernel						1				2.2	1
	Number of species	**17**	**1**	**2**	**4**	**4**	**2**	**5**	**5**	**3**	**7**		

Frequency of feeding observations, months in which feeding occurred, and number of feeding observations each month are summarized in Table 2. *P. curatellifolia* was common in Levubu in which most feeding observations occurred. Greyheaded Parrots, although more difficult to locate in Makuyu, were observed feeding on a greater number of species there. No other bird or mammal species were observed feeding on unripe fruit when Greyheaded Parrots were.

Fruit abundance

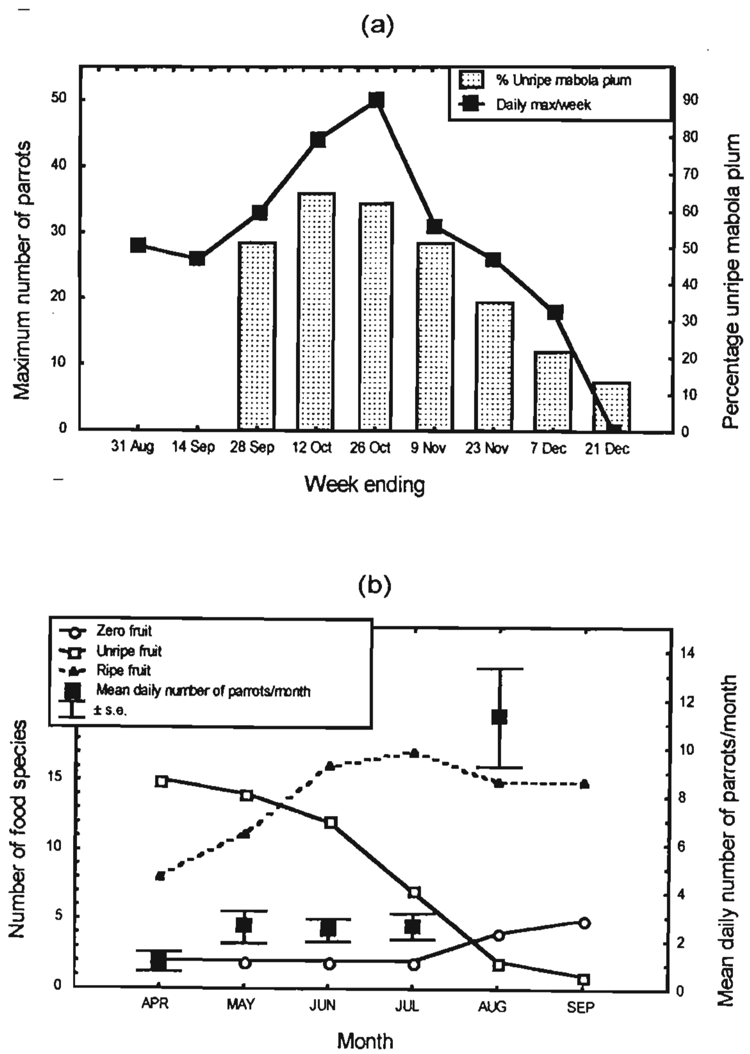

Figure 2a. Fruit abundance of *P. curatellifolia* at Levubu as represented by the proportion of trees bearing unripe fruit, and maximum daily number of parrots/two week interval. **b.** Number of food and potential food tree species with unripe fruit, ripe fruit and no fruit at Makuya, and mean number of parrots seen daily/month.

At Levubu Greyheaded Parrots were always seen feeding in large fruiting trees (> 10 m). Trees sampled for unripe fruit abundance measured (diameter at breast height; DBH ± s.e.) 71.1 ± 3.3 cm (n = 37) for *P. curatellifolia* and 69.3 ± 7.3 cm (n = 11) for *G. arborea*. An index of fruit abundance as represented by frequency of trees with unripe fruit and the maximum daily number of parrots per two week intervals at Levubu is shown in Fig. 2a.

There was a significant positive correlation between the number of trees with unripe *P. curatellifolia* and the maximum daily number of parrots seen per bi-weekly period (Spearman's r = 0.955, n = 7, P < 0.05). Abundance of *P. curatellifolia* with unripe fruit peaked in mid-October. At Levubu the first unripe *G. arborea* fruit were recorded in week ending 12 October 1999, with ripe fruit appearing in week ending 7 December 1999. By this time the presence of unripe fruit on the trees was scarce and feeding Greyheaded Parrots occurred on the lower branches where unripe fruit had not been utilized. At Makuya, canopy height where Greyheaded Parrots were seen feeding was generally lower than at Levubu (Chapt. 2). Fruiting tree species and fruiting stage at Makuya are shown (Fig. 2b). At Makuya unripe fruit became less available, and ripe and moribund fruit more available towards the end of the study period from July - September. There was no correlation between the mean maximum number of parrots seen daily each month with the number of tree species without fruit (Spearman's r = 0.707, n = 5, P > 0.05) or the number of tree species with ripe fruit (Spearman's r = 0.500, n = 5, P > 0.05; Fig. 2b). There was, however, a negative correlation between the mean maximum number of parrots seen daily each month with the number of tree species with unripe fruit (Spearman's r = - 0.900, n = 5, P < 0.05) (Fig. 2b).

Fruit quality

There was no difference in kernel energy content of *P. curatellifolia* fruit collected off a tree, and that rejected by Greyheaded Parrots where they were observed feeding (Mann-Whitney U-test, medians, 29.82 $MJ.kg^{-1}$ and 31.1 $MJ.kg^{-1}$, respectively; n = 3 and 3, respectively; U = 2.00; P > 0.05). There was also no significant difference in the energy content of food tree fruits during the non-breeding and breeding season (Mann-Whitney U-test, medians, 27.84 $MJ.kg^{-1}$ and 26.09 $MJ.kg^{-1}$, respectively; n = 3 and 5, respectively; U = 7.00; P > 0.05) (Table 3). Kernel water content did not differ between non-breeding and breeding study sites for respective food species eaten (Mann-Whitney U-test, medians, 47.5 % and 37.4 %, respectively; $n = 3$ and 4, respectively; $U = 3.5$; $P > 0.05$). Percentage water contained in the kernel, percentage water of whole fruit, gross energy ($MJ.kg^{-1}$) and protein content (dry weight %) of fruit in the diet of the Greyheaded Parrot are shown in Table 3.

Table 3. Fruit kernel water content, whole fruit water content, gross energy and protein content of major fruit in diet of Greyheaded Parrot (sample size in parentheses).

Food tree	Kernel ($\%H_2O$)	Whole fruit ($\%H_2O$)	Gross energy (MJ/kg)	Protein (%)
Parinari curatellifolia (6)	47.5 ± 7.4	55.5 ± 0.4	30.532 ± 0.421	27.26 ± 1.49
Gmelina arborea (3)	86.4 ± 0.7	81.9 ± 2.0	15.717 ± 0.099	8.75 ± 0.70
Melia azederach (1)	25.7	2.1	27.835	39.81
Commiphora mollis (2)	52.5 ± 2.5	76.6 ± 3.9	26.090 ± 0.790	28.50 ± 0.13
Pseudostachnostylis maprouneifolia (2)	25.7 ± 0.1	38.3 ± 4.1	28.616 ± 0.320	26.00 ± 0.09
Xanthocercis zambesiacum (1)	43.7	53.5	22.101	10
Terminalia prunioides (1)	14.6	50.8	25.267	32.92
Sclerocarya birrea (1)	4.1	-	31.184	31.53
Terminalia sericea (1)	-	41.4	-	-

Percentage water of *G. arborea* was highest. When Greyheaded Parrots began feeding on *G. arborea* more often, the occurrence of drinking at a nearby water source occurred less often (pers. obs.).

Fruit handling time and fruit size

Overall fruit handing times differed significantly when feeding on different fruit species (Kruskall-Wallis ANOVA, $F(6, 530) = 242.975$, $P < 0.05$). Males handled fruit for significantly longer than females when feeding on *P. curatellifolia* (Mann-Whitney U-test, medians, 97.5 and 62.0 secs, respectively; $n = 102$ and 45, respectively; $U = 1774.0$; $P < 0.05$) and *G. arborea* (Mann-Whitney U-test, medians, 14.0 and 13.0 secs, respectively; $n = 92$ and 61, respectively; $U = 2603.5$; $P < 0.05$).

Table 4. Summary of Greyheaded Parrot fruit handling times (seconds, mean ± s.e.), fruit size (length x breadth, mean mm ± s.e) and wet fruit mass (g.) (* indicates significant difference between male and female feeding times, Mann-Whitney U-test, $P < 0.05$; sample size in parentheses)

	***P. curatellifolia* ***	***G. arborea* ***	***M. azaderach***	***C. mollis***	***P. maprouneifolia***	***T. sericea***	***X. zambesiaca***	***T. prunioides***
Male	127.8 ± 11.7 (102)	18.2 ± 1.7 (92)	17.6 ± 1.7 (10)	22.2 ± 1.2 (51)	17.9 ± 1.0 (63)	17.5 ± 1.5 (2)	22.7 ± 12.3 (3)	-
Female	94.4 ± 14.1 (45)	16.9 ± 2.0 (61)	19.0 ± 1.1 (4)	18.0 ± 2.9 (15)	20.5 ± 2.0 (21)	11.3 ± 2.3 (12)	23.2 ± 2.4 (5)	-
Juvenile	112.1 ± 30.3 (14)	22.5 ± 12.5 (2)	16.5 ± 0.7 (3)	-	-	-	-	-
Unsexed	64.3 ± 18.0 (12)	18.4 ± 6.0 (7)	23.0 ± 2.7 (5)	-	11.0 (1)	-	-	-
All	**113.4 ± 8.3 (173)**	**17.8 ± 1.3 (162)**	**19.0 ± 1.1 (22)**	**21.3 ± 1.1 (66)**	**18.5 ± 0.9 (85)**	**12.1 ± 2.1 (14)**	**23.0 ± 4.3 (8)**	**-**
Fruit size	27.6 ± 0.3 x 22.1 ± 0.2 (89)	25.1 ± 0.1 x 19.3 ± 0.2 (90)	13.3 ± 0.3 x 11.9 ± 0.2 (35)	14.1 ± 0.1 x 13.0 ± 0.1 (55)	13.9 ± 0.1 x 17.8 ± 0.1 (100)	15.7 ± 0.2 x 4.9 ± 0.1 (30)	21.0 ± 0.2 x 16.8 ± 0.2 (50)	18.8 ± 0.3 x 9.7 ± 0.1 (50)
Fruit mass	11.79 (216)	4.79 (90)	0.75 (35)	1.48 (105)	2.70 (100)	0.38 (30)	3.52 (50)	1.78 (50)

There was no difference between males and females when handling *C. mollis* (Mann-Whitney *U*-test, medians, 21.0 and 20.0 secs, respectively; $n = 51$ and 15, respectively; $U = 309.0$; $P > 0.05$), *P. maprouneifolia* (Mann-Whitney *U*-test, medians, 17.0 and 19.0 secs, respectively; $n = 63$ and 21, respectively; $U = 506.5$; $P > 0.05$), Silver Cluster-leaf *Terminalia sericea* (Mann-Whitney *U*-test, medians, 17.5 and 9.0 secs, respectively; $n = 2$ and 12, respectively; $U = 4.0$; $P > 0.05$), Nyala Berry *Xanthocercis zambesiaca* (Mann-Whitney *U*-test, medians, 18.0 and 22.0 secs, respectively; $n = 3$ and 5, respectively; $U = 6.0$; $P > 0.05$) and *M. azaderach* (Mann-Whitney *U*-test, medians, 19.6 and 18.7 secs, respectively; $n = 10$ and 4, respectively; $U = 18.0$; $P > 0.05$). Fruit handling time of food species are summarized in Table 4.

There was no significant correlation between handling time of different fruit species and fruit mass (Spearman's $r = 0.536$, $n = 7$, $P > 0.05$), nor between fruit handling time and fruit size (size index calculated from fruit size dimensions, Table 4) (Spearman's $r = 0.536$, $n = 7$, $P > 0.05$).

Feeding technique

Feeding birds were observed climbing between branches of trees to reach fruit. Movements were slow and deliberate and involved the use of the bill to climb between branches. When feeding on smaller fruit (e.g. *Melia azaderach*) a small branch with 2 - 10 fruit would be broken off, held in the foot and individual fruit items removed and fed on. Feeding on fruit that may have been more difficult to open required the use of the foot to assist in manoeuvring the fruit in the bill. On occasions birds were observed reaching for a branch with fruit, pulling the branch towards themselves, holding the food branch on the perch branch and then feeding on the individual fruits without breaking the branch.

The Greyheaded Parrot has a distinctive bill that is used differently when feeding on different food items. They have a powerful mandible that articulates with the skull allowing limited vertical movement (Rowan 1983; Homberger 1985). The strongly curved upper mandible provides a secure surface against which the maxilla is able to crack fruit seeds. A series of small ridges on the undersurface or cutting edge of the maxilla assist in holding fruit while it is manipulated and the thick, fleshy tongue is used to role fruit items in the bill (Rowan 1983). With larger fruit the zygodactylous foot is used to assist in manipulating fruit items.

When feeding on *P. curatellifolia* green fruit was eaten. The resinous outer covering was partly peeled away with the maxilla and the kernel cracked open to access two soft kernels within one pip. If the maxilla was unable to crack open the fruit item the mandible was used to access two kernels through two weak points on the seed. These holes were opened by using the maxilla and removing the energy rich kernel with the sharp tip of the mandible. Maximum handling time for this fruit was 12 min 12 secs when a male bird was observed rolling the fruit in its bill, attempting to locate a weak spot in the fruit so it could access the kernel. Parrots were seldom seen feeding on ripe *P. curatellifolia*. The kernels of riper mature fruit were generally harder than greener unripe fruit and a greater proportion of flesh was removed while trying to access the kernel (pers. obs.). Removing the fleshy outer covering of the fruit reduces the size of the fruit and facilitates manouevring in the bill. Feeding method for *G. arborea* was similar to that used for *P. curatellifolia*. Fruit of *G. arborea* was softer and was broken in half to access the kernel which has a high water content (Table 3). All other fruit were fed on in a similar fashion by peeling off the fleshy outer layer of the fruit, cracking open the seed and accessing the kernel.

Footedness

Greyheaded Parrots were observed feeding using the foot to manoeuver fruit items in the bill.

Table 5. Foot use of the Greyheaded Parrot expressed as a proportion of the total observations of foot use (sample size in parentheses).

	Left	Right
Female (139)	51.8	48.2
Male (280)	63.6	36.4
Juvenile (17)	76.5	23.5
Unsexed (13)	61.5	38.5
Total (449)	60.4	39.6

Males and juveniles showed significant use of the left foot (males: $\chi^2 = 7.4$, juveniles: $\chi^2 = 28.1$, $P < 0.05$) whilst females showed no preference for either foot ($\chi^2 = 0.1$, $P > 0.05$) (Table 5). The proportion of each fruit type eaten using the foot ranged from 100 % in *P. curatellifolia* to 53.5 % in *C. mollis* (Table 6). It was expected that foot use would increase with larger fruit. There was, however, no significant correlation between proportion of fruit eaten with the foot and fruit mass (Spearman's $r = 0.393$, $n = 7$, $P > 0.05$), fruit handling time (Spearman's $r = 0.107$, $n = 7$, $P > 0.05$) or fruit size (Spearman's $r = 0.393$, $n = 7$, $P > 0.05$).

Table 6. Proportion of fruit eaten by Greyheaded Parrot using the foot.

Food tree	%	N
Parinari curatellifolia	100.0	154
Pseudostachnostylis maprouneifolia	98.9	91
Melia azederach	95.0	20
Gmelina arborea	84.4	157
Terminalia sericea	83.3	12
Xanthocercis zambesiaca	75.0	8
Commiphora mollis	53.5	71

Fruit wastage

Feeding Greyheaded Parrots would often pick a fruit and drop it without feeding, and sometimes only one kernel was removed from *P. curatellifolia* fruit. Total fruit wastage during feeding ranged from 40.3 % in *P. curatellifolia* to 31.3 % in *G. arborea* (Table 7). Of discarded fruit, 10.1 % ($N = 517$) contained parasites. Greyheaded Parrots were observed flying with the fruit of five fruit species in Levubu ($n = 18$) and Makuya ($n = 2$). Individual birds were recorded flying from a feeding tree with fruit and, either dropping the fruit while flying away (15 % of flights) or perching in a nearby tree and continuing to feed (30 % of flights). The outcome of other individuals flying away from the feeding tree was not recorded as birds may have become lost in a flock or flown out of sight.

Table 7. Fruit wastage (%) of feeding Greyheaded Parrots in two tree species.

	P. curatellifolia (10 293)	*G. arborea* (13 654)
Kernel completely eaten	46.4	68.7
Half kernel eaten	26.6	-
Zero kernel eaten	27	31.3
Total wastage	40.3	31.3

Discussion

Food trees and observational data

The Greyheaded Parrot was observed feeding on a maximum of five fruiting species during any month suggesting that feeding is restricted to few fruiting species at any one time (Table 2). Feeding may occur on other species that were observed to be in fruit but was not recorded. Very few food competitors were observed feeding in or near Greyheaded Parrot feeding flocks, or on the same fruit as Greyheaded Parrot. In many cases, where potential food competitors were absent, food items of Greyheaded Parrots were unripe kernels. By accessing this food resource, likely competition with other frugivourous species is reduced. Mixed species feeding flocks have been recorded and competition with Meyer's Parrot *Poicephalus meyeri* and Brownheaded Parrot *Poicephalus cryptoxanthus* may occur. However, these species are significantly smaller and their biology's may be quite different (Rowan 1983). These species may not be able to feed on some of the larger fruit that Greyheaded Parrot select. In areas of north-east South Africa where Greyheaded Parrots and Brownheaded Parrots occur sympatrically, Brownheaded Parrots feed on similar fruiting species (Taylor & Perrin In press). However, Brownheaded Parrots, although reliant on seasonally available food sources, feed on a greater number of species each month (Taylor & Perrin In press). Also, the most reliant species for each species differs (Taylor & Perrin In press). Meyer's Parrot, Green Pigeon *Treron calva* and Greyheaded Parrots feed together (Vincent 1946), yet in this study mixed species feeding flocks were not observed. Some hornbill species, although they do not feed on the kernel of fruit, feed on the same species e.g. *Commiphora mollis*, as Greyheaded Parrots (Kemp 1976; pers. obs.). Therefore, by accessing a food source inaccessible to many other species (i.e. the fruit kernel), and feeding on unripe fruit, Greyheaded Parrots are able to prevent food competition with other food competitors. The Cape Parrot similarly feeds on the kernels of yellowwoods when fruit is unripe, thereby reducing competition with other forest frugivores (Wirminghaus *et al.* In press a). Cape Parrots and Greyheaded Parrots have separate ranges and there is no inter-specific competition.

The Greyheaded Parrot may feed on many more species than was observed in this study, yet the number of food species for a particular region at any one time appears to be low. Feeding specialization has likely reduced the number of feeding competitors and at any one time few fruiting tree species are fed on by the Greyheaded Parrot. Observations in particular areas may therefore be biased towards the most abundant fruiting species at the time, as occurred at Levubu where all observations of feeding in *G. arborea* were at one site. However, the high energy kernel of *P. curatellifolia* forms an important component in the post-breeding diet of Greyheaded Parrot. This study only occurred during two field seasons at one site so the full range of the diet of the Greyheaded Parrot may be underestimated.

The Cape Parrot is similarly reliant on a low number of species as a source of food (Wirminghaus *et al.* In press a). In a study in two afromontane forests in the KwaZulu-Natal midlands, South Africa, feeding occurred in 38.9 % and 30.6 % of observations on *P. falcatus* and *P. latifolius* respectively (Wirminghaus *et al.* In press a). Four other species made up 22.3 % of feeding observations with other species comprising < 1.5 % of observations (Wirminghaus *et al.* In press a).

Food of the Greyheaded Parrots is high in protein and energy, and morning feeding activity is possibly sufficient to fulfil daily energy requirements. Feeding in the Greyheaded Parrot is therefore similar with feeding patterns in other southern African parrots, and the closely related Cape Parrot. Energy content of most food species of the Greyheaded Parrot was higher than that of the predominant food species in the diet of the Cape Parrot (Wirminghaus *et al.* In press a). The Cape Parrot is a dietary specialist and feeds primarily on the kernel of Outeniqua Yellowwood *Podocarpus falcatus* (gross energy content: 23.47 $MJ.kg^{-1}$) and Real Yellowwood *Podocarpus latifolius* (gross energy content: 18.23 - 18.71 $MJ.kg^{-1}$) (Wirminghaus *et al.* In press a). It has been observed feeding on *c* 20 different species in the wild, and energy content of other food items range from 20.94 $MJ.kg^{-1}$ in Cat-thorn *Scutia myrtina* to 32.42 $MJ.kg^{-1}$ in Cape chestnut *Calodendrum capense* (Wirminghaus *et al.* In press a).

Rüppell's Parrot *Poicephalus rueppellii*, a Namibian endemic, feeds on a wider range of food types through the year, and was recorded feeding on 37 plant species in the Waterberg (Selman, Perrin & Hunter In press). Lowveld Cluster-leaf *Terminalia prunioides* (42 % protein) is fed on in eleven months of the year, more than any other species (Selman *et al.* In press). It is also eaten by the Greyheaded Parrot and although observations only occurred in two months, was probably fed on for longer periods. Rüppell's Parrot has been recorded feeding on a number of food items in a year with protein content of food items ranging from 2.90 % (*Arytaina mopane* (Hemiptera, Phyllidae) exudate) to 52.57 % (Umbrella Thorn *Acacia tortilis* seeds) and protein from 16.508 MJ. kg^{-1} (immature Ana Tree *Faidherbia albida* pods) to 19.817 MJ. kg^{-1} (Leadwood *Combretum imberbe* seeds) (Selman *et al.* In press). Specialization in this smaller *Poicephalus* species was not as great as larger southern African *Poicephalus* species. Rüppell's Parrot predominantly feeds on the kernels of fruit and has been observed feeding on nectar and insects, which form an important part of the diet (Selman *et al.* In press). In the Brownheaded Parrot the greatest number of species fed on occurred in autumn and winter and declined in spring and early summer (Taylor & Perrin In press). Brownheaded Parrots are opportunistic generalist feeders with no particular tree species crucial to their survival (Taylor & Perrin In press). However, certain species are important in certain areas (Taylor & Perrin In press). Likewise, in south-eastern Brazil, the Scaly-headed Parrot *Pionus maximiliani* has been observed feeding on 38 plant species where seasonal changes in the diet are a result of seasonal changes in food availability (Galetti 1993).

