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Breeding biology of the Cape Parrot, *Poicephalus robustus*

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Breeding biology and nesting requirements of Cape Parrots in their natural habitat and in captivity were investigated. Few nests were found, suggesting that nest-sites are limiting, and that the parrots have specific nesting requirements. Nests were secondary cavities in dead *Podocarpus* spp. (branches), high up in forest canopy trees. Breeding usually occurred from August to February, but was observed in other months, particularly in captive birds. Clutch size varied from 2–5, incubation was by the female and lasted 28–30 days, with fledging a further 55–79 days. In captive birds the ovaries are mature at 2.5 years, but age at first breeding is usually at 4–6 years.

INTRODUCTION

The Cape Parrot, *Poicephalus robustus*, is endemic to South Africa, and its core range displays a discontinuous distribution from the Eastern Cape (including the former Transkei) to southern KwaZulu-Natal (Clancey 1997; Wirminghaus 1997). Populations in the Eastern Cape occasionally visit coastal forests to feed (Skead 1964, 1971, 1982). These parrot populations are endangered (Downs 2000) and declining owing to illegal collecting for the avicultural trade, shooting by pecan-nut farmers, disease and habitat destruction (Skead 1964, 1971; A. Boshoff, pers. comm.