The Greyheaded Parrot was never recorded feeding on flowers but may do so at certain times of the year. In Zimbabwe it has been observed feeding on the nectar of the Red-hot Poker Tree *Erythrina abyssinica* (Fynn 1991). Numerous parrot species feed on flowers, accessing available nectar or feeding on pollen or floral parts (Forshaw 1989). Brownheaded Parrots have been observed feeding on the flowers of the Common Coral Tree *Erythrina lysistemon*, where they act as flower predators (Taylor & Perrin In press; pers. obs.) and the Mountain Aloe *Aloe marlothii* (Skead 1971). Also, the Cape Parrot feeds on the flowers of the Coast Coral Tree *Erythrina caffra* (Skead 1971; Oatley & Skead 1972), and the seeds in flower heads of the Common Sugarbush *Protea caffra* (Wirminghaus *et al.* In press a). Rüppell's Parrot feeds on the flowers and the nectar of the Worm-bark False-thorn *Albizia anthelmintica*, which forms an important component of their diet in September (Selman *et al.* In press). Further studies may indicate that Greyheaded Parrots include nectar in their diet in certain parts of their range, and at certain times of the year. However, nectar may not form an important component in the diet of Greyheaded Parrots.

The leaf of *P. curatellifolia* is coarse and may have been used by Greyheaded Parrots to clean the cutting surface of the mandible of resinous residue accumulated on the bill while feeding. In the Greyheaded Parrot "feeding" on leaves may be displacement activities. Rüppell's Parrot feeds seasonally on leaves with most observations seen after fledging (May - June) (Selman *et al.* In press). Scaly-headed Parrots were similarly observed mandibulating leaves of *Zeyhera* *tuberculosa* but not eating them (Galetti 1993).

There were no observations in the study areas during January - March 2000 due to catastrophic flooding in the region. During this time Marula *Sclerocarya birrea* is in fruit (Pooley 1994). The kernel of this fruit is high in energy and protein and may form an important part in the diet of the Greyheaded Parrot during pre-breeding months. The fruit is similar in structure to *P. curatellifolia* and feeding on this fruit occurs in a similar fashion (C.T. Downs unpubl. data; various pers. comm.).

Fruit abundance

The occurrence of Greyheaded Parrot in Levubu is caused by the abundance of fruiting *P. curatellifolia* in the area (Chapt. 3). Post-breeding flocks move into the area to feed on this fruit and maximum number of birds accounted for on a weekly basis correlated with fruit abundance in the area. At Levubu feeding on *P. curatellifolia* accounted for 56.0 % of feeding observations. *P. curatellifolia*, was abundant from July to November at Levubu and flock size increased when food was most abundant. Similar observations have been made in the Trelawney district of Zimbabwe where Greyheaded Parrots occur seasonally from August to December, with feeding occurring primarily on *P. curatellifolia* (Fynn 1991). At Makuya the number of Greyheaded Parrots seen in a day was higher when fewer food and potential food tree species were in fruit suggesting Greyheaded Parrots were more dispersed when food was more abundant. Similar seasonal movements have been observed in the African Grey Parrot *Psittacus erithacus*. During a 14 month study at Kanyawara, Kibale forest, western Uganda, the presence of Grey Parrots corresponded closely the fruiting period of Muziru *Pseudospondias microcarpa* (Chapman, Chapman & Wrangham 1993). Large numbers were only observed during a 10 week period when they fed heavily on fruiting *P. microcarpa* (Chapman *et al.* 1993). These parrots are thought to travel great distances, tracking fruit sources which become locally available (Chapman *et al.* 1993).

In the Cape Parrot seasonal feeding responses occur in a habitat, afromontane forest, that shows variation in food abundance through the year (Koen 1992; Wirminghaus *et al.* In press a & c). Feeding on different food items at different times of the year suggest that diet reflects seasonal changes in food availability. This may occur in the Greyheaded Parrot where local movements are determined by the availability of seasonally available food sources.

Fruit quality

Although the Greyheaded Parrot primarily feeds on the kernel of fruit it may also supplement its diet with bark and arthropods. Insects form an important protein source for nestling avian frugivores and granivores, and adult birds (Long 1984; Maclean 1990). Observations of Greyheaded Parrots chewing on branches and bark may be attempts to extract insects. Certain food sources may be deficient in certain proteins which are obtained from alternate food sources e.g. insects. Greyheaded Parrots were not observed eating insects but crop contents of a dead chick removed from a nest contained insect parts (Scarabaoidae) (Chapt. 7). Some cockatoo's eat insects and tear away bark in search of wood boring grubs (Forshaw 1989). Scaly-headed Parrots have been observed eating galls, possibly extracting insects (Galetti 1993) and numerous Australian parrots include insects in their diet (Jenkins 1969; Brooker 1973; Nicholls 1978; Cannon 1981; Long 1984; Forshaw 1989). Insects form an important component in the diet of the Redcapped Parrot *Purpureicephalus spurius*, Western Rosella *Platycereis icterotus* and Port Lincoln Parrot *Barnadius zonarius* (Long 1984). Insect parts have been found in the stomach of African adult Redfronted Parrots *Poicephalus gulielmi gulielmi* (Chapin 1939) and nestlings of Rüppell's Parrot (Selman *et al.* In press). Brownheaded Parrots were observed feeding on cocooned caterpillars at Pretoriuskop, KNP, and possibly eat insects at other times of the year (Taylor & Perrin In press). This activity is likely widespread in African parrots, where insectivory offers a protein supplement at times of decreased food supply (Taylor & Perrin In press).

Geophagy has been reported in numerous bird species (see Diamond. Bishop & Gilardi 1999 for review). Plant seeds contain poisonous and/or bitter tasting compounds to deter would be animal consumers (Diamond *et al.* 1999). Compounds in soil may bind to toxic and bitter compounds and enable animals to eat otherwise nutritious plant parts (Diamond *et al.* 1999). Greyheaded Parrots were never observed feeding on soil but may do so like Cape Parrots (D. Kemp pers. comm.; pers. obs.).

Greyheaded Parrots were observed feeding on bark, although they may chew branches as displacement activities when perched (Chapt. 6). Most observations of feeding on bark were in *Combretum* spp. *Combretum* spp. are used by traditional healers for a wide range of ailments in southern Africa and exhibit significant anti-inflammatory, anthelminthic and antischistosomic activity, and some have been shown to possess good antibacterial activity (Eloff 1999; McGaw *et al.* In press). The function of feeding on bark is not known yet may serve a similar function as geophagy where the ingestion of soil may provide protection against toxic and/or bitter secondary compounds (Diamond *et al.* 1999).

Fruit handling time and fruit size

Male Greyheaded Parrots are significantly larger than females (Wirminghaus *et al.* In press b) and males provision females during the breeding season (Chapt. 7). Bill measurements of males range from 2.3 - 10.4 % larger than females (Wirminghaus *et al.* In press b). Differences in feeding times between males and females suggest that resource partitioning may occur between sexes. Also, the North Island Kaka *Nestor meridionalis septentrionalis* displays pronounced sexual dimorphism in culmen-length and culmen-depth, with male bill dimensions ranging from 12.4 - 13.6 % larger than that of females (Moorhouse, Sibley, Lloyd & Greene 1999). It was suggested, that this characteristic may be ancestral in the nestorine parrots and that although no adaptive significance has been demonstrated, it has been maintained by stabilizing selection (Moorhouse *et al.* 1999). Similarly, this may also occur in the Greyheaded Parrot.

There was no correlation between fruit handling time and mass or size of fruit. In a study of handling techniques of fruit-eating birds it was found that fruit handling time differed markedly with seed size (Levey 1987). It was also shown that handling time was markedly different for different types of feeders (Levey 1987). However, in Greyheaded Parrots fruit handling time is likely related to the accessibility of the seed kernel within the fruit.

Greyheaded Parrots employ a unique method of removing the kernel from the fruit as found in some other parrot species. The use of the extended upper mandible tip likely provides an adaptive advantage for removing fruit kernels from hard *P. curatellifolia* (and *S. birrea*) fruit. This technique is also employed by Baudin's Cockatoo *Calyptorhynchus baudinii* (or Long-billed White-tailed Black Cockatoo) when feeding on marri *Corymbia calophylla* or jarra *Eucalyptus marginarta* fruit (Cooper 2000). This method of feeding possibly requires learning as captive Baudin's Cockatoo's did not feed in the expected manner (Cooper 2000). Wild observations of Greyheaded Parrots suggest that feeding effectively and efficiently on *P. curatellifolia* requires experience (pers. obs.).

However, in this study, where sample sizes were small in many cases the biological significance of the data may be misinterpreted.

Feeding and footedness

The ability to lift the foot to the bill is a feature unique only to parrots and owls (Rowan 1983). This, together with regular use of the foot, and feeding on unripe fruit reduces potential for competition with other species and enables parrots to utilize food resources to the greatest capacity. The use of the foot while feeding enables birds to manipulate large food items while accessing the seed kernel. No significant relationship between the proportion of fruit handled with the foot and fruit mass and fruit size suggest that use of the foot is possibly correlated with other factors such as ability to access the seed kernel efficiently.

Greyheaded Parrots showed a preference for use of the left foot when feeding. Two observations (0.4 %) were made where birds swopped feet while manipulating food. Foot swapping was not noted by Harris (1989). In all other instances where the foot was used, individuals used the same foot for each fruit item fed on. If the foot, rather than the beak, is considered the primary agent for manipulation then evidence suggests that Greyheaded Parrots are left footed (Harris 1989). Footedness has been observed in certain species of birds (Harris 1989; Rogers 1989) with a predominance of left-footedness in several species of African parrots (Friedman & Davis 1938). The Cape Parrot, for example, has been noted in using the left foot more often when feeding (Skead 1964). The significance of feeding using either foot is not known and research in Australia is seeking to address questions relating to "handedness" or "laterality" in parrots (Chambers 1997).

Fruit wastage

Greyheaded Parrots dropped 16.5 % of fruit picked before removing any flesh. The reason for Greyheaded Parrots discarding fruit is unknown, but birds may be able to detect the presence of parasites in the fruit, thereby increasing feeding efficiency. No eaten fruit appeared to have contained parasites and it is suggested that parasitized fruit is rejected, especially when feeding on *P. curatellifolia*. When feeding on yellowwoods, Cape Parrots wasted 56 % of fruit selected (Skead 1964). Wasted fruit includes fruit that was picked and not handled at all to fruit that was peeled yet uncracked (Skead 1964). However, fruit collected off trees Rüppell's Parrots were observed feeding in showed a high proportion (44 - 90 %) of seeds parasitized (Selman *et al.* In press.). It was shown that Rüppell's Parrots preferred parasitized fruit (Selman *et al.* In press.), unlike Greyheaded Parrots.

African Grey Parrots were never seen flying with fruit (Chapman *et al.* 1993). In this study Greyheaded Parrots were seen flying with fruit. The outcome of fruit with many individuals flying away from the feeding tree was not recorded as birds may have become lost in a flock or flown out of sight. Therefore, although Greyheaded Parrots are seed predators they play a minor role in dispersal of seeds. Uneaten fruit dropped below trees becomes available to secondary dispersers (e.g. rodents).

In Zambia and Zimbabwe, Greyheaded Parrots have been observed feeding on maize cobs and millet heads (du Bocage 1881; Wilkes 1928; Mackworth-Praed & Grant 1970; L. Warburton pers. comm.). Formal and informal interviews with residents in the study area indicated that Brownheaded and Meyer's Parrots feed on maize and sorghum and that Greyheaded Parrots seldom did so. A number of parrot species are reported to attack cultivated crops in Australia and the neotropics (Long 1985; Bucher 1992). In many instances these species are recognized as pests. Pecan nut farming occurs in the Levubu region yet Greyheaded Parrots were seldom observed feeding on this species (S. Hoffman, A. Whyte pers. comm.). The Cape Parrot has been recorded feeding on unripe and ripe pecan nuts (Wirminghaus 1997; Downs & Symes 1998). Pecan nuts fruit from September to March and Greyheaded Parrots are absent from the area during some of these months (Chapt. 3). Macadamia fruiting corresponds the arrival of Greyheaded Parrots at Levubu yet birds were never observed feeding on this species. Greyheaded Parrots in captivity are easily able to open the hard nut of ripe macadamia nuts and access the kernel (W. Horsfield pers. comm.). However, the foliage of these trees is thick and may prevent easy access to fruit by feeding parrots.

Conclusion and implications for conservation

Greyheaded Parrots are strong fliers and track the seasonal availability of food resources. At any one time a low number of food species may form the major component of their diet, yet feeding specialisation has enabled Greyheaded Parrot to access a high energy food source inaccessible to many other species. This may have conservation implications where regular feeding grounds may be susceptible to agricultural development and food trees removed. Also, birds gathering in flocks at regular feeding grounds outside of protected areas are vulnerable to capture for the illegal trade market.

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References

Bannerman, D.A. 1953. The birds of west and equatorial Africa. Oliver & Boyd, Edinburgh.

Benson, C.W. & White, C.M.N. 1957. Checklist of the birds of Northern Rhodesia. Govt. Printer. Lusaka.

Benson,C.W. & Irwin, M.P.S. 1966.The Brachystegia avifauna. Ostrich Suppl. 6, 297-321.

Benson, C.W. & Benson, F.M. 1977. The birds of Malawi. Mountfort Press, Limbe.

Benson, C.W., Brooke, R.R., Dowsett, R.J & Irwin, M.P.S. 1971. The birds of Zambia. Collins, London.

Brooker, M.G. 1973. Port Lincoln feeding on moth larvae. Emu 73, 27-28.

Bucher, E.H. 1992. Neotropical parrots as agricultural pests. Pp. 201 - 219. in New world parrots in crisis: solutions from conservation biology. Eds. Beissinger, S.R. & Snyder, N.F.R. Smithsonian Institution Press, Washington and London.

Chambers, L. 1997. Survey on handedness in parrots. Eclectus 2 (April), 12-13.

Cannon, C.E. 1981. The diet of eastern and pale-headed rosellas. Emu 81, 101-110.

Chapin, J.P. 1939. The birds of the Belgian Congo, Part II. Bulletin of the American Museum of Natural History 75, 1-632.

Chapman, C.A., Chapman, L.J. & Wrangham, R. 1993. Observations on the feeding biology and population ecology of the Grey Parrot *Psittacus erithacus*. Scopus 16, 89-93.

Cooper, C. 2000. Food manipulation by Southwest Australian Cockatoos. Eclectus 8: 3-9.

Dean W.R.J. 1999. The birds of Angola. BOU Checklist No. 17. British Ornithologists Union, Tring.

Diamond, J., Bishop, K.D. & Gilardi, J.D. 1999. Geophagy in New Guinea birds. Ibis 141, 181-193.

Downs, C.T & Symes, C.T. 1998. Cape Parrots. Report on the second Cape Parrot big birding day, (25 April 1998). Psittascene 10(3), 5-7.

du Bocage, J.V.B. 1881. Ornithologie D'Angola. Imprimerie Nationale, Lisbonne.

Eloff, J.N. 1999. The antibacterial activity of 27 southern African members of the Combretaceae. South African Journal of Science 95, 148-152.

Forshaw, J.M. 1989. Parrots of the world. Lansdowne Books, Willoughby.

Friedman, H. & Davis, M. 1938. 'Left-handedness' in parrots. Auk 80, 478-480.

Fry, C.H., Keith, S. & Urban, E.K. 1988. The birds of Africa. Vol. III. Academic Press. London.

Fynn, A.R. 1991. Feeding and movements of the Brownecked Parrot in the Trelawney district. Honeyguide 37(1), 5-8.

Galetti, M. 1993. Diet of the Scaly-headed Parrot (*Pionus maximiliani*) in a semideciduous forest in southeastern Brazil. Biotropica 25(4), 419-425.

Harris, L. J. 1989. Footedness in parrots: Three centuries of research, theory and mere surmise. Canadian Journal of Psychology 43(3), 369-396.

Homberger, D. 1985. Parrot. Pp. 437-439. in A dictionary of birds. Eds. Campbell, B. & Lack, E.. Poyser.Calton, T & A.D, Staffordshire, U.K.

Hopkinson, E. 1910. The Brown-necked Parrot *Poeocephalus fuscicollis*. Journal of the Avicultural Society 1, 107-112.

Jacobsen, N.H.G. 1979. Birds of the Sengwa Wildlife Research area, Zimbabwe-Rhodesia. Southern Birds 6. Witwatersrand Bird Club, Benmore.

Jenkins, C.F.H. 1969. Notes on the feeding habits of some Western Australian birds. Western Australian Naturalist 11, 52-55.

Kemp, A.C. 1976. A study of the ecology, behaviour and systematics of *Tockus* hornbills (Aves: Bucerotidae). Transvaal Museum, Pretoria.

Koen, J.H. 1992. Medium-term fluctuations of birds and their potential food resources in the Knysna Forest. Ostrich 63, 21-30.

Lang, E.M. 1969. Some observations on the Cape Parrot. Avicultural Magazine 74, 84-86.

Levey, D.J. 1987. Seed size and fruit-handling techniques of avian frugivores. The American Naturalist 129(4), 471-485.

Lippens, L. & Wille, H. 1976. Les oiseaux du Zaïre. Lanoo a Tielt, Brussels.

Long, J.L. 1984. The diets of three species of parrots in the south of Western Australia. Australian Wildlife Research 11, 357-371.

Long, J.L. 1985. Damage to cultivated fruit by parrots in the south of Western Australia. Australian Wildlife Research 12, 75-80.

Maclean, G.L. 1990. Ornithology for Africa. University of Natal Press, Pietermaritzburg.

Mackworth-Praed, C.W & Grant, C.H.B. 1970. Birds of west central and western Africa. Vol. 1, Series 3. Longman, London & New York.

McGaw, L.J., Rabe, T., Sparg, S.G., Jäger, A.K., Eloff, J.N, & van Staden, J. In press. An investigation into the biological activity of *Combretum* species. Journal of Ethnopharmacology.

Moorhouse, R.J., Sibley, M.J., Lloyd, B.D. & Greene, T.C. 1999. Sexual dimorphism in the North Island Kaka *Nestor meridionalis septentrionalis*: selection for enhanced male provisioning ability? Ibis 141, 644-651.

Nicholls, O.G. 1978. The Port Lincoln Parrot (*Barnardius zonarius zonarius*) feeding on lerps at Kalgoorlie. Western Australian Naturalist 14, 76-77.

Oatley, T.B. & Skead, D.M. 1972. Nectar feeding by South African birds. Lammergeyer 15, 65-74.

Parker, V. 1999. The atlas of the birds of Sul do Save, southern Mozambique. Avian Demography Unit and Endangered Wildlife Trust, Cape Town and Johannesburg.

Penry, H. 1994. Bird Atlas of Botswana. University of Natal Press, Pietermaritzburg.

Perrin, M.R., McGowan, P., Downs, C., Symes, C. & Warburton, L. 2000. Africa - an overview. Pp. 68-70. in Eds. Snyder, N., McGowan, P., Gilardi, J. & Grajal, A. 2000. Parrots. Status, survey and conservation action plan (2000-2004). IUCN, Gland, Switzerland and Cambridge, UK.

Pooley, E. 1994. The complete guide to the trees of Natal, Zululand and Transkei. Natal Flora Publications Trust, Durban.

Reichenow, A.N.T. 1898. Bericht uber die Februar-Sitzung. Journal fur Ornithologie 46, 314.

Rogers, L.J. 1989. Laterality in animals. International Journal of Comparative Psychology 3(1), 5-25.

Rowan, M.K. 1983. The doves, parrots, louries and cuckoos of southern Africa. David Phillip, Cape Town.

Selman, R.G., Hunter, M.L., & Perrin, M.R. In Press. The feeding ecology of Rüppell's Parrot *Poicephalus rueppellii* in Namibia. Ostrich.

Skead, C.J. 1964. The overland flights and the feeding habits of the Cape Parrot, *Poicephalus robustus* (Gmelin) in the eastern Cape Province. Ostrich 25(1), 202-223.

Skead, C.J. 1971. The Cape Parrot in the Transkei and Natal. Ostrich Supplement 9, 165-178.

Smithers, R.H.N., Irwin, M.P.S. & Paterson, M.L. 1957. Checklist of the birds of Southern Rhodesia. Rhodesian Ornithological Society.

Snow, D.W. (Ed.). 1978. An atlas of speciation of African non-passerine birds. British Museum

(Natural History), London.

Swynnerton, C.F.M. 1907. On the birds of Gazaland, Southern Rhodesia, Part 2. Ibis 9, 279-311.

Tarboton, W.R., Kemp, M.I. & Kemp, A.C. 1987. Birds of the Transvaal. Transvaal Museum. Pretoria.

Taylor, S. & Perrin, M.R. In press. The diet of the Brown-headed Parrot (*Poicephalus cryptoxanthus*) in the wild in South Africa. Parrot Biology.

Traylor, M.A, 1963. Checklist of Angolan birds. Publicações Culturais, Lisbon.

Vincent, A.W, 1946. On the breeding habits of some African birds. Ibis 88(1), 48-67.

Wilkes, A.H. Paget. 1928. The birds of the region south of Lake Nyasa - Part 1. Non-passerine birds. Ibis 4, 690-748.

Wirminghaus, J.O. 1997. Cape Parrot *Poicephalus robustus*. Pp. 526-527. in The atlas of southern African birds - Vol 1. Eds. Harrison, J.A., Allan, D.G., Underhill, L.L., Herremans, M., Tree, A.J., Parker, V. & Brown, C.J. Birdlife - South Africa, Johannesburg.

Wirminghaus, J.O., Downs, C.T., Symes, C.T. & Perrin, M.R. In Press (a). Diet of the Cape Parrot *Poicephalus robustus* in afromontane forests in KwaZulu-Natal, South Africa. Ostrich.

Wirminghaus, J.O., Downs, C.T., Perrin, M.R & Symes, C.T. In press (b). Taxonomic relationships of the subspecies of the Cape Parrot *Poicephalus robustus* (Gmelin). Journal of Natural History.

Wirminghaus, J.O., Downs, C.T., Symes, C.T. & Perrin, M.R. In Press (c). Fruiting in two afromontane forests in KwaZulu-Natal, South Africa: the habitat type of the endangered Cape Parrot *Poicephalus robustus*. South African Journal of Botany.

CHAPTER 6

Behaviour and some vocalisations of the Greyheaded Parrot *Poicephalus fuscicollis suahelicus* (Psittaciformes: Psittacidae)

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Summary

Symes, C.T. & Perrin, M.R. 2001. Behaviour and some vocalizations of the Greyheaded Parrot *Poicephalus fuscicollis suahelicus* (Psittaciformes: Psittacidae) in the wild. *Durban Museum Novitates* 00:00-00. Behaviours and vocalizations of Greyheaded Parrots were studied at two study sites in Northern Province, South Africa. Observations were conducted in the Levubu region during the non-breeding season (September - December) and at Makuya during the breeding season (April - August). Greyheaded Parrots have a complex vocal repertoire, similar to the Cape Parrot *P. robustus*. They are conspicuous in flight where a characteristic *tzu-weee* call is given. Variations of this call are found with the addition of various notes resulting in complex song phrases. Synchronized duetting between paired birds and flock members may serve to strengthen intra-specific bonding between pairs. Descriptions of intra- and interspecific interactions and behaviours are given.

KEYWORDS: *behaviour, Greyheaded Parrot,* Poicephalus fuscicollis suahelicus, *vocalisations*

Introduction

Parrots are renown for their ability to mimic human speech (Pepperberg 1981; Birchall 1990). They are able to do this because of the unique construction of the syrinx that has evolved in parallel with songbirds (Homberger 1999). In conjunction with a complex call repertoire, parrots show ritualized displays during intra-specific interactions (Holyoak & Holyoak 1972). They are also highly dextrous, climbing deliberately and agilely in the canopies of trees (Forshaw 1989). However, these behaviours, of major ecological importance, are poorly understood.

The Greyheaded Parrot *Poicephalus fuscicollis suahelicus* has recently been described as a separate species from the Cape Parrot *Poicephalus robustus* based on morphometric measurements, plumage colour differences and different habitat requirements (Wirminghaus, Downs, Symes & Perrin In press a). Preliminary molecular data support these findings (Solms, Berruti, Perrin, Downs & Bloomer 2000). Vocalisation differences were not investigated. The vocalisations and behaviour of the Cape Parrot have been described (Wirminghaus, Downs, Symes, Dempster & Perrin 2000). Like many other parrots, Greyheaded Parrots show complex social behaviours and associated calls. This study was conducted to investigate calls of the Greyheaded Parrot in the wild. It was hypothesized that calls of the Greyheaded Parrot would be similar to those of the Cape Parrot. However, species specific calls unique to Greyheaded Parrots were expected to be identified.

Materials & Methods

Observations of Greyheaded Parrots in the wild were made at two study sites in the Northern Province, South Africa. Observations began in the Levubu district (23° 00' S - 23° 15' S, and 30° 05' E - 30° 30' E) from August 1999 to December 1999 (16 weeks). This study period covered the non-breeding season of the Greyheaded Parrot when they occur seasonally in the area (Chapt. 7; various pers. comm.). Here they were observed in large flocks (up to 50 birds), feeding mostly on Mabola Plum *Parinari curatellifolia* (Chapt. 4 & 5). Exceptionally high rains from January to mid-March 2000 throughout the southern African sub-region, and flood damage in the study areas prevented fieldwork during these months. Field work continued in the region of the Luvhuvhu-Mutale river confluence (22° 26' - 22° 32' S, and 30° 50' - 31° 05' E) from April 2000 to September

2000 (19 weeks) and included the breeding season of the Greyheaded Parrot (Chapt. 7). Additional observations were made from a vehicle in the Punda Maria campsite vicinity, Kruger National Park (KNP) during this period.

Greyheaded Parrot behaviours were recorded by direct observation in the field. Behaviours, based on previous experience of field observations of the Cape Parrot, were identified (Wirminghaus *et al.* 2000). Greyheaded Parrots are difficult to locate in trees with leaves, especially when quiet and feeding and many observations where made of birds in snags, leafless trees or at early morning gathering sites (Chapt. 4; pers.obs.). Perch activities were identified as preening, allo- and mutual preening, sunning and feeding. Socialising and displaying activities were also recorded. Additional intra-specific interactions including duet calls and arch-angel wing extension displays (Wirminghaus *et al.* 2000), food soliciting by juveniles from adults, and sexual and aggressive displays were recorded. Unusual or unrecorded behaviour, and interspecific interactions (e.g. predator interactions) were also noted. Drinking was also recorded.

Groups (1 - 8 individuals) within perched flocks were sampled opportunistically (mostly in the morning when Greyheaded Parrots were most conspicuous) to record perched activity state (i.e. perch/rest, preening, allo- and mutual preening and social interacting, climbing/searching, feeding) at 30 s intervals (Altmann 1974). Long distance contact call (LDCC) calling rate was determined in feeding flocks by counting the number of LDCC for 30 second intervals. Long distance contact calls are defined as loud clear call, audible at a distance of > 100 m. Short distance contact calls are defined as soft chirps, given by Greyheaded Parrots when feeding and resting.

Vocalisations were recorded using a Tascam DA-P1 Digital Audio Tape Recorder and analysed using Batsound - Sound Analysis (Version 1.2). Various calls and behaviours are described. LDCC calling rate was determined for feeding flocks by counting the number of contact calls per 30 second interval.

Results

Daily activities

In the wild Greyheaded Parrots seldom do not call in flight. They are vocal in the early morning when flying to feeding grounds and activity centres, and late afternoon when returning to roosts

(Chapt. 4). These daily behaviours are characteristic and predictable (Chapt. 4). Early morning activities were characterised by overland flights from roosts to feeding sites and early morning social gathering sites. Intra-specific socialisation occurred with preening, allo- and mutual preening taking place (Fig. 1 & 2). At both sites allo- and mutual-preening was observed throughout the day, and most was conspicuous between pair birds at nest sites (Fig. 1; Chapt. 7). In the morning preening and allo-/mutual preening was followed by feeding, perching and sunning, and then feeding until late morning (Fig. 1 & 2). Thereafter, birds moved to feed and rest quietly in the canopies of large trees during the heat of the day (Fig. 1; Chapt. 4). During this time they were difficult to locate and often were only located when flushed from a tree. These late afternoon movements were characterized by gathering flocks returning to roost sites (Chapt. 4). Observations of different perched activities (preening, allo- and mutual-preening, feeding and drinking) and selected intraspecific interactions (duetting, archangel or AA displays, juveniles and soliciting) at Levubu and Makuya are summarized in Figure 1. Different start and finish times of different activities at Levubu and Makuya are accounted for by variation in day length between seasons (Fig. 1). Daily perched activities, as determined by random sampling, which were biased towards morning sampling, are shown in Figure 2.

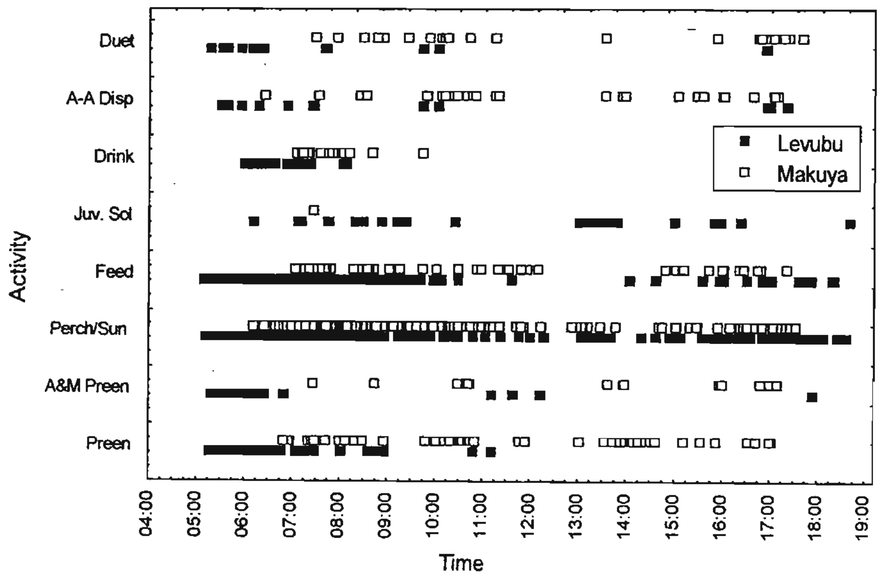

Fig 1. Figure showing times of different perched behaviours, displays and call types of the Greyheaded Parrot at Levubu and Makuya.

Drinking of Greyheaded Parrots was recorded at Levubu and Makuya and occurred at ground water sources (Levubu - one site; Makuya - three sites) (Fig. 1). Numbers of birds drinking at one time ranged from singletons to >20 birds and was only observed in the morning. Individual birds were observed drinking from water collected in trees, once in a Baobab *Adansonia digitata* at Makuya and once in a snag at Coetzer dam. At Coetzer Dam (Punda Maria, KNP) and Levubu, artificial drinking sites attracted the birds. Greyheaded Parrots drank by taking sips from the water source, and remaining vigilant and observant between sips. Drinking birds took one to 16 sips (7.1 ± 0.8, n = 21) (Table 1). At drinking sites activity was pronounced, and if any sign of danger was detected (e.g. presence of close observer), birds did not drink. Drinking time did not differ between the breeding season at Makuya and non-breeding season at Levubu site (t-test independent samples, t = 1.42, *df* = 61, *P* = 0.162) (Table 1). There was no significant difference in time spent drinking between males, females or juveniles at each site (Kruskall-Wallis ANOVA; Levubu: $\chi^2 = 4.61$; *df* = 3; *P* = 0.20; Makuya: $\chi^2 = 2.06$; *df* = 2; *P* = 0.36), or in males and females between sites (t-test independent samples; male: t = 1.08, *df* = 29, *P* = 0.29; female: t = 0.85, *df* = 15, *P* = 0.41).

Table 1. Duration of drinking times (seconds) of the Greyheaded Parrot at Levubu and Makuya, Northern Province.

	Levubu	Makuya	Average
Male	54.1 ± 9.5 (14)	43.4 ± 4.4 (17)	48.2 ± 4.9 (31)
Female	66.9 ± 17.8 (10)	47.4 ± 5.5 (7)	58.4 ± 10.7 (17)
Juvenile	59.0 ± 7.1 (7)	-	59.0 ± 7.1 (7)
Unsexed	30.3 ± 6.3 (6)	23.5 ± 15.5 (2)	28.6 ± 5.6 (8)
Total	**54.4 ± 6.3 (37)**	**42.9 ± 3.5 (26)**	**49.7 ± 4.1 (63)**

Once at Levubu an adult pair and three juveniles were observed drinking. The male bird drank first, with the female joining a few seconds later. When they had finished drinking, the male remained vigilant on a fence strand above the water trough while the three juveniles drank.

Bathing at drinking sites was not observed although birds may do so. Observations, made at Makuya and in Zimbabwe, of adults returning to nest sites in the early morning noted birds with wet underbody feathers. This may increase humidity in the nest, and occurred when birds bathed.

Flight types

Between roosts, feeding sites and activity centres, Greyheaded Parrots flew high, in a slightly zig-zag flight path, described as a rapid action of the wings with little movement above the horizontal (Skead 1964; Rowan 1983). Flight direction was direct with deliberate wingbeats, and continuous calling. At activity centres, small flocks circled the area with diving and squawking occurring while birds socialized (Fig. 1 & 2; Chapt. 4). While feeding, movement within the canopies of trees was deliberate and slow (Skead 1964). Greyheaded Parrots moved between branches by mostly climbing, using the bill as an additional limb, or making short, quiet flights. Juveniles were often identified by uncoordinated attempts of climbing between branches. Sometimes juveniles were seen "falling" off a branch while attempting to climb within the tree canopy.

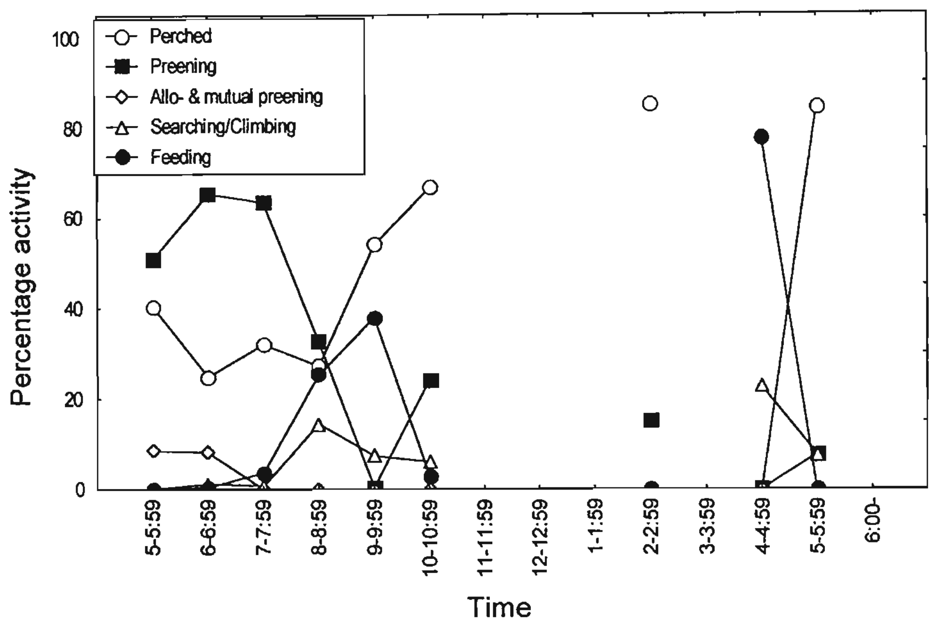

Fig. 2. Figure showing time proportions of different perched activities of Greyheaded Parrots at Levubu.

Behaviour

Socialising, maintenance and intra-specific interactions

Perch activities at Makuya were not determined by random sampling because few observations of small flocks were made. During early morning activities aggregated birds would often sunbathe, preen, allo-preen and mutual-preen. While preening, parrots would often shake and ruffle the plumage. Sometimes a bird would approach another and solicit preening from that individual by offering the back or side of the head. If preening did not occur immediately the site for preening would be re-offered with a movement closer to the other bird by the solicitor. Allo- and/or mutual-preening would then occur or not occur. Allo- and mutual-preening occurred mostly around the head region of the preened bird.

Additional intraspecific behaviours identified in Greyheaded Parrots included lunging with the bill forward at other individuals (agonistic display), head bobbing (sexual courtship display by male), wing flicking (possibly an agonistic display) and wing stretching (maintenance activity).

Unique feeding behaviour, likely learned, involved reaching for a branch with fruit, pulling the branch towards the perch, holding the branch on the perch with one foot and biting off individual fruits to feed (Chapt. 5). This action reduced search time between branches and was observed more than once.

Reciprocal feeding between pairs, and adults and juveniles was observed. The feeder, a male when pairs were observed and an adult when an adult and juvenile were observed, would head bob before regurgitating food (Chapt. 7). The receiver would stimulate regurgitation by lowering the body on the perch, bending the head upwards, and bobbing it in synchrony with the bobbing regurgitation motion of the feeder.

Play behaviour occurred when Greyheaded Parrots were most active and vocal in the early morning at activity centres (Chapt. 4). At an activity centre small flocks would fly together, circling the area, and resettle. On snag perches, Greyheaded Parrots would climb along branches using the bill, or hang from perches by the bill before flying off. Birds were also observed falling forward off perches, and climbing back up the other side using the bill.

Table 2. Intra-specific aggression in the Greyheaded Parrot in Levubu and Makuya, indicating date and time of activity, sex of individuals involved and tree species in which activity took place.

Locality	Date	Time	Tree sp.	Displacer	Displaced
Levubu	17-Sep-1999	07:58	*Gmelina arborea*	male	male
	27-Sep-1999	16:04	*Trichilia emetica*	"	"
	"	16:20	"	"	"
	"	16:32	"	"	"
	19-Oct-1999	07:15	*Parinari curatellifolia*	"	"
	15-Nov-1999	05:33	*Gmelina arborea*	"	juvenile
Makuya	26-May-2000	10:17	*Adansonia digitata*	"	male
	11-Jul-2000	09:03	*Combretum imberbe*	"	female
	16-Jul-2000	07:20	*Kigelia africana*	male & female	male
	17-Jul-2000	16:41	snag	male	"
	05-Aug-2000	07:54	*Combretum apiculatum*	"	female
	"	07:56	"	"	male
	11-Aug-2000	07:00	*Xanthocercis zambesiaca*	"	female

Scratching with the foot (underwing scratching) was observed as a maintenance activity and/or displacement activity. The foot was directed to different parts of the head (back: nape, crown and frons; and side of the head: lores, ear coverts and cheek) (Brereton & Immelman 1962; Serpell 1989). Often the foot would be held off the perch before and/or after scratching, sometimes not making contact with the head region.

Greyheaded Parrots were observed sleeping and resting during the heat of the day in a crouched position on a perch, with the bill often resting over the back. Sometimes they would perch on one leg while resting.

"Intention movements" (Daanje 1950) or incomplete locomotory actions signifying an intention to move were observed. This was specifically observed by the male at a nest hole entrance. A leaning forward action by the male, as though about to fly off, would be made. The significance of this behaviour was not interpreted.

Displacement off a perch occurred when a bird flew towards a perched bird and took its place on a perch. Intraspecific displacement occurred mostly when males displaced other birds off a perch (Table 2). These activities were not alway obviously aggressive.

Inter-specific interactions

Inter-specific interactions were observed at both study sites and are summarized in Tables 3 & 4 (see also Chapt. 7, Table 8). Interspecific aggression towards other species was only observed at Makuya during the breeding season (Table 3). Agonistic behaviour towards other species occurred towards nine bird species and occurred mostly in Baobabs when Greyheaded Parrots were most conspicuous and socialized (Table 3). Intraspecific agonistic behaviour was observed with, most often, the male as the aggressor. Aggressive behaviour was observed in 12 instances with six bird species (Table 4).

Only one species was observed feeding on *Commiphora mollis* at the same time and tree as a Greyheaded Parrot. Aggressive behaviour towards a Grey Hornbill, a predominantly insect eating hornbill, also occurred in a *C. mollis* (Table 3).

Response to predators was characterized by panic squawking in alarmed fright, dropping off the perch, and flying off low away from danger. An unidentified raptor (possibly juvenile African Hawk Eagle *Hieraaetus fasciatus* or Brown Snake Eagle *Circaetus cinereus*) was once observed chasing two Greyheaded Parrots and one Brownheaded Parrot *Poicephalus cryptoxanthus* (Table 4). During the chase the flock remained cohesive, zig-zagging in flight and calling alarmingly. The raptor was unsuccessful. Records of aggressive behaviour from Pied Crow *Corvus albus* occurred at a feeding site in Levubu where a pair of Pied Crow were nesting. Flocks of up to 30 parrots fed at this particular site and the presence of socialising parrots perching in the crow's nest tree possibly threatened the crows. The presence of African Hawk Eagle *Hieraaetus spilogaster* and Lizard Buzzard *Kaupifalco monogrammicus* invoked alarm responses from feeding and socialising parrots.

Table 3. Inter-specific aggression of Greyheaded Parrot towards other species indicating date and time of activity, sex of aggressor, species displaced, and tree species in which activity took place. No records were observed at Levubu. * indicates secondary cavity nesting species.

Locality	Date	Time	Sex	Tree sp.	Species
Makuya	11-Apr-2000	16:28	male	*Adansonia digitata*	Yellowbilled Hornbill *
	"	13:28	"	"	" *
	12-May-2000	15:27	"	"	Grey Lourie
	15-May-2000	08:10	"	"	Glossy Starling *
	"	08:13	unidentified	"	Redbilled Woodhoepoe *
	"	08:15	"	"	" *
	"	08:15	"	"	" *
	"	08:18	male	"	Redbilled Hornbill *
	17-May-2000	06:46	"	"	Forktailed Drongo
	03-Jun-2000	08:17	female	"	Yellowbilled Hornbill *
	27-Jun-2000	12:07	male	"	Brownheaded Parrot *
	"	12:07	"	"	" *
	16-Jul-2000	07:39	male & female	*Combretum*	" *
	05-Aug-2000	07:36	male	"	Blackeyed Bulbul
	11-Aug-2000	08:23	"	*Commiphora mollis*	Grey Hornbill *

Sexual behaviour was observed more often during the breeding season at Makuya than at Levubu, although duet calling was also heard regularly at Levubu from paired birds (Chapt.7). Arch-angel (AA) displays, in which the wings are held back, exposing the orange of the forewing, were observed at both study sites (Fig. 2). It was most common at Levubu in the early morning at activity centres (Chapt. 4). This display was used in aggressive displays (e.g. when another bird approached) and sexual displays during duetting between pairs (Chapt. 7).

Once at Levubu a group of eight Greyheaded Parrots (four pairs) was observed duetting and AA displaying together in a tree. Each pair was easily identifiable as a separate unit, and there was no intimate socializing between pairs.

Etepimeletic (begging) behaviour was observed from juvenile birds. Persistent soliciting from juveniles, with continuous *zeek-zeek* calling was observed in feeding flocks at Levubu. The adult responded by either feeding the juvenile, moving away, or beak lunging aggressively at the soliciting bird.

Table 4. Inter-specific aggression towards Greyheaded Parrot by other species indicating date and time of activity, aggressor, action involved.

Locality	Date	Time	Species	Action
Levubu	30-Aug-1999	07:35	Lizard Buzzard	frighten
	17-Sep-1999	07:53	African Hawk Eagle	"
	29-Sep-1999	06:47	Pied Crow	intimidating
	30-Sep-1999	16:44	"	chase
	04-Oct-1999	07:00	"	"
	"	08:36	"	"
	05-Oct-1999	08:20	"	"
	11-Oct-1999	08:00	"	frighten
	16-Oct-1999	07:52	"	"
Makuya	15-May-2000	08:06	Forktailed Drongo	chase
	"	09:04	Lilacbreasted Roller	"
	14 June 2000	16:19	African Hawk Eagle	frighten
	24-Jun-2000	09:20	juv. African Hawk Eagle or Brown Snake Eagle	chase

Tree usage

Tree species most frequently used when Greyheaded Parrots were active in early morning and late afternoon differed at each site. At Levubu the most commonly used trees were *P. curatellifolia* (30.91 %) and *G. arborea* (13.98 %) in which birds were observed feeding (Table 5). Snags or dead trees (15.35 %) were used during early morning and late afternoon activities when socializing, and *Acacia* spp. (11.81 %) were used often near a drinking site. Other tree species (13.39 %) used include Jackal Berry *Diospyros mespilliformis*, Flat-crown *Albizia adianthifolia*, White Stinkwood *Celtis africana*, Silver Cluster-leaf *Terminalia sericea*, *Ficus* spp. and Marula *Sclerocarya birrea* (Table 5). Baobabs were absent from Levubu (Chapt. 2 & 7). Many of these trees represent potential food species although Greyheaded Parrots were not seen feeding in some of them (Chapt. 5).

Table 5. Frequency of Greyheaded Parrot observations in different tree species at respective study sites. Top three species are highlighted. * food species (Chapt. 5); † prominent socializing perches (Chapt. 4).

Tree species	Levubu	Makuya
Adansonia digitata †	-	41.69
Paranari curatellifolia *	30.91	-
Other	13.39	32.03
Snag †	15.35	5.93
Gmelina arborea *	13.98	-
Acacia spp.	11.81	-
Ecalyptus sp. †	8.86	-
Kirkia acuminata *	-	7.12
Commiphora mollis *	-	4.07
Terminalia sericea *	-	2.54
Melia azaderach *	2.36	-
Sclerocarya birrea *	-	1.86
Pseudostachnostylis maprouneifolia *	-	1.86
Trichilia dregeana	1.77	-
Erythrina lysistemon *	1.57	-
Xanthocercis zambesiaca	-	1.53
Combretum spp.	-	1.36

At Makuya Greyheaded Parrots were most often observed in Baobabs *Adansonia digitata* (41.69 %), White Seringa *Kirkia acuminata* (7.12 %) and snags (5.93 %) where they were seen socializing and breeding (Table 5; Chapt. 7). Other trees they were observed in included Lowveld Cluster-leaf *Terminalia prunioides*, *Acacia* spp., Mopane *Calophospermum mopane*, Sausage Tree *Kigelia africana*, False Marula *Lannea schweinfurthii* and Jackal Berry. Mabola Plum and White Teak were absent from Makuya (Chapt. 2 & 7).

Exploration behaviour was observed by Greyheaded Parrots climbing the uppermost branches of snags and baobabs. A pair was once observed inspecting a large cavity in a baobab. Chewing behaviour involved chewing bark off branches, biting off twigs, and biting off leaves (Chapt. 5 & 7).

Tree species used as roosts are summarized in Table 6. Some birds were observed roosting in *Eucalyptus* spp. near a *G. arborea* feeding site in Levubu (Chapt. 5) although they did not regularly use this site. Roosts were difficult to locate as Greyheaded Parrots settled down quickly in the late afternoon to roost, and became active early, seldom giving pre-flight calls before departing the roost.

Table 6. Positively identified roost sites of the Greyheaded Parrot at Levubu and Makuya.

Locality	Date	Time	Flock size	Tree species	Remark
Levubu	16 Oct 1999	05:31	3	*Diospyros mespilliformis*	flushed from tree
	18 Oct 1999	18:17	10	*Pterocarpus rotundifolia*	"
	20 Oct 1999	18:14	3	*Burkea africana*	"
	26 Oct 1999	18:10	2	*Eucalyptus* sp.	enters tree in afternoon
	27 Oct 1999	05:17	2	"	flushed from tree
	1 Nov 1999	04:59	2	"	flies from tree
	12 Nov 1999	18:23	3	"	flushed from tree
	15 Nov 1999	04:57	2	"	flies from tree
Makuya	3 Apr 2000	06:14	1	*Adansonia digitata*	flushed from side of road

Vocalisations

The Greyheaded Parrot gave similar calls to those identified in the Cape Parrot. A common perched call sonogram is displayed (Fig. 3a) is similar to the Cape Parrot (call 1, Wirminghaus *et al.* 2000). This *tzu-wee* varies in amplitude with an emphasis on the second notes. This variation gives a clear call metallic call (Fig. 3b). Also, the second harmonic is less clear. This call is similarly given when perched or flying. In flight, for example, when moving to early morning feeding sites, these syllables are given repeatedly in a series of song phrases (Fig. 4) in LDCC's. Additional SDCC's (chirps and chatters) are added to give a complex song type, specific to and characteristic of Greyheaded Parrots. In continuous flight these syllables are given alternately and are audible from a distance of *c* 1km. While socializing, Greyheaded Parrots gave a complex series of call phrases (Fig. 5a & b).

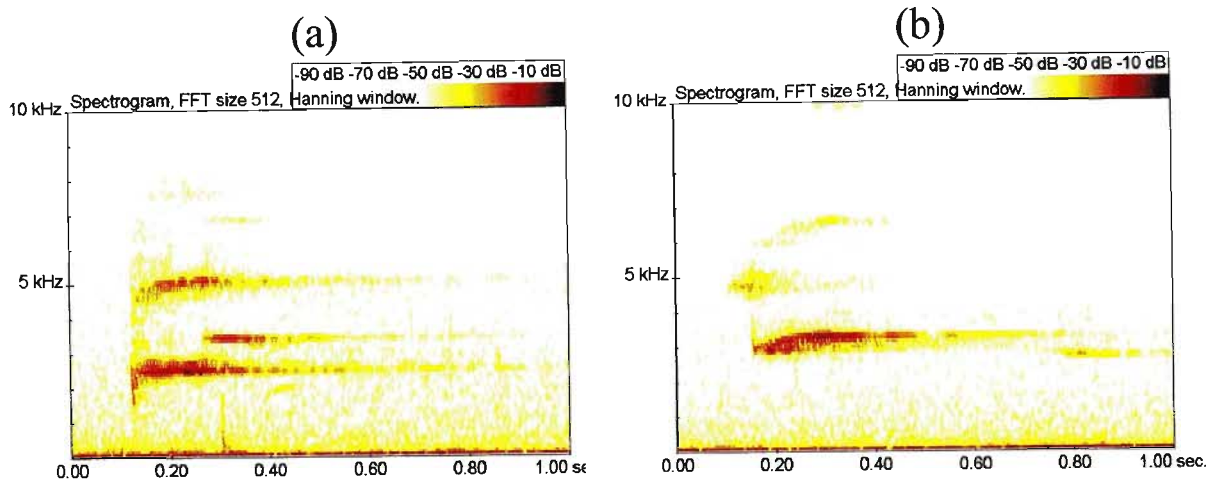

Fig. 3. a. Sonogram of Greyheaded Parrot *tzu-wee* call given in flight and when perched. There is less emphasis placed on the second note in this call than the following call (3b). This gives the call a more grating tone. **b.** Sonogram of Greyheaded Parrot call variation of *tzu-weee* call as given in flight and when perched. In this call greater emphasis is placed on the second note, giving the call a more metallic ring.

Greyheaded Parrots showed typical psittascine flocking behaviour with monogamous pairing (Arrowood 1988). This pair bond is possibly strengthened by duetting, both inside and outside the breeding season (Fig. 1). Greyheaded Parrots also showed controlled synchrony in duet calls, with complex and variable calls recorded between pairs (Fig. 6) and was often associated with AA wing displays (Fig. 1). Different notes given by each individual are not identified. The duet call was initiated by the male with an accompanying AA display, with a response of varying intensity from the female. At Levubu AA displays were recorded more often in the morning whereas at Makuya they were recorded throughout the day, often at a nest site. AA displays were nearly always accompanied with duetting. The female would continue the duet, and sometimes display. The intensity with which the female responded with an AA display appeared to be correlated with the degree of synchrony and length of the duet call itself (pers. obs.). A duet phrase in which a clear note *teeeu* was identified at the end of the call often ended the duet, but was not tape recorded. This completion to the duet phrase has not been identified or heard in the Cape Parrot (pers. obs.).

An additional note not recorded in the Cape Parrot was noted frequently in the Greyheaded

Parrot while calling and socializing at activity centres (Chapt. 4). This resonating nasal *kraa*, reminiscent of a crow *kraa*, is represented as a sonogram (Fig. 7 at time *c* 1.0 secs, and beginning

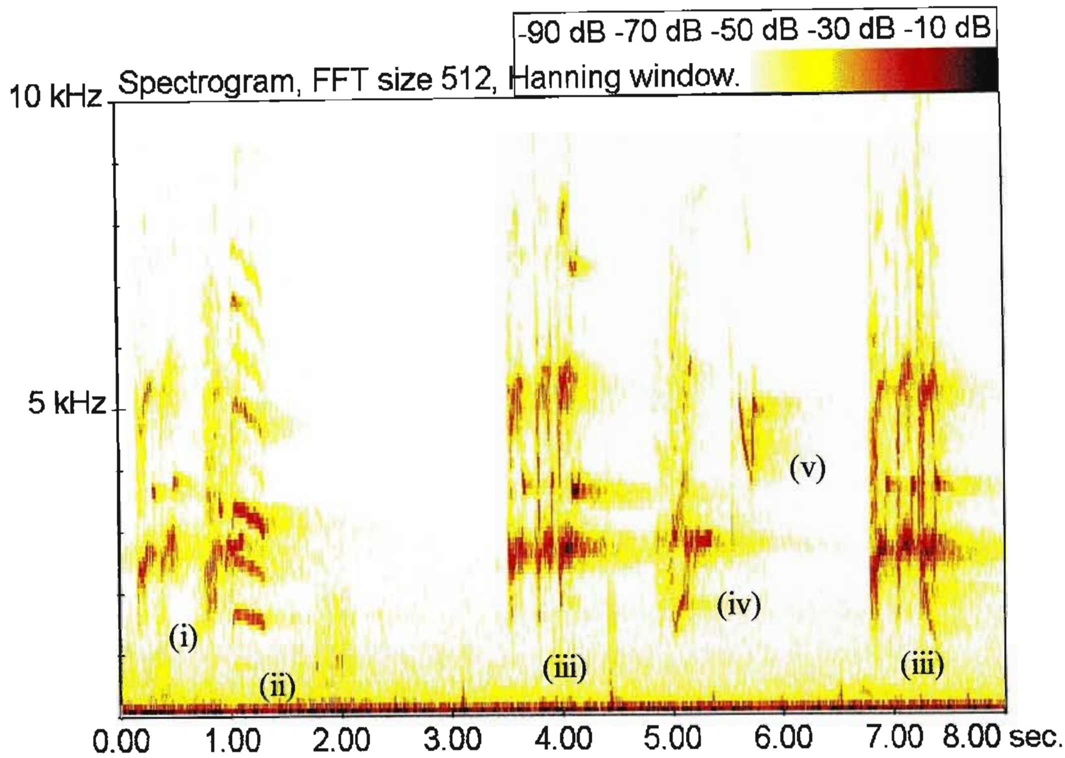

Fig. 4. Sonogram of Greyheaded Parrot song phrases with different call components identified. i) alternate calling from two birds (two calls; similar to Fig. 3a), ii) *kwéé* call, iii) alternate calling from two birds (three calls), iv) complex call combination, v) high pitched *seeu* call.

of Fig. 5a).

Juveniles were identified at a nest at Makuya giving conspicuous rasping *zeek-zeek.....zeek-zeek-zeek* soliciting calls from the nest. This call was initiated by the return of the adult pair to the nest and never given when the pair were absent (Fig. 8). These juvenile soliciting calls were also heard in Levubu a number of months after fledging. In the nest an aggressive grating call was given by threatened nestlings (i.e. removing them for analysis). This defensive call was also given by captive adults when threatened or confined (pers. obs.; Fig. 5 & 6 in Wirminghaus *et al.* 2000).

Another call, not detected in Cape Parrots, was given mostly by male birds. This *click* call, bearly audible, was given by a male bird while perched in a White Seringa *Kirkia acuminata*. It was possibly maintaining contact with a female in the nest. This call may be synonymous with that detected by Holyoak & Holyoak (1972). It was also heard elsewhere, mostly during non-socializing activities.

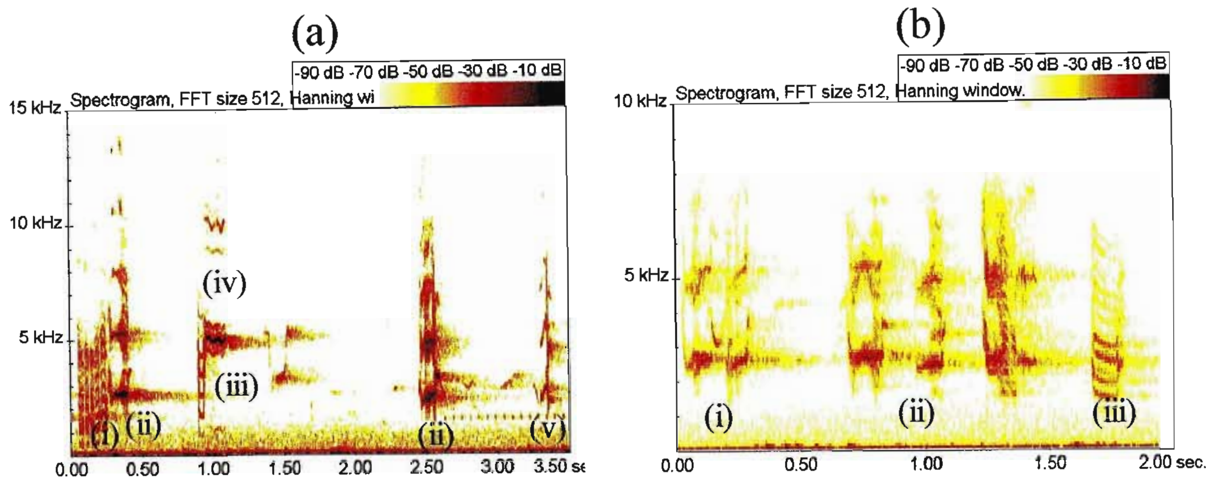

Fig. 5 a. Sonogram of complex series of song phrases of Greyheaded Parrot while socializing. i) unique *kraak* call, ii) *zeek* call given in flight and perched, more grating/rasping tone than Figure 3a and reminiscent of soliciting call of juveniles, iii) high pitched contact *tzeep* call, iv) higher pitched rapid *tsip* contact call, v) softer *zeek* call, similar to (ii).

b. Sonogram of complex series of song phrases of Greyheaded Parrot while socializing. i) *zeek-zeek* call, reminiscent of juvenile soliciting call, ii) three *zeek* calls, possibly two birds alternating, at different intensity, iii) rapid *kraa* call, with warbled tone, similar to unique *kraak* call
Note different time scale on x-axis and frequency scale on y-axis.

In a flock of seven Greyheaded Parrots feeding in a stand of *G. arborea*, LDCC's (mostly calls in Fig. 3) were given at a rate of 1.94 calls/bird/min (sample for 10 min), in a flock of four at a rate of 1.96 calls/bird/min (sample for 6.5 min), and in a flock of two at a rate of 1.8 calls/bird/min (sample for 7.5 min). Calling rate increased significantly for birds in flight between roosts, feeding sites and activity centres (pers. obs.). Calls between feeding, perched and resting birds were mostly a series of quiet chirps. This complex repertoire was difficult to examine and requires further investigation. Short distance contact call (SDCC) calling rate was not determined because Greyheaded Parrots give a wide variety of different calls when feeding and socializing.

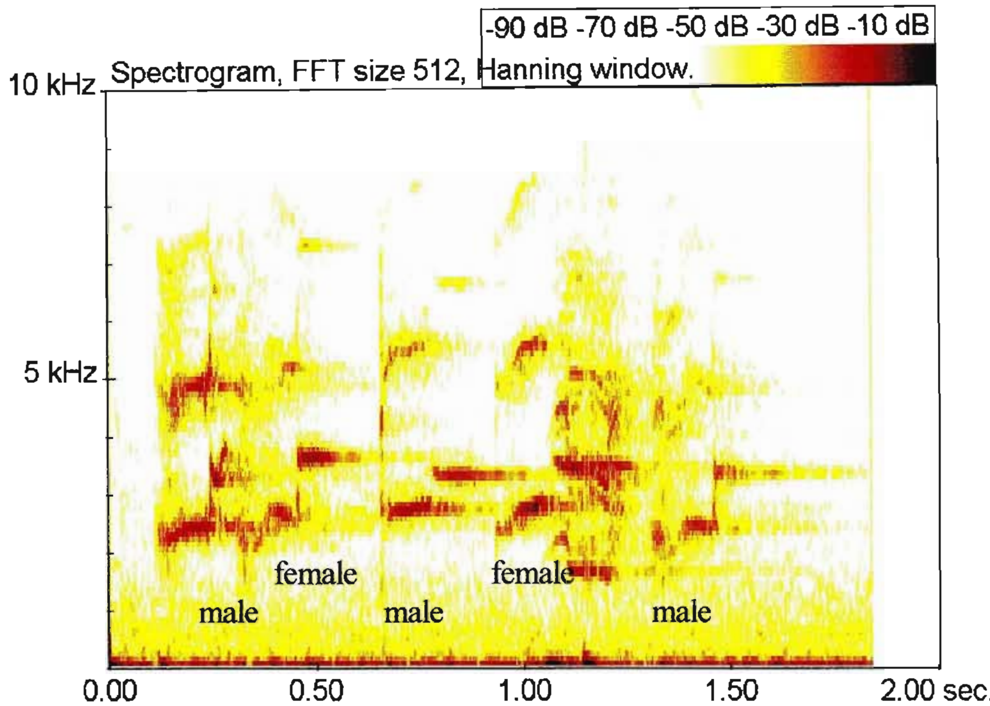

Fig. 6. Sonogram of Greyheaded Parrot duet call. Possible male-female involvement in call indicated. Call components similar to *tzu-wee* call (Fig. 3a).

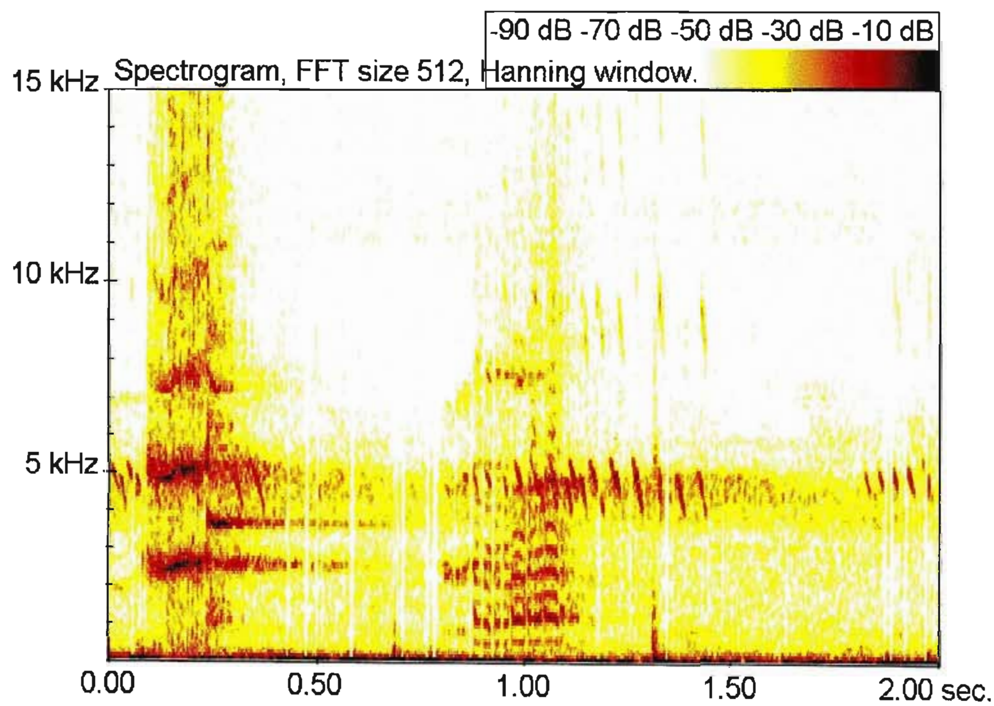

Fig. 7. Sonogram of Greyheaded Parrot *kraaa* call (cricket calling in background). *zeek* call as in Figure 5b, followed by unique *kraaa* call as in Figure 5a.

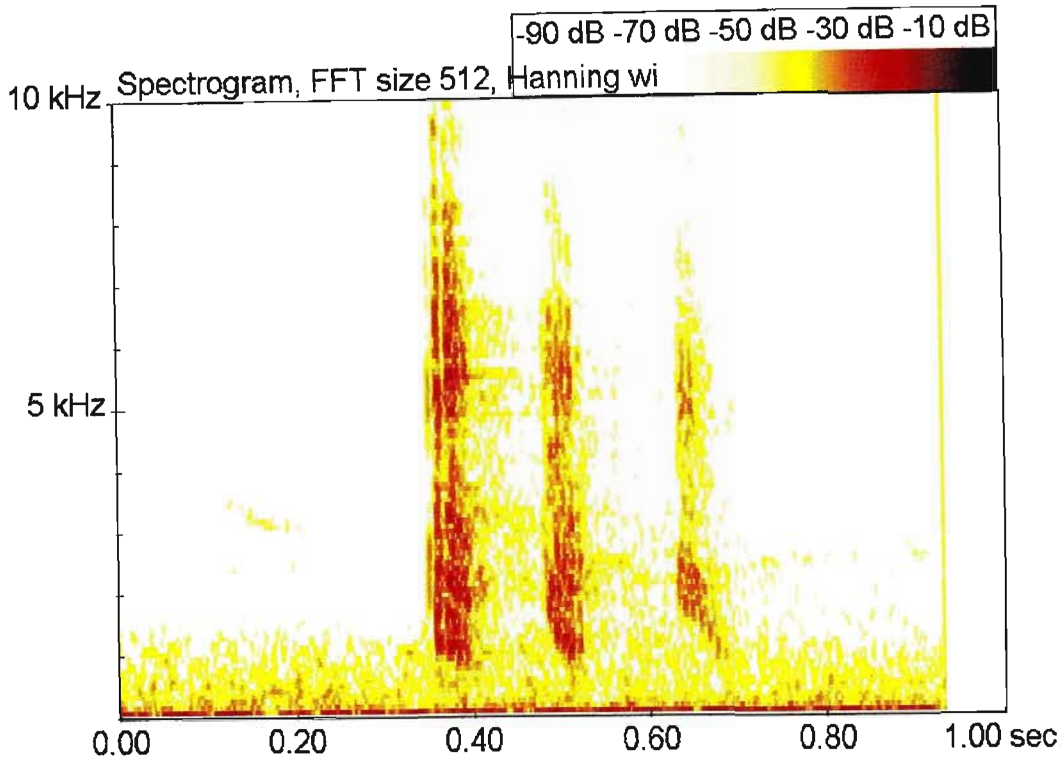

Fig. 8. Sonogram of juvenile Greyheaded Parrot *zeek-zeek-zeek* soliciting call.

Discussion

Behaviour

Greyheaded Parrots showed typical, yet exaggerated, avian behaviours (Holyoak & Holyoak 1972; Maclean 1990). Some of these visual displays appear to be derived from behaviours with no apparent communicating significance (Serpell 1989). In many cases, body and plumage maintenance activities form one of the main sources from which these signals are derived (Serpell 1989). Specific examples are given below.

Because individual birds are difficult to identify, the presence of a hierarchical structure was difficult to determine. In all instances of intra-specific aggression, where one bird displaced another on a perch, males mostly displaced males. This greater number of intra-specific agonistic behaviours by male Greyheaded Parrots suggests that male birds are dominant. Holyoak & Holyoak (1972) suggest otherwise. In the Cape Parrot no dominance was observed except when approaching water sites where a male would often go to the water first (Wirminghaus *et al.* 2000; pers. obs.). It is suggested that intraspecific dominance behaviours are subtle and seldom observed as obvious. Detecting any form of a hierarchy is therefore difficult. The female that accompanied a male during the displacement of another male suggests that a females' status in a flock is established by the status of her male partner (Table 4). There appeared to be no territories established at feeding sites. No intra-specific interactions were observed at nest sites suggesting that nest sites are sufficiently dispersed to avoid territorial disputes (Chapt. 7). Aggressive behaviour towards secondary cavity nesting species and potential nest site competitors during the breeding season suggests that competition for nest sites exists and that nest sites may be limiting. Another secondary cavity nester, the Lilacbreasted Roller *Coracias caudata* behaved aggressively towards a Greyheaded Parrot (Table 4). Cavity nesters were also recorded investigating Greyheaded Parrot nests, but because Greyheaded Parrots breed from April to August competition for nest sites may be reduced (Chapt. 7).

Agonistic displays in *Poicephalus* spp. are highly ritualized with wing threats being common (Holyoak & Holyoak 1972). Most *Poicephalus* spp. are characterized by the presence of bright "flash colours" beneath the wing that, in some species are visible on a perched bird on the leading edge of the wing (*P. robustus* superspecies complex - orange to red; *P. meyeri* superspecies complex - yellow to orange) (Snow 1978; Rowan 1983; Forshaw 1989; Wirminghaus 1997). These colours may be used to emphasize the degree of the respective display e.g. agonistic, sexual.

Displacement head scratching, as observed in *Trichoglossus* spp. (Serpell 1989), was observed out of context and interpreted as an aggressive, sexual and/or social reaction, depending on the situation observed (pers. obs.). Certain behaviours, possibly derived from feeding behaviours may strengthen intraspecific bonds within a flock. For example, head bobbing as observed in captive birds prior to copulation and breeding, is also observed prior to regurgitation of food (W. Horsfield pers. comm.). In Greyheaded Parrots, several signals have evolved where the derivative may be obscure. In the wild, behaviours have been difficult to observe and studies of captive birds may give insight and clearer interpretations into the significance of species specific signals. For example, wing flicking and tail wagging in socializing wild flocks is difficult to notice and place in context when the identity of each individual birds is unknown. As a result observing them in wild birds was not analysed.

Mixed species flocks have been recorded in neotropical (Chapman, Chapman & Lefebvre 1989; Munn 1992) and Australasian (Westcott & Cockburn 1988; Marsden 1999) parrot species. Greyheaded Parrots are specialized feeders on fruit kernels yet possible food competitors include Southern Yellowbilled Hornbill *Tockus leucomelas* which is common in the area, and Trumpeter

Hornbill *Bycanistes bucinator* and Crowned Hornbill *Tockus alboterminatus* (Chapt. 5). Smaller frugivorous species such as Brownheaded Parrots and starling species may provide competition to a lesser degree (Chapt. 5).The specialised feeding habits of the Greyheaded Parrot reduce inter-specific competition for food. The Cape Parrot has been observed feeding in mixed species flocks of Redwinged Starlings *Onychognathus morio* and Rameron Pigeons *Columba arquatrix* (Wirminghaus, Downs, Symes & Perrin In press b).

Greyheaded Parrots probably have few avian predators and the one instance of a Brown Snake Eagle chasing a Greyheaded Parrot in a mixed species flock of two Greyheaded Parrots and one Brownheaded Parrot was observed (Table 4). Numbers of raptor species recorded at each study site were similar suggesting that predation is not responsible for flocking (Chapt. 4 & 7). No raptor species may specifically target Greyheaded Parrots yet opportunistic predation may occur. The number of raptor and potential aerial predator species of the Greyheaded Parrot is greater than the Cape Parrot (Chapt. 7; Wirminghaus, Downs, Symes & Perrin In press c). However, the Cape Parrot may form an important prey of the Black Sparrowhawk *Accipiter melanoleucus*.

Increased flock size and flocking behaviour benefit species by reducing predation (Ward & Zahavi 1973; Caccamise & Morrison 1986; Krebs & Davies 1999).; increased vigilance, dilution and group defence also decrease predation. In each case where predators were observed and parrots were alarmed, flocks remained together calling raucously in alarm. These cohesive groups possibly acted as strong anti-predatory behaviour devices, especially during post-breeding months when newly fledged young are vulnerable to predation.

Vocalisations

Unique calls identified in the Greyheaded Parrot are summarized, yet detailed comparisons with those of the Cape Parrot were not possible because different equipment was used in each study. Although, audible differences between calls are noticeable, further investigation is required (G. Gibbon pers. comm.; pers. obs.).

The biological significance of duetting is not clear (Malacrane, Cucco & Camanni 1991). In the Greyheaded Parrot duetting was observed inside and outside the breeding season supporting the hypothesis of pair bond strengthening in a monogamous species that flocks outside the breeding season (Chapt. 4). It is also suggested that co-ordinated duetting and displaying also serve to promote reproductive synchronization (Malacrane, Cucco & Camanni 1991; Massa

1995).

Vocal learning occurs in psittascines. Post-breeding dependence in Greyheaded Parrots may therefore be an important period for juveniles when they learn complex song phrases, important in socializing and communicating. Orange-bellied Parrots *Poicephalus crassus* and Cape Parrots use contact calls frequently when feeding and socializing (Massa 1995; Wirminghaus *et al.* 2000). No vocal mimicry was recorded in the wild, although it may occur as recorded in wild African Greys (Cruickshank, Gautier & Chappuis 1993).

Distress calls of nestlings, as observed when approaching a nest cavity for inspection, are un-parrot like, and more reminiscent of a feline-like growl. Such a sound, emanating from a dark cavity is likely to invoke a cautionary response from any potential predator. This distress/alarm call, also observed in adult captive birds when handled, has been identified in six *Poicephalus* species (*P. cryptoxanthus*, *P. meyeri*, *P. rufiventris*, *P. senegalus*, *P. robustus*, *P. gulielmi*). Similar anti-predatory strategies have also been identified in other cavity nesting species where the potential prey is out of view of the predator. These sounds include hissing (snake like) noises made by Southern Black Tit *Parus niger* (A. Kemp pers. comm.), Desert Cisticola *Cisticola aridula* (P. Lloyd pers. comm) and Black Collared Barbets *Lybius torquatus* (J. Wilson pers. comm.), and rasping/grating sounds from parrots and hornbill species (e.g. Redbilled Hornbill *Tockus erythrorhynchus*) (pers. obs.). It is likely that these anti-predatory responses have co-evolved in various cavity nesting passerine and non-passerine species.

Preliminary observations of calling rate suggest that LDCC's are used regularly at a specific call rate when birds are feeding. These calls are given at a constant rate irrespective of flock size. SDCC's, given regularly between feeding and socializing birds may strengthen intra-specific bonds and improve flock cohesiveness.

Conclusion

This preliminary study has shown the Greyheaded Parrot to have a complex vocal repertoire and set of inter- and intra-specific set of behaviours similar to that of the Cape Parrot. Some of these behaviours have been described in context yet requires further study. Understanding the biological and ecological significance of these vocalizations and behaviours would require detailed studies of notes and syllables of the respective species song phrases.

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References

ALTMANN, J. 1974. Observational study of behavior: sampling methods. *Behaviour* 49: 227-267.

ARROWOOD, P.C. 1988. Duetting, pair bonding and agonistic display in parakeet pairs. *Behaviour* 106: 129-157.

BIRCHALL, A. 1990. Who's a clever parrot then? *New Scientist* 24 Feb 1990: 38-43.

BRERETON, J.H.G. & IMMELMAN, K. 1962. Headscratching in the Psittaciformes. *Ibis* 104: 169-175.

CACCAMISE, D.F. & MORRISON, D.W. 1986. Avian communal roosting: implications of diurnal activity centers. *Am. Nat.* 128(2):191-198.

CHAPMAN, C.A., CHAPMAN, L.J. & LEFEBVRE, L. 1989. Variability in parrot flock size: possible functions of communal roosts. *Condor* 91: 842-847.

CRUICKSHANK, A.J., GAUTIER, J.P. & CHAPPUIS, C. 1993. Vocal mimicry in wild African Grey Parrots *Psittacus erithacus*. *Ibis* 135: 293-299.

DAANJE, A. 1950. On locomotory movements in birds and the intention movements derived from them. *Behaviour* 3: 48-98.

FORSHAW, J.M. 1989. *Parrots of the world.* Lansdowne Books. Willoughby, Australia.

HOLYOAK, D.M. & HOLYOAK, D.T. 1972. Notes on the behaviour of African parrots of the genus *Poicephalus*. *Avicult. Magazine* 78:88-95.

HOMBERGER, D.G. 1999. The avian tongue and larynx: Multiple functions in nutrition and vocalisation. In: Adams, N.J. & Slotow, R.H (eds). Proc. 22 Int. Ornithol. Congr., Durban: 94-113. Johannesburg: BirdLife South Africa.

KREBS, J R. & DAVIES, N.B. 1999. *An introduction to behavioural ecology (3rd Edition).* Blackwell Science. Oxford.

MACLEAN, G.L. 1990. *Ornithology for Africa.* University of Natal Press. Pietermaritzburg.

MALACRANE, G., CACCO, M. & CAMANNI, S. 1991. Co-ordinated visual displays and vocal duetting in different ecological situations among Western Palaearctic non-passerine birds. *Ethology, Ecology and Evolution* 3: 207-219.

MARSDEN, S.J. 1999. Patterns of diurnal flight activity in three Indonesian parrot species. *Papageienkunde* 3 (S):1-8.

MASSA, R. 1995. Performance of socio-sexual activity at a communal site in the African Orange-bellied Parrot *Poicephalus rufiventris. Ostrich* 66: 141.

MUNN, C.A. 1992. Macaw biology and ecotourism, or "when a bird in the bush is worth two in the hand". pp. 47-72. In: Beissinger, S.R. & Snyder, N.F.R. (Eds). New world parrots in crisis: solutions from conservation biology. Smithsonian Institution Press. Washington.

PEPPERBERG, I.M. 1981. Functional vocalizations by an African Grey Parrot (*Psittacus erithacus*). *Zeitschrift fur Tierpsychologie* 55: 139-160.

ROWAN, M.K. 1983. *The Doves, Parrots, Louries and Cuckoos of southern Africa.* David Phillip. Cape Town.

SERPELL, J. 1989. Visual displays and taxonomic affinities in the parrot genus *Trichoglossus. Biological Journal of the Linnean Society* 36: 193-211.

SKEAD, C.J. 1964. The overland flights and the feeding habits of the Cape Parrot, *Poicephalus robustus* (Gmelin) in the eastern Cape Province. *Ostrich* 25(1):202-223.

SNOW, D.W. (Ed.). 1978. *An atlas of speciation in African non-passerine birds.* British Museum (Natural History). London.

SOLMS, L., BERRUTI, A., PERRIN, M., DOWNS, C. & BLOOMER, P. 2000. Phylogenetic relationships of the three subspecies of the Cape Parrot *Poicephalus robustus.* 17th Congress of the South African Genetics Congress. June 2000. Pretoria.

WARD, P. & ZAHAVI, A. 1973. The importance of certain assemblages of birds as "information centres" for food finding. *Ibis* 115: 517-534.

WESTCOTT, D.A. & COCKBURN, A. 1988. Flock size and vigilance in parrots. *Australian Journal of Zoology* 36: 335-349.

WIRMINGHAUS, J.O. 1997. Cape Parrot *Poicephalus robustus*. In: Harrison, J.A., Allan, D.G., Underhill, L.L., Herremans, M., Tree, A.J., Parker, V. & Brown, C.J. (Eds). The atlas of southern African birds - Vol 1. BirdLife - South Africa. Johannesburg

WIRMINGHAUS, J.O., DOWNS, C.T., SYMES, C.T., DEMPSTER, E. & PERRIN, M.R. 2000. Vocalisations and behaviours of the Cape parrot *Poicephalus robustus* (Psittaciformes: Psittacidae). *Durban Museum Novitates* 25: 12-17.

WIRMINGHAUS, J.O., DOWNS, C.T., SYMES, C.T. & PERRIN, M.R. In press a. Taxonomic relationships of the subspecies of the Cape Parrot *Poicephalus robustus* (Gmelin). *J. Nat. Hist.*

WIRMINGHAUS, J.O., DOWNS, C.T., SYMES, C.T. & PERRIN, M.R. In Press b. Diet of the Cape Parrot *Poicephalus robustus* in afromontane forests in KwaZulu-Natal, South Africa. *Ostrich.*

WIRMINGHAUS, J.O., DOWNS, C.T., SYMES, C.T. & PERRIN, M.R. In press c. Breeding biology of the Cape Parrot *Poicephalus robustus*. *Ostrich.*

CHAPTER 7

BREEDING BIOLOGY OF THE GREYHEADED PARROT *POICEPHALUS FUSCICOLLIS SUAHELICUS* IN THE WILD

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Abstract

The Greyheaded Parrot breeds in the southern limit of its range from April to August, yet further north breeds in other months of the year. Egg laying between monogamous pairs is synchronous and 2 - 4 eggs are laid in natural cavities in baobabs Adansonia digitata. *Post-breeding seasonal movements occur into regions where nest sites are scarce or possibly absent. Males provision the female in the nest cavity during incubation and early stages of nestling development. Female attendance at the nest is reduced once fledglings are able to thermoregulate on their own. By the end of the fledging period visitation rates to the nest site by the male and the female are reduced to twice a day (mid-morning and late-afternoon). Nest sites are possibly limiting with inter-specific competition for nest sites occurring. Intra-specific competition for nest sites in areas where populations have declined has possibly been reduced. Removal of chicks from nests threatens populations outside protected areas. The conservation of this species in the southern limit of its range is thus highlighted.*

Keywords: Greyheaded Parrot, *Poicephalus fuscicollis suahelicus*, breeding, *Adansonia digitata*.

INTRODUCTION

The Greyheaded Parrot *Poicephalus fuscicollis suahelicus* is an obligate secondary cavity nester (Rowan 1983; Forshaw 1989) and breeds in various months of the year throughout its range (see Table 1 & 2). Present knowledge of the breeding biology of the Greyheaded Parrot is that obtained from incidental observations and anecdotal notes in the literature. Greyheaded Parrots are dichromatic with females identified by the presence of orange feathers on the crown. Males lack this orange in adult plumage. Adult birds differ from juveniles in their first year by the presence of orange on the tarsal feathers and leading edge of the wing. The onset of adult plumage begins in the first year and is fully attained at 2 - 3 years (Symes & Downs 1998a; W. Horsfield pers. comm.).

The Greyheaded Parrot has been bred successfully in captivity (Isert & Isert 1980; Low 1982, 1995; Brickell 1985; Sharples 1989), yet little is known of its breeding biology in the wild. This study was conducted to investigate the breeding biology of the Greyheaded Parrot and make recommendations for the conservation of this species in the wild. By comparing these findings with captive breeding results, knowledge would be provided to improve captive breeding success, and promote the overall conservation of the species.

Timing of breeding in the Cape Parrot *Poicephalus robustus* occurs at different times of the year from spring to early summer (Wirminghaus *et al.* In press). Onset of breeding is possibly initiated by fruiting Outeniqua Yellowwood *Podocarpus falcatus* and laying time appears to be synchronous between pairs (Wirminghaus *et al.* In press). This is supported by the appearance, over a short period of time, of larger flocks in May and June when yellowwood fruit is ripe (Wirminghaus *et al.* In press, 2001). Similar observations have been made in the Greyheaded Parrot in north-eastern South Africa, where large flocks (> 20 birds/flock) make their appearance in Levubu for particular months of the year (Chapt. 4). This post-breeding flocking is recorded in various parts of the range of the Greyheaded Parrot (Fynn 1991; I. Riddel pers. comm.; Chapt. 3 & 4). It was hypothesized that breeding of the Greyheaded Parrot is confined to particular regions of its range where nest sites are limited. Within the breeding range nest sites were predicted to be limiting, with breeding occurring in response to available food sources. In addition, it was predicted that synchrony in laying between breeding pairs occurs.

Table 1. Historical individual nesting records of *P. f. suahelicus*

Tree species	Nest details	Clutch size	Date	Locality	Reference
Adansonia digitata	hole ht = 710 cm; aspect = 350°; DBH = 226 cm; hole entrance dia. = *c* 17 cm	3 chicks in nest	July	Pafuri, northern Kruger National Park	A. Kemp (pers. comm.)
Adansonia digitata	overhanging trunk	pr at nest	19 Apr	Sianzovu, Kalomo, Gwembe Valley, Zambia	Anon
-	-	3 eggs laid	4 - 14 April	Zambia	Rowan (1983)
Brachystegia randii	hole 6 m from ground; 30 cm deep x 18 cm wide	3 eggs	9 May	Zimbabwe	Vincent (1946)
Acacia glaucescens	nest in tall tree	-	April 1966	Sengwe Wildlife Research Area, n-w Zimbabwe	Jacobsen (1979)
Hyphaena ventricosa	high up dead tree	pr emerging	12 Sept	Mfuwe, South Luangwa, Zambia	Beel (1994)
Albizia tanganyicensis	nest hole *c* 8 - 9 m high	possibly on eggs by behaviour	10 May 2000	Chobe River, Botswana	R. Randall (pers. comm.)
Albizia tanganyicensis	hole in tree	pair at hole	May 1997 & March 1998	Masuma Dam, Hwange Nat. Park, Zimbabwe	H. Erwee (pers. comm.)
snag ?	snag knocked over by elephants	-	-	Kaudom National Park, Namibia	P. Lane (pers. comm.)
"live tree"	unlined cavity at ht of *c* 8.5 m	3 eggs	7 Nov	Matabeleland, Zimbabwe	Carlisle (1923)

STUDY SITES & METHODS

The study was conducted at two sites in the southern limit of the range of the Greyheaded Parrot (Fig. 1). Greyheaded Parrots occur seasonally in the Levubu district (23° 00' - 23° 15' S, and 30° 05' - 30° 30' E) from August to December and arrive to feed on fruiting trees in the area (Chapt. 3 & 5). Breeding has not been recorded in this area but large flocks of up to 50 individuals are conspicuous at one time (Chapt. 4). Juveniles are often present and observed soliciting food from adults (Chapt. 5 & 6). Field work occurred in this area from August 1999 to December 1999. Observations were conducted to confirm non-breeding activity. Heavy rains and flood damage in north-eastern South Africa from January 2000 to March 2000 prevented access to the region and observations on pre-nesting behaviour. Field work recommenced in April 2000 and continued to September 2000 in the region of the Luvhuvhu-Mutale river confluence (22° 26' - 22° 32' S, and 30° 50' - 31° 05' E). This season included breeding months of the Greyheaded Parrot.

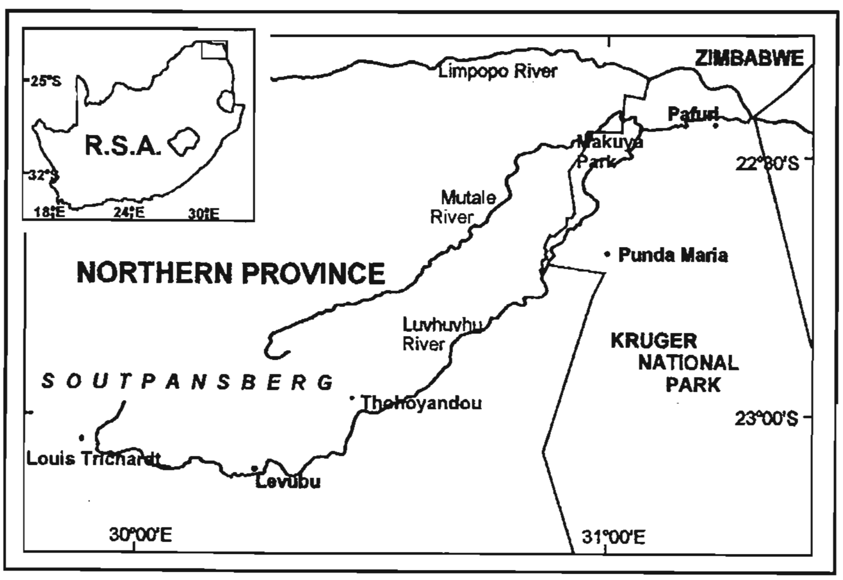

Figure 1. Location of study area in north-east South Africa.

Nests were located by observing birds in the wild and inspecting potential cavities in baobabs and snags where Greyheaded Parrots were observed socialising. The assistance of residents in the Makuya area was called upon to help locate nests.

Nest site requirements

The following characteristics of active and inactive nests were measured: tree species, diameter at breast height (DBH) of nest tree, height of nest hole, aspect of nest hole, nearest baobab distance and DBH of nearest baobab. Cavity dimensions (nest hole size, cavity size) of active nests were measured.

Nest site availability

Nest availability was determined by quantifying potential nest tree species (i.e. baobabs) at the two study sites. DBH of baobabs 50 m either side of three road transects at Makuya were measured (Fig. 1). All baobabs in the Levubu area were recorded.

Breeding behaviour

At active nests the following time period observations were made of the male and female at a nest located in Makuya Park: time in nest cavity; time at nest cavity entrance (i.e. head peeping out or bird perched at entrance hole); time on nest tree; time nearby nest tree (perched within calling distance); time away from nest tree (beyond audible calling distance).

Behaviour of pair birds at nest sites located was recorded e.g. social interacting, duet calling, allo- and mutual preening and other behaviours. Interspecific interactions were also recorded at the nest site.

Similar observations were made at a nest located on Senuko Ranch, Save Valley Conservancy, south-east Zimbabwe, in July 1999. The nest was observed for nine days from 7 - 15 July and various behavioural aspects at the nest site recorded. On leaving the area sightings of birds were made by a resident Game Guard at Senuko Lodge. The nest site area was visited again on 21 September 1999. The nest hole was, however, not accessible at the time.

Development of Greyheaded Parrot nestlings has not been recorded in the wild and care was taken not to unnecessarily disturb breeding birds. Nestlings of the nest under observation were weighed (Pesola 600 g balance with 5 g divisions) and measured approximately every two weeks.

At four nests located blood samples were collected from chicks. This was used to sex individual nestlings using DNA techniques. Sex ratios of wild populations were determined using three methods. Ratios of males to females were determined by considering all individuals recorded when determining feeding times (Chapt. 5), when recording drinking times (Chapt. 6), and by random sampling at activity centres (Chapt. 4). It was assumed that males and females had equal chances of being detected at water holes (when females were not incubating), when feeding, and when active at activity centres (Chapt. 4).

Moult

Greyheaded Parrots exhibit characteristic wing displays when socialising and these include wing-and-leg-stretch and both-wings-stretch (archangel display in Wirminghaus *et al.* 2000; Maclean 1990). During such displays, moult and/or condition of primary and secondary remiges was recorded.

Competitors and predators

Raptor species and cavity nesting species were investigated at each study site. Two transects were walked at each site where parrots were known to occur. Transects were walked from October to December at Levubu and from May to July at Makuya. A 300 m transect at each locality was walked 16 times, on separate days, each month. Each day was divided into four time periods (before 09h00, 09h01 - 12h00, 12h01 - 15h00, after 15h00) and four transects walked at random times during each time period. This was done to control for differences in detection rate of different species through a day. The same time period was walked only once in a given day and transects lasted 30 min. Presence of all raptor species and cavity nesting birds species were recorded visually and audibly.

Cavity nesting bird species were used as indices of nest site availability. Species identified when not conducting transects were also recorded.

Blood collected was used to test for disease (Avian Polyoma Virus - APV, *Chlamydia psittaci* - CP, Psittacine Beak and Feather Disease - PBFDV). Two dead chicks were found in a nest and removed (Table 2). Blood was collected to test for APV, CP and PBFDV. The crops were full and contents removed for analysis. These specimens are housed in the Transvaal Museum (specimen numbers: TM 78816 & TM 78817). A single louse specimen was also removed from a chick (nest 24) for identification.

Many nests were not in use, yet had been used in the past. These nests were identified by trappers and residents in the area. Removal of chicks from these nests had occurred, in many instances by chopping open the nest cavity. As a result, nest sites outside protected areas have possibly become limiting. Details concerning past breeding in cavities, past removal of chicks from cavities, chopping of nest hole for removal of chicks and placing of pegs on tree to access cavity were recorded for all nests (active and inactive) discovered. Interviews were conducted with 62 Vendas in the Tshikuyu community at Makuya where parrots have been recorded breeding in the past, and where trade and removal of nestlings from active nests is known to occur. A Venda interpreter was used to translate as people in the area were very suspicious of a white stranger in the area.

Table 2. Dimensions of active nests recorded in this study (all nests in Baobabs *Adansonia digitata*).

Nest	Tree DBH (cm)	Hole ht (m)	Hole aspect (mag. north °)	Cavity dimensions	Nearest baobab DBH (cm)	Nearest baobab dist (m)	Locality	Comment
Zim	318	*c* 750	*c* 315	entrance dia. *c* 20 cm	-	-	20° 39.1' S 31° 59.2' E	nest observed 7 - 15 July 1999 with nestlings, possibly 3 fledge successfully
9	274	1 160	60	entrance dia. *c* 12 cm; deep entrance extending horizontally into nest tree	213	29	22° 27.0' S 30° 56.0' E	bees take over nest, another destroyed cavity in same tree, removal of chicks in past
24	140	715	305	entrance *c* 14 cm wide x 15 cm high, depth *c* 75 cm at 15° into tree	51	11.5	22° 29.3' S 31° 02.7' E	2 chicks fledge successfully, weighed and sampled successfully
33	233	570	50	entrance *c* 9 cm wide x 12 cm high, depth *c* 50 cm (L-shape into tree)	211	24	22° 30.6' S 30° 59.7' E	3 chicks, only two removed for sampling due to inaccessibility, inspected once
34	238	890	310	entrance *c* 7 cm wide x 13 cm high, *c* 65 cm deep	157	95	22° 31.1' S 31° 04.3' E	chicks already fledged on inspection
38	254	987	170	entrance *c* 13 cm wide x 19 cm high, depth *c* 50 cm	261	17.5	22° 29.4' S 31° 03.7' E	remove 2 dead chicks, entrance damaged in past

RESULTS

Greyheaded Parrots have been recorded breeding in cavities in a number of different tree species and historical records of nest sites are summarised in Table 1. The nest recorded in Chobe was possibly the first breeding record of this species in Botswana (R. Randall pers. comm.) and in 1999 a nest was found in the Save Valley Conservancy (nest site: 20° 39' 06" S, 31° 59' 13" E), south-east Zimbabwe. The nest was a natural cavity in a Baobab *Adansonia digitata* at a height of approximately 7.5 m and entrance diameter *c* 20 cm (Table 2).

At Tshikuyu a cavity that was used in past years was visited by a pair of Greyheaded Parrots in early-April 2000 (see Table 2 for nest details - nest 9). The nest was observed for 590 minutes on 11 April (Fig. 3). This nest was taken over by bees in early-May 2000. The cavity was deep and it was unknown whether breeding had begun. Other active nests recorded in the study are summarised in Table 2.

Nest site requirements

Dimensions of all nests recorded in the study area were in natural cavities in baobabs and are summarised in Table 3. At Makuya thirty-four nest sites were identified and five (14.7 %) were active (Table 3). DBH of nest trees was large and ranged from 140 - 318 cm (Table 2). Mean DBH of baobabs measured on transects were significantly smaller than mean DBH of nest trees (Mann-Whitney U-test, $U = 656.0, p < 0.05$) and mean DBH of baobabs nearest nest trees (Mann-Whitney U-test, $U = 800.0, p > 0.05$). However, there was no significant difference between the mean DBH of nest trees and mean DBH of baobab nearest nest tree (Mann-Whitney U-test, $U = 462.0, p > 0.05$) (Table 3).

Table 3. Characteristics of active and historically recorded nest sites at Makuya study site.

Characteristic	Dimension	N
Nest tree mean DBH (cm ± s.e.)	242.0 ± 12.1	34
Hole height (cm ± s.e.)	872.3 ± 31.9	34
Nearest baobab (m ± s.e.)	70.2 ± 20.4	33
Nearest baobab mean DBH (m ± s.e.)	220.3 ± 16.4	33

The compass direction in which nest entrances faced were categorized as facing in either one of four quadrants (NE = 1-90°, SE = 91-180°, SW = 181-270°, NW = 271-360°). There was a significant difference in aspect of nest entrances ($\chi^2 = 10.02$, df = 3, $p < 0.05$) with the majority of nest entrances facing north-west (32.4 %) (Fig. 2).

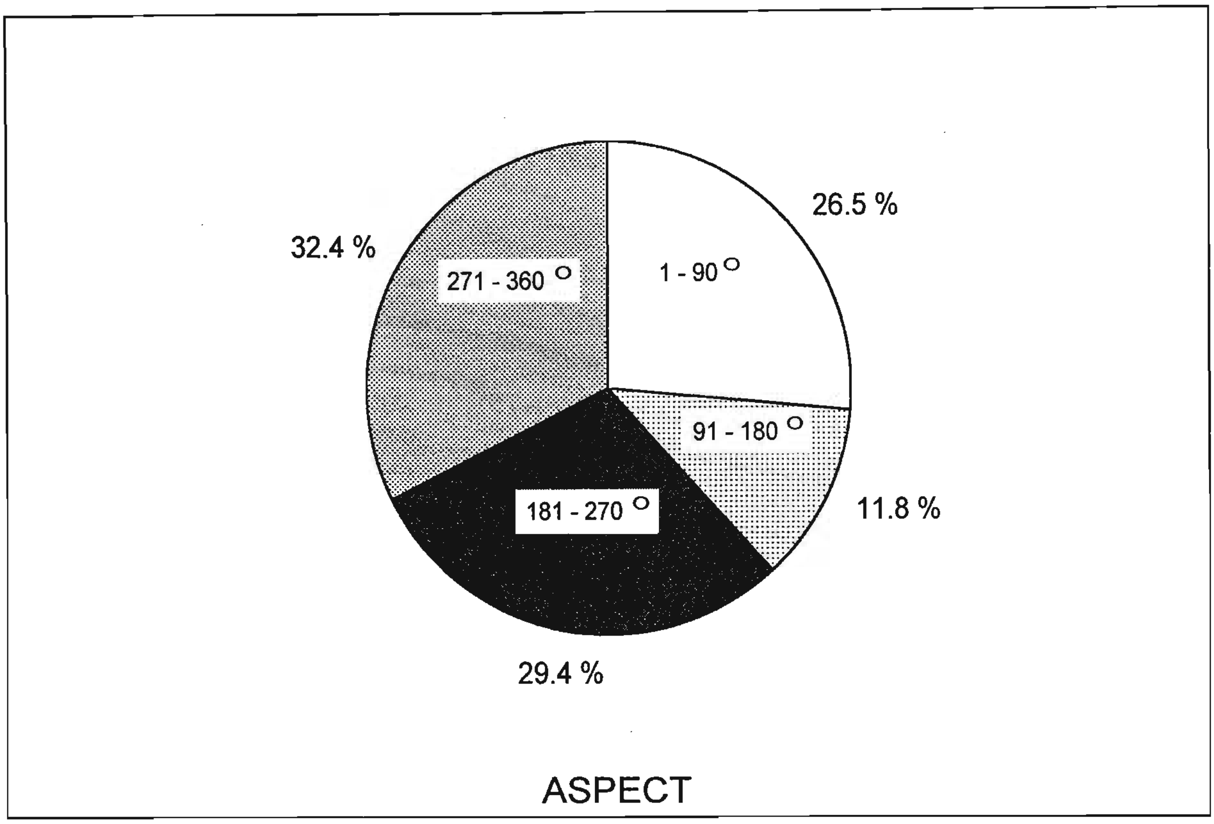

Figure 2. Nest cavity orientation.

Nest site availability

No baobabs were located at Levubu, except three specimens, planted in gardens (all DBH < 100 cm). At Makuya density of baobabs near the Luvhuvhu river was greater than the Makuya plateau (area out of Luvhuvhu river valley) and Tshikuyu (Table 4). Baobabs on the Luvhuvhu river were also significantly larger than baobabs on the Makuya plateau (Mann-Whitney U-test, $U = 225.5$, $p < 0.05$) while mean DBH of baobabs recorded at Tshikuyu and Makuya plateau were similar (Mann-Whitney U-test, $U = 86.0$, $p > 0.05$).

Table 4. Baobab *Adansonia digitata* density and mean DBH, and Baobabs with potential nest cavities at Makuya study site.

Site	Baobab density (tree. ha^{-1})	Trees with potential cavities (%)	Area sampled (ha)	Mean DBH (cm ± s.e.)	N
Luvhuvhu river	2.36	64.7	14.4	203.3 ± 15.9	34
Makuya plateau	0.50	37.5	52.0	119.5 ± 15.4	26
Tshikuyu	0.29	19.2	27.7	163.5 ± 44.5	8
Total	0.72	44.1	94.1	166.5 ± 12.0	68

In addition to the higher density of baobabs near the Luvhuvhu river, a greater proportion of trees near the Luvhuvhu river appeared to have cavities (Table 4). However, not all of these cavities were inspected to see if they were suitable for Greyheaded Parrots.

Breeding

Greyheaded Parrots were never observed copulating although allo- and mutual preening was observed between pairs.

Nest attentiveness and behaviour

The nest discovered in Zimbabwe was observed for 2 764 min (46.07 hrs) over 7 days (7 July - 15 July). Attentiveness at the nest site is summarized in Figure 3. At the Zimbabwe nest an equal amount of time was spent by the male and female at the nest (Fig. 3). Juveniles were heard soliciting from the nest-hole when the adults were present and age was estimated at 50 - 70 days. When the pair returned to the nest, on most occasions (13 of 14 observations), the female entered the nest cavity first. On 31 July a pair was seen at a water hole near the nest site, and on 5 August (16:50), 6 August (17:30), 8 August (17:00), 11 August (16:30) and 12 August (17:00) five birds, presumably the adult pair and three fledglings, were seen at the same water-hole. With and incubation period of 24 - 28 days and nestling period of 55 - 85 days (Low 1982, 1995), egg laying was therefore estimated at mid- to late May. The nest site area was visited on 21 September 1999 and no birds were seen in the immediate vicinity. From the discovery of this nest the breeding months of the Greyheaded Parrot in the south-east of its range were determined. Observations and field work occurred the following season in north-east South Africa.

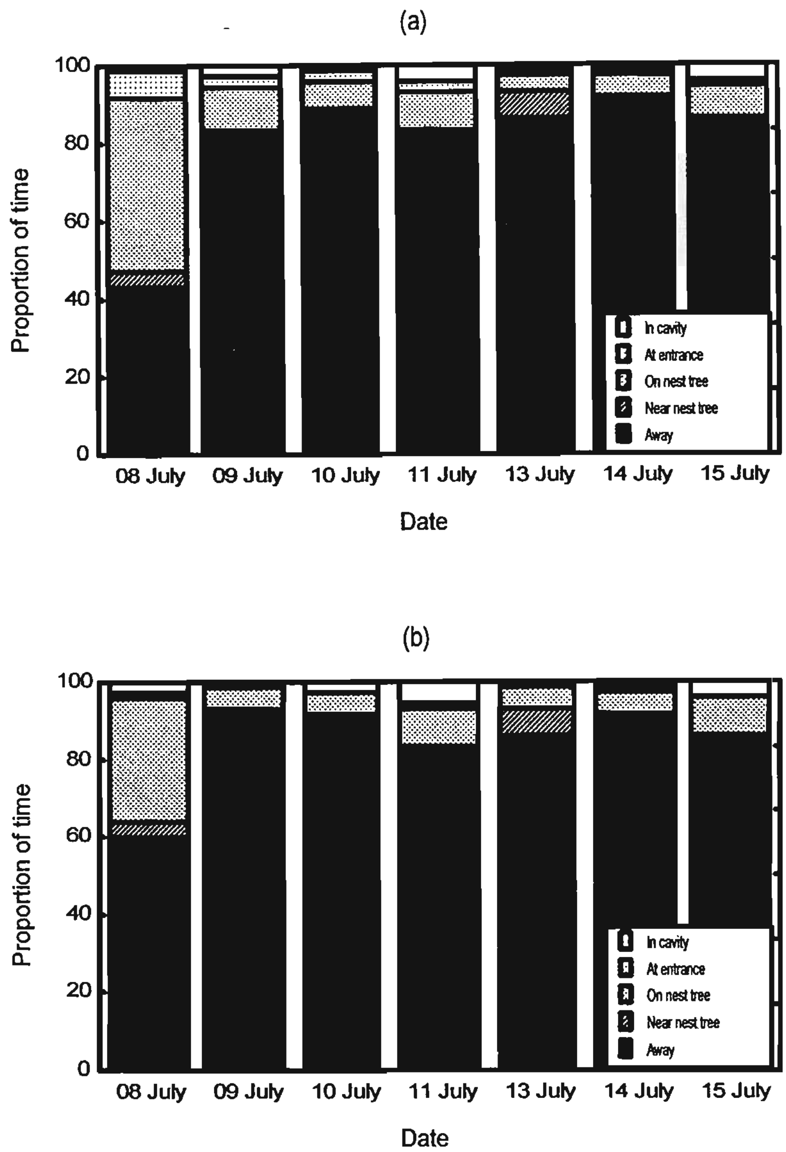

Figure 3. Time proportions of a) male and, b) female during one week at a Greyheaded Parrot nest in Zimbabwe.

A nest located in Makuya Park was observed from 6 June to 30 July for 4 162 minutes (69.37 hrs) over 9 days. The female was seen at the nest for longer periods than the male during early stages of chick development (Fig. 4). The male was absent for long periods from the nest but returned to feed the female and chicks (Figure 4). As the juveniles grew and were inferred to thermoregulate on their own, the pair were absent from the nest for longer time periods. Whenever the pair returned to the nest site together, in most cases the female entered the nest cavity first (15 of 20 observations). General activity then involved an absence of the pair in the early morning. Arrival of the pair from the west was announced by clear long distance contact calls (LDCC), made continuously in flight. This initiated soliciting calls in the nestlings (Chapt. 6). The pair perched on the nest tree or nearby and calling was reduced to short-distance contacts calls (SDCC), with periodic LDCC. Duetting, social interaction (allo- and mutual-preening) and feeding of the nestlings occurred (Chapt. 6). The pair then left, returning again in the late afternoon. During the absence of the adults, nestlings were inactive and remained quiet in the nest.

An increased absence of the male and female away from the nest for the first three days of observation is accounted for by the presence of observers as a threat to the breeding pair. Although observations occurred from behind thick vegetation, at a distance of *c* 15 m, behaviour of the pair seemed to indicate their awareness of observers. The following is a summary of observations of adult behaviour at nest 24 (nestling age estimated in parentheses) (see Fig. 4 for summary of times spent in, near and away from nest of male and female):

6 June (15/16 days): Nest discovered. Pair active in vicinity of nest in mid-morning. Female takes flight from nest hole when observers walk beneath nest-hole (12:37). Observations continue from cover nearby. Pair return (14:32) and perch nearby. Male observed regurgitating food to female in baobab near nest tree. Pair enter nest-hole. Juveniles heard soliciting from hole when adults present. Behaviour of adults interrupted by presence of observer during afternoon.

8 June (17/18 days): Pair present in vicinity of nest on arrival. Pair observed feeding on *Terminalia prunioides* fruit kernels on ridge *c* 100 m from nest (07:19). Male drinks from shallow cavity on nest tree (07:31). "Process" chicks (09:00 - 10:00). Parents agitated for rest of observation period, but calm down later in day. Female in nest and male calling nearby at end of observation period at 17:05. Female possibly in hole overnight

10 June (19/20 days): Pair return (07:18) after morning absence and duet call on tree. Female enters nest hole on arrival and possibly feeds juveniles. Juveniles soliciting. Male remains on nest tree and drinks from shallow cavity on nest tree (07:23 & 07:59). Male enters hole, and possibly feeds juveniles. Pair active around nest tree for early morning. Male away from nest tree for periods of up to 235 min. Female in hole for most of day, only peeping out every so often. Female

still in hole at end of observation period in late afternoon (16:48). Possibly spends night in hole.

23 June (32/33 days): Pair return to nest (07:12) after morning absence. Active around nest. Possibly aware of observer presence. Male and female spend equal time periods away from nest. Pair fly off in late afternoon (16:42). Possibly absent from nest-hole over night.

06 July (45/46 days): Pair arrive from west (07:52) after morning absence. Juveniles soliciting in nest hole. Food on bill of female from feeding. Female to nest hole first, followed by male, possibly to feed juveniles. Moult observed in flight feathers of male bird while displaying (Chapt. 6). Pair absent from nest during mid-day hours for 237 min. Return at 14:15, male to nest-hole first, followed by female. Pair active around nest tree, displaying and calling. Fly off 15:50, for 58 min, and on return female enters nest-hole first. Pair fly off (17:01), and both probably absent from nest-hole overnight.

19 July (58/59 days): Observe afternoon only. Juveniles soliciting when adults present. Pair fly north-west in late afternoon (16:57) and both probably absent from nest-hole overnight.

29 July (68/69 days): Adult pair return to nest (08:04), giving LDCC in flight, and perch in nest tree. (Observer hears adults approaching before chicks begin responding). Juveniles peeping out hole and calling. Adults fly west, followed by chick 1 (08:09). Disappear in distance to west, with juvenile flying strongly. Parents absent from nest for remainder of day. Chick 2 peeps out nest-hole once, calls, then returns down hole (14:33). Adults and juvenile absent for rest of day.

30 July (69 days): Chick 2 peeping out nest-hole and calling. Parents arrive from west and settle in nest tree (07:30). Chick 1 absent. Pair fly west, with chick 2 following (07:31).

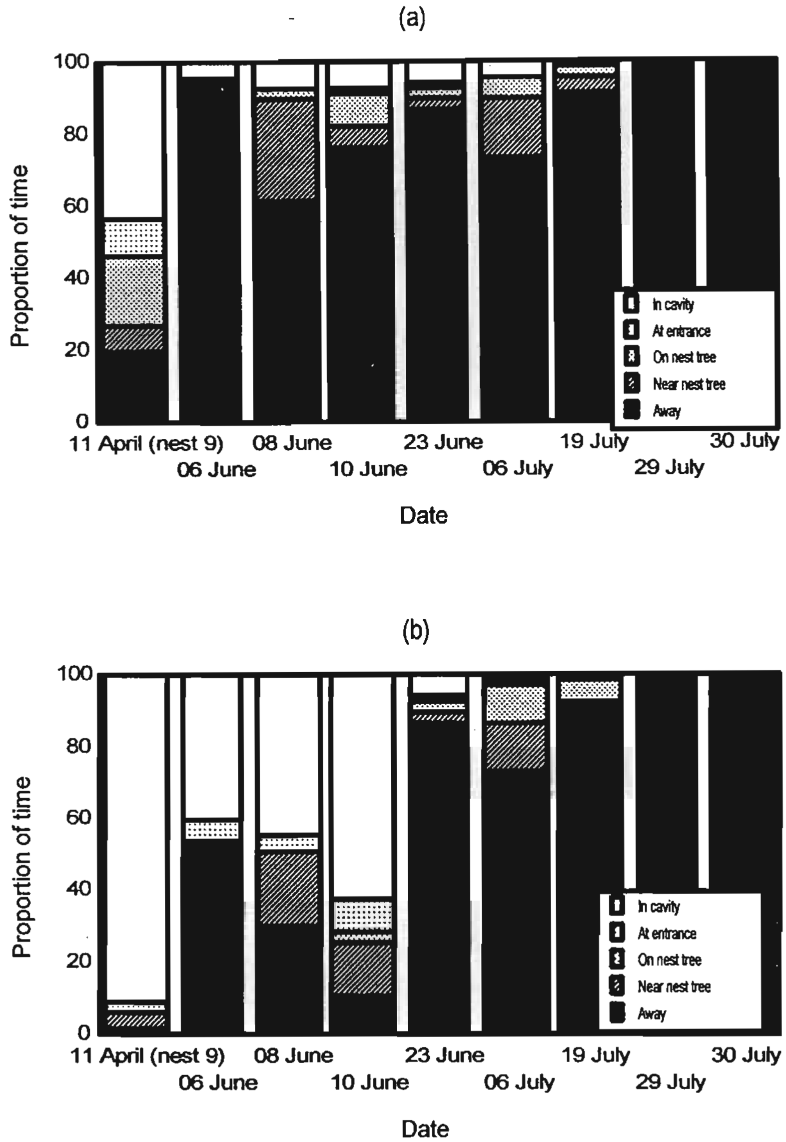

Figure 4. Time proportions of: a) male and, b) female Greyheaded Parrots in cavity, at cavity entrance, on nest tree, near nest tree (< 200 m) and away from nest tree. Observations on 11 April are at nest 9, and rest at nest 24.

Development of nestlings

Growth rates of wild chicks from nest 24, and weights of chicks from two other nests (nests 33 and 38) are summarised in Figure 5. Nest inspections were conducted after the morning visit and feeding session by the adults. Growth and development of nest 24 chicks is recorded as follows:

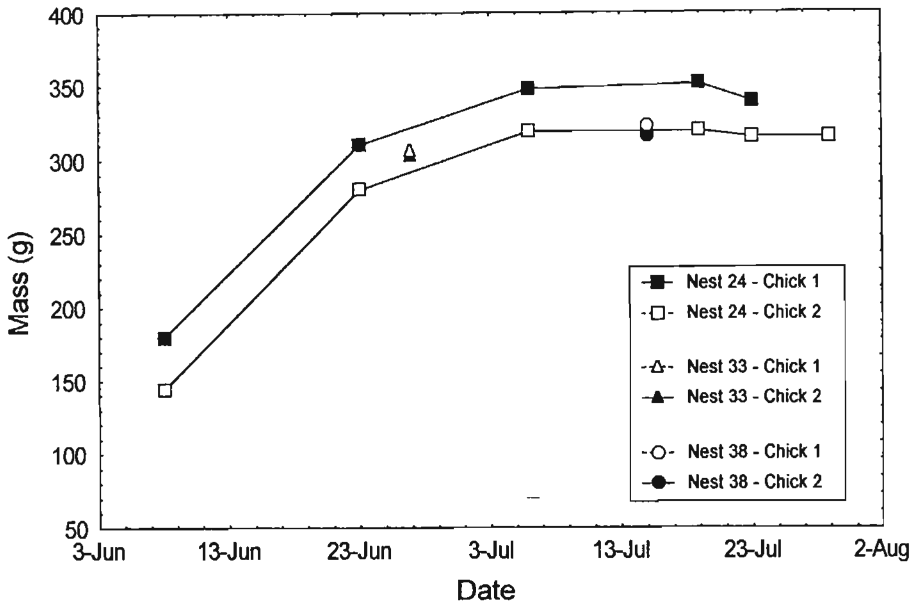

Figure 5. Growth rate of two chicks from nest 24 and weights of four chicks at two other nests (nests 33 & 38).

06 June: Nest discovered.

08 June: Crops engorged, contents of pulpy consistency. Eyes slightly open and bodies covered in clear white down. Chick 1: mass = 180 g, tarsus = 27.0 mm; Chick 2: mass = 144 g, tarsus = 24.9 mm. Chicks estimated at 15-16 days old with eggs hatching 1 - 2 days apart (W. Horsfield pers. comm.). This places egg hatching on approximately 20 - 21 May. Incubation is approximately 28 - 32 days (Isert & Isert1980; Low 1995) thereby placing egg laying at 22 - 23 April.

23 June: Crops partly full, contents of coarse consistency. Wing and tail feathers appearing through as long pins, with body covered in white down. Orange prominent on frons. Aggressive growl call given. Chicks placid in hand. Chick 1: mass = 310 g, tarsus = 28.3 mm; Chick 2: mass = 280 g, tarsus = 29.4 mm.

06 July: Primary feathers appearing through shafts. Down still present on back and beneath wings. Tail feathers 5 - 10 mm. Orange frons prominent (length = 30 mm). Noisy, giving alarm *zeeking* call, chick 2 most aggressive. Chick 1: mass = 348 g, tarsus = 30.0 mm; Chick 2: mass = 319 g, tarsus = 29.8 mm.

19 July: Almost fully fledged, but wing feathers still not full length. Chick 2 most aggressive. Chicks aggressive in nest, lunge when hand placed at entrance. Chick 1: mass = 351 g, tarsus = 30.1 mm; Chick 2: mass = 319 g, tarsus = 29.8 mm.

23 July: Chick 1: mass = 339 g; Chick 2: mass = 315 g.

29 July: Chick 1 leaves nest. Chick 2: mass = 315 g.

30 July: Chick 2 leaves nest.

The first observation of juveniles soliciting from adult birds was observed on 13 July 2000 on the Luvhuvhu river, in Makuya Park.

Sex ratios and recruitment

Six chicks tested were all males. The ratios of males to females in the wild was approximately one female to two males (Table 5). Results of different sampling methods at both study sites are given in Table 5. Random sampling to determine sex ratios was not conducted at Makuya as females were incubating and any sampling would naturally be biased towards males. An overall ratio of 1 juvenile: 9 adult birds indicates a recruitment ratio of approximately one juvenile successfully fledged per 4 - 5 adult pairs. Insufficient nests were located to determine fledging success.

Table 5. Sex ratios (male:female) at Levubu and Makuya based on different sampling methods, and breeding success as indicated by ratio of juveniles: adult Greyheaded Parrots at Levubu (sample size in parentheses).

	Levubu	Makuya	Total	Juv: adult ratio
Feeding	65: 35	67: 33	66: 34	6: 94
	(325)	(189)	(514)	(344)
Drinking	58: 42	71: 29	65: 35	21: 79
	(24)	(24)	(48)	(34)
Random sexing	60: 40	-	60: 40	11: 89
	(236)		(236)	(265)
Total	63: 37	68: 32	64: 36	9: 91
	(585)	(213)	(798)	(643)

Nutritional requirements

The number of food species fed on at any one time by the Greyheaded Parrot was low (Chapt. 5). Marula *Sclerocarya birrea* fruit from January to March and possibly form an important component of the pre-breeding diet of Greyheaded Parrots (Chapt. 5). During the breeding season the kernel of the fruit of Velvet Corkwood *Commiphora mollis*, Kudu Berry *Pseudostachnostylis* *maprouneifolia*, Jackal Berry *Diospyros mespilliformis* and Nyala Berry *Xanthocercis zambesiaca* were eaten (Chapt. 5). Greyheaded Parrots were also observed feeding on bark (Chapt. 5).

The crop contents of two dead chicks were removed and are summarised in Table 6. Insect parts (Scarabaoidae) were identified in the crop of one chick, and the seeds of *P. maprouneifolia* in both chick's crops (Table 6).

Table 6. Details of dead chicks removed from nest 38.

Dimension	**Chick 1 (TM 78 117)**	**Chick 2 (TM 78 116)**
Sex	Male	Male
Mass (g)	322	316
Wing (mm)	197	159
Tail (mm)	81	64
Tarsus (mm)	21	21
Crop contents wet mass (g)	2	2.6
Crop contents dry mass (g)	0.86 (43.0 %)	0.74 (28.5 %)
Crop contents		
- Bark pieces	1 - 2 mm: 55 2 - 3 mm: 21 > 3 mm: 5	1 - 2 mm: 108 2 - 3 mm: 20 > 3 mm: 15
- Seed kernels (possibly *P. maprouneifolia*)	whole: 2 half: 2	whole: 9 half: 4
- Insect parts (Scarabaoidae)	31 pieces (largest: leg *c* 5.1 mm)	0
- Seed shell pieces	28 (largest 4.0 mm x 2.7 mm)	1 (1 mm x 1 mm)

Competitors and predators

Cavity nesting birds species communities differed between Levubu and Makuya. A greater number of large cavity nesting species and potential avian nest competitors were recorded at Makuya (13 species) than at Levubu (3 species) (Table 7). Southern Yellowbilled Hornbill *Tockus leucomelas*, Redbilled Hornbill *Tockus erythrorhynchus* and Grey Hornbill *Tockus nasatus* were most abundant at Makuya and were possibly the greatest competitors for nest sites. Evidence of hornbill use of cavities was made at a number of cavities where Greyheaded Parrots were known to have bred. Of 18 cavities inspected 6 (33 %) showed previous use by a hornbill species (evidence of plughole or feathers in cavity).

Greyheaded Parrots were not observed breeding at Levubu and occurred there during the non-breeding season in flocks (Chapt. 3 & 4). No baobabs were recorded at the Levubu site. Cavity nesting species were observed investigating active nest sites (Table 8).

Table 7. Relative abundance of large cavity nesting species and potential nest site competitors of Greyheaded Parrots as represented by number of transects each species was recorded in (* indicates most important potential nest site competitors, assumption based on size of species being similar to Greyheaded Parrot; species recorded out of transect times each month are indicated by zero).

Species		H'shoe			Tshikuyu			Prinsloo's			Joubert's		
		M	J	J	M	J	J	O	N	D	O	N	D
Dickinson's Kestrel *	*Falco dickinsoni*	0											
Greyheaded Parrot	*Poicephalus fuscicollis*	7	4	4	3	2	2	1	2		9	5	
Brownheaded Parrot	*P. cryptoxanthus*					1							
Meyer's Parrot	*P. meyeri*	0	1										
African Scops Owl	*Otus senegalensis*		0	0			0						
Pearlspotted Owl	*Glaucidium perlatum*		0	0		1	0						
Narina Trogon	*Apaloderma narina*							0					0
Lilacbreasted Roller	*Coracias caudata*	8	3	2	2	1	0						
Purple Roller *	*C. naevia*	3	6	2									
Trumpeter Hornbill *	*Bycanistes bucinator*				2	4	4						
Grey Hornbill *	*Tockus nasutus*	8	9	4	6	13	8						
Redbilled Hornbill *	*T. erythrorhynchus*	6	3	5	11	7	8						
Southern Yellowbilled Hornbill *	*T. leucomelas*	13	11	10	8	7	11	1					
Crowned Hornbill *	*T. alboterminatus*	1											
Number of species	**14**		**11**			**9**			**3**			**2**	

Table 8. Cavity nesting bird species observed inspecting active Greyheaded Parrot nests.

Nest	Species		Activity	Date	Time	Comment
Zimbabwe	Southern Black Tit	*Parus niger*	perches and inspects entrance	10 July 1999	08:14	pair away from tree
"	Bearded Woodpecker	*Thripias namaquus*	flies near entrance	"	09:17	male on tree, flies to entrance after woodpecker
"	African Hoepoe	*Upupa epops*	hovers at nest cavity entrance	14 July 1999	08:25	adult pair away from nest
Nest 9	Lesser Honeyguide	*Indicator minor*	perches and inspects entrance	11 April 2000	12:40	pair in nest cavity
Nest 24	Lesser Honeyguide	"	perches and inspects entrance (twice)	10 June 2000	07:33	female in trees nearby, male absent
"	Yellowthroated Sparrow	*Petronia superciliaris*	into hole while chicks in hole	10 June 2000	08:06	in hole for *c* 5 secs
"	Lesser Honeyguide	*Indicator minor*	perches at entrance and inspects hole	10 June 2000	08:42	female in nest-hole, male absent

At each site at Makuya, 10 and 12 diurnal raptor species were recorded, and at Levubu, 10 and five raptor species were recorded. Overall, 23 raptor species were recorded at both sites. Raptor species recorded during transects is summarised in Table 9.

Table 9. Relative abundance of diurnal raptors species at two localities at Levubu (Prinsloo's & Joubert's) covering months of the non-breeding season of the Greyheaded Parrot, and two localities at Makuya (Horseshoe & Tshikuyu) covering months of the breeding season of the Greyheaded Parrot. Relative abundance figure represents the number of transects each bird species was recorded. (Sixteen transects walked per month; Zero represents species recorded out of transect times for each month). Taxonomy follows Maclean (1994).

Species		H'shoe			T'kuyu			P'loo's			J'bert's		
		M	J	J	M	J	J	O	N	D	O	N	D
Whitebacked Vulture	*Gyps africanus*		1			1			1				
Lappetfaced Vulture	*Torgos tracheliotus*		0										
Yellowbilled Kite	*Milvus parasitus*							1	0	1		1	
Blackshouldered Kite	*Elanus caeruleus*							1	1				
Cuckoo Hawk	*Aviceda cuculoides*							1	0				
Black Eagle	*Aquila verreauxii*	1				0							
Wahlberg's Eagle	*Aquila wahlbergi*									1			
African Hawk Eagle	*Hieraaetus spilogaster*		1				1						
Martial Eagle	*Polemaetus bellicosus*	0		3									
Crowned Eagle	*Stephanoaetus coronatus*										0	0	1
Blackbreasted Snake Eagle	*Circaetus pectoralis*				1			2		2			
Bateleur	*Terathopius ecaudatus*	3	3	2	1								
African Fish Eagle	*Haliaeetus vocifer*	1							0				
Steppe Buzzard	*Buteo buteo*								1			1	
Jackal Buzzard	*Buteo rufofuscus*												1
Lizard Buzzard	*Kaupifalco monogrammicus*					1		0	0	0			
Little Sparrowhawk	*Accipiter minullus*						1						
Little Banded Goshawk	*Accipiter badius*					1							
African Goshawk	*Accipiter tachiro*		0	0		0			2		0	2	1
Gabar Goshawk	*Micronisus gabar*				1								
Dark Chanting Goshawk	*Melierax metabates*					1							
Gymnogene	*Polyboroides typus*	1			0								
Dickinson's Kestrel	*Falco dickinsoni*	0											
Number of species	**23**	**10**			**12**			**10**			**5**		

Parasites

No external wounds were visible on dead chicks removed from nest 38. Tests for APV, CP and PBFDV were negative for all chicks tested. The louse collected was of the Menoponidae family but could not be identified to species level because only a female specimen was recovered (E. Green pers. comm).

Nestling removal

Evidence of nestling removal and illegal parrot trade was gained from formal and informal interviews with residents at both study sites. White residents in Levubu all agreed that numbers of parrots over the last 20 years had decreased. Many could not explain a reason while some blamed Blacks for catching and eating birds. White residents in Makuya attributed declines to similar reasons. However, some residents in Makuya knew of people involved in dealing in parrots, and removing chicks from nests. At Tshikuyu, 46 Vendas (74.2 % of those interviewed) knew parrots and 20 (32.3 %) knew the Greyheaded Parrot in particular. Twenty-four (38.7 %) knew someone who had caught a parrot before, and of these 13 (54.2 %) sold it, 7 (29.2%) ate it and 4 (16.7 %) didn't know the outcome. Nine (14.5 %) had caught a parrot once before, and 11 (17.7) had eaten a parrot previously.

Table 10. Interpretation of nestling removal and nest damage at the Makuya study site.

Criterion	Total nests
Active nests (2000 breeding season)	5 (14.7%)
Nest cavity &/or entrance damaged	18 (52.9 %)
Pegs in tree leading to cavity	23 (67.7 %)
Past use confirmed	17 (50.0 %)
Removal of chicks in past confirmed	9 (26.5 %)

Evidence at located nests suggested that past removal of nestlings in the area was high. Such activities may have a detrimental effect on the breeding of Greyheaded Parrots in the region. A summary of nestling removal and effects on nests is presented in Table 10.

Moult

Observations of moult indicate that active moult occurred during the breeding season. Estimated moult scores are summarised in Table 11. Remiges collected beneath trees at a regular feeding site in Levubu during the non-breeding season also indicated their active moult. Moult of the male observed breeding at a nest (nest 24) was extrapolated to estimate the primary moult of males to be *c* 70 days (Table 11).

Table 11. Records of active moult in the Greyheaded Parrot (* indicates same individual; moult scores: 0 = old, 1 = pin, 2 = < 25 %, 3 = 26 - 50 %, 4 = 51 - 75 %, 5 = > 76 %, new)

Date	Sex	Secondary moult score	Primary moult score	Locality
17 May 2000	?M	000 000 015 5	-	Horseshoe
10 June 2000	M *	-	555 555 100 0	Nest 24
13 June 2000	M	-	555 555 100 0	Horseshoe
"	F	-	555 555 400 0	Horseshoe
"	M	-	555 555 500 0	Horseshoe
6 July 2000	M *	-	555 555 551 0	Nest 24

DISCUSSION

Greyheaded Parrots are monogamous and pairs nest in natural tree cavities at 6 - 12 m above the ground (Rowan 1983; Fry *et al.* 1988; Wirminghaus 1997). Two to four eggs are laid and incubation is by the female for a period of 24 - 28 days (Low 1982, 1995; Table 1). Ovate eggs are white and dimensions of two clutches are as follows 36.8 x 29.7, 34.1 x 30.2 and 35.4 x 29.9 mm (Vincent 1946), and 32 x 26, 33 x 26 and 34 x 27 mm (Carlisle 1923). Fledging period ranges from 55 - 85 days and the young are fed by regurgitation by the male and female (Rowan 1983; Low 1982, 1995). In this study fledging period was estimated at 71 days. Breeding in the Greyheaded Parrot has been recorded in other months of the year throughout its range.

In Zambia egg laying has been recorded in April (Benson 1963) and on 8 September two fully feathered young were taken from their nest hole (Benson & Irwin 1967). On 30 August two young removed from a nest *c* 100 km east of Lusaka were fully feathered, one retaining some down, and unable to fly (G. Lyon in Benson & Irwin 1967). Near Kalabo, on 24 July, two young removed from a nest were completely covered in down (R. Hart in Benson & Irwin 1967). This indicates egg laying occurring from April to June in Zambia. In late-April/early-May 1999, between Chisamba and Lusaka, Greyheaded Parrots were offered for sale on the side of the main road (M. Bingham pers. comm.).These were presumed chicks but in light of the data presented may have been adults.

In Zimbabwe the breeding range of the Greyheaded Parrot is possibly concentrated in the lowveld in the Middle Zambezi Valley (Kazangula - Luangwa), in the Save Valley and south-east lowveld, in the Limpopo river Valley and the heavily wooded country of north-west Matabeleland (M.P.S. Irwin pers. comm.). When not breeding birds may move onto the central plateau in search of fruiting trees (M.P.S. Irwin pers. comm.). In Zimbabwe eggs have been recorded in March (A. W. Wragg in Benson & Irwin 1967), May (Vincent 1946), July (Child in Benson & Irwin 1967), and November (Carlisle 1923) and three young in June (A. W. Wragg in Benson & Irwin 1967). An additional three breeding records were in May, October and November (Smithers *et al.* 1957). These records suggest egg-laying from March to July, similar to Zambia. Nestlings and juveniles offered for sale on the roadside near Birchenough Bridge (32° E, 20° S) from May to August support these data (various pers. comm.). Additional data included that of Clancey (1996) who notes breeding as occurring from May onwards, while Priest (1934) places egg laying in April and May, when holes in baobabs are used.

Four breeding records in Tanzania are for April (2), June (1) and July (1) (N. Baker pers. comm.), and in southern Malawi breeding is noted as occurring in January (Wilkes 1928). In the Gambia the Brown-necked Parrot *Poicephalus fuscicollis fuscicollis* starts breeding in March or April, where it nests in the holes of mangroves *Rhizophora* spp. (Gore 1981).

Greyheaded Parrots inhabit a variety of habitats and breeding may occur at different times of the year. The breeding account in south-eastern Zimbabwe in 1999 and the records in north-eastern South Africa suggest that breeding in the southern limit of the range of the Greyheaded Parrot occurs during dry months. Egg-laying occurs in the latter half of May, with chicks fledging in late-July or early-August. For three *Poicephalus* species, 26 % and 20 % of 31 egg laying records were for April and May respectively with food considered the controlling factor (Benson 1963). An interview with a trapper who said he always removed chicks on approximately 21 June indicates that breeding in this area is regular and synchronous each year. Also, these data, and seasonal occurrence of flocks in certain parts of their range at particular times of the year (Chapt. 3), suggest that egg laying occurs in autumn (April - May).

Nest site requirements

Greyheaded Parrots are specific in nest site selection, requiring natural cavities in large baobabs. Active nests were in larger than normal baobabs, and cavities fulfilling nest site requirements are only found in large trees. Similarly, in Indonesian parrots and hornbill on Sumba, nest trees were larger than surrounding trees (Marsden & Jones 1997). Also, nest selection for trees of the family Datiscaceae was highly significant (Marsden & Jones 1997). In Australia, larger parrots selected larger trees with cavities (Mawson & Long 1994). In the Greyheaded Parrot, vertical cavity depth may not be an important criterion since nest 24 was relatively shallow, slanting downwards at a slight angle into the nest tree. However, cavity volume is likely critical where 2 - 4 nearly fledged chicks of 300 - 350 g require enough room in a cavity for growth.

All nest sites recorded in this study were in natural cavities. In Australia, cavities used by parrots were naturally formed (Mawson & Long 1994). At the site where larger baobabs were recorded (Luvhuvhu river; Table 5) a greater proportion of trees had nest cavities. This emphasizes the importance of large baobabs in the breeding biology of the Greyheaded Parrot. Similarly, in Indonesian parrots and hornbill, 85 % of nests were at the site of scars from dropped branches with half the nests situated on the trunk and half on the sides of branches (Marsden & Jones 1997).

All Greyheaded Parrot nests were on the main tree trunk at 0° to the vertical or on the underside of branches. Such orientation may reduce or prevent precipitation run-off into the nest cavity and resultant nest failure. However, in Indonesian parrots and hornbill, the direction to which nest holes faced did not differ from random and the most upwardly facing nest was one at 15° to the vertical with most (87 %) overhanging or < 5° from the vertical (Marsden & Jones 1997). Rainfall in the region is mostly from low pressure weather systems moving in a north-westerly direction from the Mozambique channel in the south-east. Nests on the leeward sides of trees are protected from approaching winds and rain, and less susceptible to flooding. Nest side selection in the Greyheaded Parrot showed a preference for leeward side nests (north-west facing).

No nesting material is brought to the nest but in captivity preparation of the cavity possibly occurs for 1 - 2 months prior to breeding (W. Horsfield pers. comm.). In the Jihu, Mozambique (20° 28' S, 32° 46' E), *c* 20 km south-east of Mount Selinda, Zimbabwe, it is believed that Greyheaded Parrots bite off ripe heads of *Sorghum* and return them to hollow trees where they are stored for when there are no crops (Priest 1934). A similar belief is held by the Shona, of south-east Zimbabwe, where seeds (*Sorghum* and millet) stored in nests by Greyheaded Parrots and Meyer's Parrots and collected by an *nyanga* (healer, medicine man, witch-doctor) to be used as evil medicine.

During interviews, one interviewee noted that he had once caught a Greyheaded Parrot leaving a hole in an exposed bank. A similar independent record was recorded from a trapper in KwaZulu-Natal Province who knew of a nest in a steep, exposed bank (pers. obs.). This has not been recorded before and requires further investigation. In Sumba, parrot nests were recorded in earthy epiphytes, a behaviour previously unrecorded (Marsden & Jones 1997). Some species of parrots such as Hooded Parrots *Psephotus dissimilis* and Green-rumped Parrotlets *Forpus passerinus* breed in termitaria (Waltman & Beissinger 1992; Reed & Tidemann 1994) so such behaviour, in a species where nest sites are possibly limited in tree cavities, should not be ruled out. The Puerto Rican Parrot *Amazona maugei* is also known to breed in holes in the ground (Snyder, Wiley & Kepler 1987).

Nest site availability

Numerous studies of cavity nesting bird species have shown nest sites to be limiting factors in breeding birds (see Newton 1994 for review). The greater number of cavity nesters and potential competitors at Makuya suggests that cavities were more available there. The breeding range of Greyheaded Parrots in the southern limit of their range is possibly limited by nest site availability. Greyheaded Parrots are recorded seasonally through various parts of their range suggesting that nest sites may be limiting in these areas too (Chapt. 3). In Indonesian parrots and a hornbill, up to five nests occurred in one tree with nest sites restricted to large tree species (Marsden & Jones 1997). In south-west Australia nest choice by parrots was nearly always in the dominant tree species (Saunders 1979; Saunders, Smith & Rowley 1982).

At Makuya the Baobab is widespread, with a patchy distribution. It is not threatened by removal as a source of firewood outside protected areas, but recruitment may be affected by clearing of lands and cattle trampling. The long lived Baobab is therefore the most important nesting tree for the Greyheaded Parrot in this part of its range. Similarly, in south-western Australia parrot and cockatoo species select specific tree species that are long lived (Mawson & Long 1994).

Breeding

Breeding is recorded in captivity at > 3 yrs (W. Horsfield pers. comm.) and is likely at a greater age in the wild. Few juveniles in the total wild population suggests that only a small proportion of the entire population actively breed. Co-operative breeding has been suggested to occur in the Cape Parrot (Armstrong & Juritz 1996) yet has not been recorded. Evidence of co-operative was not recorded in this study despite predictions based on life history traits and breeding requirements

(Armstrong & Juritz 1996).

Copulatory behaviour while sitting on eggs has been observed in the Bahama Parrot *Amazona leucocephala bahamensis* yet was not recorded in this study (Gnam 1991). Further observation are needed to investigate the courtship and copulating behaviour of the Greyheaded Parrot.

Nest attentiveness and behaviour

During early incubation and early fledging, the female Greyheaded Parrot spends most of her time in the nest. During this period she is provisioned by the male, who spends much of his time away from the nest. As the chicks develop and grow, and are able to thermoregulate more on their own so the female is able to spend greater periods of time away from the nest gathering food for the nestlings. Absence by the pair from the nest overnight is likely to occur when the nestling are approximately 30 days old. Chicks are then fed by both parents with the male no longer provisioning the female. This behaviour is similar to other parrots such as the Bahama Parrot, the Puerto Rican Parrot *Amazona maugei*, the White-tailed Black Cockatoo *Calyptorhynchus funereus* and the Green-rumped Parrotlet (Saunders 1982; Snyder *et al.* 1987; Waltman & Beissinger 1992; Gnam 1991).

Development of nestlings

Eggs in captivity are each laid 1 - 2 days apart (Low 1995; W. Horsfield pers. comm.). In the wild, with little difference in clutch size, competition between individual chicks is reduced. Adult Greyheaded Parrots are able to sufficiently provision all young and only as many young as can be raised are laid. Chicks weighed suggest that laying synchrony occurs. Hatching asynchrony occurs in many bird species and has been shown to occur in some parrot species (Snyder *et al.* 1987; Beissinger & Waltman 1991; Waltman & Beissinger 1992; Gnam 1991). This does possibly not occur to any significant degree yet a greater number of nests needs to be monitored to confirm this.

Fledging occurred in the morning with little coaxing from the adults. Fledging was actively vocal with the newly fledged flying strongly from the first flight. This is different to the Bahama Parrot where fledging occurred silently, mostly in the morning, and required coaxing by the adult from the nest (Gnam 1991).

Post-fledging dependence is estimated from 2 - 3 months in the Greyheaded Parrot. This time involves a learning period in which juveniles learn specialist feeding techniques and the localities of seasonally abundant food sources (Chapt. 5). Post-fledging dependence in other parrot species ranges from 22 days in the smaller Green-rumped Parrotlet to 72 days in the White-fronted Amazon *Amazona albifrons* (Skeate 1984; Waltman & Beissinger 1992). Young White-tailed Black Cockatoos remained with their parents until the next breeding season (Saunders 1982). It is not known if Greyheaded Parrot pairs breed each year but they are suspected to do so.

Sex ratios and recruitment

A biased sex ratio of approximately two males to one female was calculated for both study areas. Greyheaded Parrots obtain full adult plumage after 2 - 3 years (W. Horsfield pers. comm.). During this time distinguishing sub-adults (or birds > 1 yr old) from juveniles may be difficult as the amount of orange present on the wings and tarsus, and on the crown in females, may be minimal (Symes & Downs 1998a). Therefore, although great effort was carried out in preventing errors in sexing and ageing birds the bias of a greater proportion of males may be a result of misidentifying juveniles < 3 years as males. The actual sex ratio is therefore likely to be even. However, the identification of all nestlings as male seems to support the sampling results where more males in the population occur. Results obtained from captive breeding Eclectus Parrots *Eclectus roratus*, a species that also shows reverse dichromatism and breeds cooperatively, showed that when two young fledged they were likely to be the same sex (Heinsohn *et al.* 1997). However, the sex ratio of 209 fledglings did not differ from parity (Heinsohn *et al.* 1997). In Australian parrots, sex ratios dominated by males have been recorded in Red-capped Parrots *Purpureicephalus spurius*, Australian Ringneck Parrots *Barnardius zonarius* and Eastern Rosellas *Platycercus eximius* (Wyndham *et al.* 1983; Mawson 2000). However, certain sampling techniques and different behaviour patterns of birds when sampling may result in sampling bias (Mawson 2000).

Fledging success recorded for other parrot species ranges from 46 % of egg laying pairs fledging young in the Bahama Parrot, to 63 % and 82 % of egg laying pairs in the Hispaniolan Parrots *Amazona ventralis* and Green-rumped Parrotlets respectively fledging young (Snyder *et al.* 1987; Waltman & Beissinger 1992; Gnam 1991). These studies, however, did not record the percentage of the population breeding. In this study insufficient nests were located and monitored to determine significant levels of fledging success.

Nutritional requirements

Greyheaded Parrots were observed feeding on few fruit species during the non-breeding and breeding season (Chapt. 5). Fruit availability and timing are important factors determining the onset of breeding in the Greyheaded Parrot. A similar scenario exists in the Cape Parrot where breeding is likely initiated by the fruiting of *Podocarpus falcatus* (Wirminghaus *et al.* In press). In Cuba, the Cuban Parrot *Amazona leucocephala* was observed feeding on 39 plant species during the breeding season (Aguilera *et al.* 1998). An additional 17 species used by parrot species in other areas were identified as being attractive for Cuban Parrots (Aguilera *et al.* 1998). In the Bahama Parrot the late breeding season coincides with abundance and availability of food sources (Gnam 1991) and in most *Amazona* spp. in the Caribbean, egg laying, occurs in late winter to early Spring (Snyder *et al.* 1987).

Competitors and predators

In the Greyheaded Parrot competition with other cavity nesters (e.g. hornbill species) may occur. However, asynchronous breeding with other cavity nesting species may prevent competition (Benson 1963). Benson (1963) found 57 % and 21 % of 49 egg laying records of six *Tockus* (hornbill) species occurred in October and November respectively. Kemp (1976) found no hornbill nests (N = 178) in baobab trees, although this may reflect the habitats studied where few baobabs were present. In this study evidence of hornbill use (plughole remains and feathers in cavity, 19 % (4) of cavities inspected) was recorded in cavities used in the past by Greyheaded Parrots, and in these areas inter-specific competition for nest sites may occur.

Cavity nesting species were observed inspecting active nests, and most agonistic behaviours were towards other cavity nesting species (Table 8; Chapt. 6), although no aggressive behaviour for nest site occupation was observed. Four cavity nesting species were inspecting cavities while Greyheaded Parrots were breeding (Table 8). These species are not considered major competitors and constitute no threat in being able to evict breeding parrots from a nest hole. They were possibly searching for food at the time. At a Cape Parrot nest a Trumpeter Hornbill *Bycanistes bucinator* was observed inspecting an active nest site (pers. obs.). Nests sites are possibly limiting for Cape Parrots (Downs & Symes 1998; Symes & Downs 1998b) with hornbill species being an important competitor for nest sites.

In Kaudom National Park competition for a cavity was observed between Dickinson's Kestrel *Falco dickinsoni* and Greyheaded Parrots (P. Lane pers. comm.). The Dickinson's Kestrels were observed entering the cavity while the parrots were foraging (P. Lane pers. comm.). However, the tree was pushed over by Elephants *Loxodonta africana* before any results were observed (P. Lane pers. comm.).

Parasites

A single louse, collected off a nestling (nest 24) was identified as being from the Menoponidae family, but not any species known to occur on African parrots or lovebirds (E. Green pers. comm.). *Psittacomenopon impar* (Menoponidae) has been collected off the Cape Parrot, as well as off *Poicephalus cryptoxanthus*, *P. meyeri*, *P. rueppellii*, *P. senegalus*, *P. rufiventris*, *P. gulielmi* and *Psittacus erithacus* (Ledger 1980). The species collected was neither *P. impar* or *Afrimenopon waar*, another species collected from African parrot species (E. Green pers. comm.)

Nestling removal

A high degree of nestling removal in the breeding range of the Greyheaded Parrot indicates that populations outside of protected areas are threatened with decline. Residents in the area agree that populations have declined over the past few decades (various pers. comm.). Agricultural development and accompanying persecution of parrot populations may lead to local extinctions.

Parrots are possibly one of the most threatened families of birds worldwide (Collar & Andrew 1988). Up to 30 % are faced with some form of threat (Forshaw 1989, Collar & Juniper 1992; Collar *et al.* 1994; Snyder *et al.* 2000). The Greyheaded Parrot is widespread yet declines in populations have been recorded (Chapt. 2). Numerous studies have identified nestling removal as a major threat in the decline of wild populations (Gnam 1991; Mountford 1991; Juste 1996; Wilkinson 1998). This is likely the greatest threat to Greyheaded Parrot populations outside protected areas in South Africa.

Moult

Greyheaded Parrots are unique in moulting while breeding. This occurs in certain other bird species (e.g. hornbill and penguin species) yet can be explained by the respective species life history traits (Maclean 1990). The primary moult of the male observed breeding (nest 24) was estimated to have started on *c* 2 May, during the nestling period. It was estimated to have completed its moult on *c* 11 July, three weeks before the chicks fledged. In the Galah *Cacatua roseicapilla*, moult occurs in an annual cycle well into the breeding cycle with the male starting moult before the female (Rowley 1988). Males took longer (155 days) to moult than females (165 days) with non-breeding birds taking 185 days (Rowley 1988). In the Budgerigar *Melopsittacus undulatus* moult begins after most of the young had fledged and occurs in an eight-month cycle (Wyndham 1981). This is accounted for by the availability of food to a nomadic species (Wyndham 1981).

CONCLUSION

Wood removal where local human populations live at subsistence levels may have implications for parrot nest site availability. Members of the local indigenous population are unaware of the true market value of Greyheaded Parrots and prices fetched from the sale of illegally caught birds range from ZAR 20.00 - ZAR 300/bird. This contrasts significantly with the sale of birds in the avicultural trade where prices of up to ZAR 3 500.00/birds are fetched (*Avizandum* 1999 - 2001). These factors, and the possible limited availability of nest sites, place pressures on populations of Greyheaded Parrots. As a result, conservation of natural habitat and the implementation of laws regulating illegal traded birds needs to be prioritized. In communities where local populations act as custodians of the land sustainable utilization of resources needs to be considered. However, detailed information on breeding success, fledging success and recruitment need to be determined before any sustainable utilization practices are implemented.

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REFERENCES

Aguilera, X.G., Rivera, J.R., Quiala, F.G. and Wiley, J.W. (1998) Breeding season diet of the Cuban Parrot *Amazona leucocephala* in Los Indios Ecological Reserve, Isla de la Juventud, Cuba. *Papageienkunde* **2**, S. 325-334.

Armstrong, A.J. and Juritz, J. (1996) Prediction of co-operative breeding by terrestrial birds species in South Africa. *Ostrich* **67**(1), 1-8.

Beel, C. (1994) *Zambian Orn. Soc.* Newsletter **24**(10), 137.

Beissinger, S.R. and Waltman, J.R. (1991) Extraordinary clutch size and hatching asynchrony of a neotropical parrot. *The Auk* **108**, 863-871.

Benson, C.W. (1963) The breeding seasons of birds in the Rhodesias and Nyasaland. *The Proceedings XIIIth International Ornithological Conference.* pp. 623-639.

Benson, C.W. and Irwin, M.P.S. (1967) A contribution to the ornithology of Zambia. *Zambia Museum Papers 1*. OVP. Zambia.

Brickell, N. (1985) The feeding and breeding of three *Poicephalus* parrots in captivity and in the wild. *Avicultural Magazine* **91**(3), 162-165.

Carlisle, J.S. (1923) Rare South African birds' eggs. *S. Afr. J. Nat. Hist.* **4**, 63-68.

Clancey, P.A. (1996) *The birds of southern Mozambique*. African Bird Book Publishing, Westville.

Collar, N.J. and Andrew, P. (1988) *Birds to watch: the ICBP world check-list of threatened birds*. Cambridge, United Kingdom, International Council for Bird Preservation Tech. Publ. 8.

Collar, N.J. and Juniper, A.T. (1992) Dimensions and causes of the parrot conservation crisis.

In: *New world parrots in crisis: Solutions from conservation biology*. eds S.R. Beissinger and N.F.R. Snyder, pp. 1 - 24. Smithsonian Institution Press, Washington, DC.

Collar, N.J., Crosby M.J. and Stattersfield, A.J. (1994) *Birds to watch 2: the world list of threatened birds*. BirdLife International. Cambridge.

Downs, C.T and Symes, C.T. (1998) Cape Parrots. Report on the second Cape Parrot Big Birding Day, (25 April 1998). *Psittascene* **10**(3), 5-7.

Forshaw, J.M. (1989) *Parrots of the World*. Lansdowne Books, Willoughby.

Fry, C.H., Keith, S. and Urban, E.K. (1988) *The birds of Africa*. Vol. III. Academic Press, London.

Fynn, A.R. (1991) Feeding and movements of the Brown-necked Parrot in the Trelawney district. *Honeyguide* **37**(1), 5-8.

Gnam, R.S. (1991) Nesting behaviour of the Bahama Parrot *Amazona leucocephala bahamensis* on Abaco Island, Bahamas. In: Ecology and social behaviour of parrots and parakeets. eds D.A. Saunders and P.C. Arrowood, pp. 673-680. *Acta XX Congressus Internationalis Ornithologici*, Symposium 8.

Gore, M.E.J. (1981) *Birds of The Gambia: an annotated checklist*. B.O.U. Checklist No. 3. British Ornithologists Union, London.

Heinsohn, R., Legge, S. and Barry, S. (1997) Extreme bias in sex allocation in *Eclectus* parrots. *Proc. R. Soc. Lond. B*. **264**, 1325-1329.

Isert, G. and Isert, H. (1980) Breeding the western race of the Cape Parrot. *Avicultural Magazine* **86**, 205-209.

Jacobsen, N.H.G. (1979) Birds of the Sengwa Wildlife Research area, Zimbabwe-Rhodesia. *Southern Birds* **6**. Witwatersrand Bird Club, Benmore.

Juste, J.B. (1996) Trade in the Gray Parrot *Psittacus erithacus* on the island of Principe (São Tomé and Principe, Central Africa): initial assessment of the activity and its impact. *Biological Conservation* **76**, 101-104.

Kemp, A.C. (1976) *A study of the ecology, behaviour and systematics of Tockus hornbills (Aves: Bucerotidae)*. Transvaal Museum Memoir No. 20. Transvaal Museum, Pretoria.

Ledger, J.A. (1980) *The arthropod parasites of vertebrates in Africa south of the Sahara. Vol. IV. Phthiraptera (Insecta)*. South African Institute for Medical Research, Johannesburg.

Low, R. (1982) Breeding the Cape Parrot. *Avicult. Mag.* **88**, 1-11.

Low, R. (1995) Breeding the Cape Parrot at Palmitos Park. *Psittascene* 7(2), 10-12.

Maclean, G.L. (1990) *Ornithology for Africa.* University of Natal Press, Pietermaritzburg.

Maclean, G.L. (1993) *Roberts' birds of southern Africa.* John Voelcker Bird Book Fund, Cape Town.

Marsden, S.J. and Jones, M.J. (1997) The nesting requirements of the parrots and hornbill of Sumba, Indonesia. *Biological Conservation* **82**, 279-287.

Mawson, P.R. and Long, J.L. (1994) Size and age parameters of nest trees used by four species of parrot and one species of cockatoo in south-west Australia. *Emu* **94**, 149-155.

Mawson, P. (2000) Sex bias or sampling bias? What you see isn't necessarily what you get. *Eclectus* **8**, 12-14.

Mountford, G. (1990) The desperate plight of the worlds parrots. *Psittascene* **2**(1), 1.

Newton, I. (1994) The role of nest sites in limiting the numbers of hole-nesting birds: a review. *Biological Conservation* **70**, 265-276.

Priest, C.D.(1934) *The birds of Southern Rhodesia.* Vol 2. William Clowes and Sons Ltd., London.

Reed, M.A. and Tidemann, S.C. (1994) Nesting sites of the Hooded Parrot *Psephotus dissimilis* in the Northern Territory. *Emu* **94**, 225-229.

Rowan, M.K. (1983) *The Doves, Parrots, Louries and Cuckoos of southern Africa.* David Phillip, Cape Town.

Rowley, I. (1988) Moult by the Galah *Cacatua roseicapilla* in the wheatbelt of western Australia. *Corella* **12**(4), 109-112.

Saunders, D.A. (1979) The availability of tree hollows for use as nest sites by White-tailed Black Cockatoos. *Aust. Wildl. Res.* **6**, 205-216.

Saunders, D.A. (1982) The breeding behaviour and biology of the short-billed form of the White-tailed Black Cockatoo *Calyptorhynchus funereus. Ibis* **124**, 422-455.

Saunders, D.A., Smith, G.T. and Rowley, I. (1982) The availability and dimensions of tree hollows that provide nest sites for cockatoos (Psittaciformes) in western Australia. *Aust. Wildl. Res.* **9**, 541-556.

Sharples, A. 1989. Breeding the Cape Parrot (*Poicephalus robustus suahelicus*). *Watchbird* **6**, 52-54.

Skeate, S.T. (1984) Courtship and reproductive behaviour of captive White-fronted Amazon parrots. *Bird Behaviour* **5**, 103-109.

Smithers, R.H.N., Irwin, M.P.S. and Paterson, M.L. (1957). *A checklist of the birds of Southern Rhodesia*. Rhodesia Ornithological Society. University Press, Cambridge.

Snyder, N.F.R., Wiley, J.W. and Kepler, C.B. (1987) *The parrots of Luquillo: natural history and conservation of the Puerto Rican Parrot*. Western Foundation of Vertebrate Zoology, Los Angeles.

Snyder, N., McGowan, P., Gilardi, J. and Grajal, A. (eds). (2000) *Parrots. Status, survey and conservation action plan (2000-2004)*. IUCN, Gland, Switzerland and Cambridge, UK.

Symes, C.T and Downs, C.T. (1998a) The Cape Parrot: an additional valid species. A response to Clancey 1997. *Honeyguide* **45**(2), 127-128.

Symes, C.T and Downs, C.T. (1998b) The role of nest sites in population declines of the Cape Parrot. *Avizandum*. Sept 1998, 32-33.

Vincent, A.W. (1946) On the breeding habits of some African birds. *Ibis* **88**, 48-67.

Waltman, J.R. and Beissinger, S.R. (1992) Breeding behaviour of the Green-rumped Parrotlet. *Wilson Bull.* **104**(1), 65-84.

Wilkes, A.H. Paget. (1928) The birds of the region south of Lake Nyasa - Part 1. Non-passerine birds. *Ibis* **4**, 690-748.

Wilkinson, R. (1998) The conservation status of African Parrots: a review for the World Parrot Trust - Part 1. *Psittascene* **10**(2), 6-9.

Wirminghaus, J.O. (1997) Cape Parrot *Poicephalus robustus*. In *The atlas of southern African birds - Vol 1*. eds. J.A. Harrison, D.G. Allan, L.L. Underhill, M. Herremans, A.J. Tree, V. Parker, and C.J. Brown. pp. 526-527. BirdLife - South Africa. Johannesburg.

Wirminghaus, J.O., Downs, C.T., Symes, C.T., Dempster, E. and Perrin, M.R. (2000) Vocalisations and behaviours of the Cape parrot *Poicephalus robustus* (Psittaciformes: Psittacidae). *Durban Museum Novitates* **25**, 12-17.

Wirminghaus, J.O., Downs, C.T., Perrin, M.R. and Symes, C.T. (2001) Abundance and activity of the Cape Parrot *Poicephalus robustus* in afromontane forests in southern Africa. *African Zoology* **36**(1), 71-77.

Wirminghaus, J.O., Downs, C.T., Symes, C.T. and Perrin, M.R. (In press). Breeding biology of the Cape Parrot *Poicephalus r. robustus. Ostrich.*

Wyndham, E. (1981) Moult of Budgerigars *Melopsittacus undulatus*. *Ibis* **123**, 145-157.

Wyndham, E., Brereton, J. le Gray and Beeton, J.S. (1983) Moult and plumages of eastern rosellas *Platycercus eximus*. *Emu* **83**, 242-246.

CHAPTER 8

CONCLUSION

This study has shown the biology of the Greyheaded Parrot *Poicephalus fuscicollis suahelicus* to be similar to the Cape Parrot *P. robustus* in many aspects. Despite distinct habitat requirements and distributions both species exhibit similar feeding methods (Chapt. 2 & 5). Although food type differs, specialist feeding on the kernels of unripe fruit reduce competition with other frugivores (Chapt. 5). Feeding changes in response to seasonally available food sources and may involve long distance movements (+ 20 km) from roosts to feeding grounds (Chapt. 3). Daily behavioural patterns are similar with a distinct bimodal daily activity pattern displayed (Chapt. 4). However, seasonal movements of the Greyheaded Parrot, in response to food availability and breeding are more pronounced and obvious than in the Cape Parrot. It is, however, suspected that seasonal movements between forest patches in the Cape Parrot do occur. This needs to be further investigated and with improved telemetry techniques will prove feasible. Both species share similar breeding habits, with a limitation on recruitment restricted by nest site availability (Chapt. 7). However, timing of breeding is in different months. Also, further research on the complex vocalization repertoire of the Greyheaded Parrot may help in understanding the complex social behaviour of this species (Chapt. 6).

The model developed on daily activity patterns of the Greyheaded Parrot is intended to serve as a template against which further studies on African parrots can be compared (Chapt. 4). Further studies may therefore serve to define the implications behind these behaviours. In addition to genetic studies, behavioural clues may assist in solving the riddle concerning the evolutionary history of African parrots (Massa 1998). Only ten species of *Poicephalus* parrots occur in Africa (Snow 1978; Forshaw 1989). The small *P. meyeri* superspecies group (seven species) and larger *P. robustus* superspecies group (3 species) (Snow 1978; Wirminghaus, Downs, Symes & Perrin In press) possibly share a pre-Quaternary ancestor, with recent events of climatic change during the Quaternary responsible for the evolution of respective species in each group (Chapt. 2). The small *P. meyeri* superspecies taxonomy is complex and within each species a number of subspecies are often identified (Forshaw 1989). For example, six subspecies of Meyer's Parrot *P. meyerii* are identified on the basis of minor colour differences and geographical location (Irwin

1998). Genetic studies may assist in answering these questions.

This study has made available to scientists, aviculturists and conservationists, knowledge on the biology of the Greyheaded Parrot *Poicephalus fuscicollis* not previously know. Although most of the field work was carried out in a region at the southern limit of the range of the Greyheaded Parrot, what has been presented can be considered applicable to the species. Although certain aspects of the study may be deficient of detailed information, the data presented, in many instances, represent new information of this species. This information will therefore assist if further studies of other African parrots in the wild, and assist in the conservation of this enigmatic family of birds in captivity and the wild. In addition, this study has raised questions on the specific status of the recently separated *P. f. fuscicollis* and *P. f. suahelicus* (Wirminghaus *et al.* In press). Are specimens identified in the Cabinda region (Angola) more likely *P. f. fuscicollis*, with a break in distribution with the west African population due to a lack of data? Also, was there ever a continuous distribution of *P. fuscicollis*, and if so, is the separation of *P. f. fuscicollis* and *P. f. suahelicus* a recent speciation event in progress? Additional questions raised, that may have implications on the conservation of the Greyheaded Parrot, concern the origin of seasonally migrant populations. Further research involving radio telemetry and satellite tracking may highlight important migratory routes and feeding sites.

REFERENCES

Forshaw, J.M. 1989. *Parrots of the world.* Lansdowne Books. Willoughby.

Irwin, T. 1998. Know your Meyer's Parrots. *Avizandum* 10(9): 26-27.

Massa, R. 1998. A molecular approach to the taxonomy and biogeography of African parrots. In: Adams, N.J. & Slotow, R.H. (Eds) Proc.22 Int. Ornithol. Congr., Durban. *Ostrich* 69:406.

Snow, D.W. (Ed.). 1978. *An atlas of speciation in African non-passerine birds.* British Museum (Natural History). London.

Wirminghaus, J.O., Downs, C.T., Symes, C.T. & Perrin, M.R. In press. Taxonomic relationships of the subspecies of the Cape Parrot *Poicephalus robustus* (Gmelin). *J. Nat. Hist.*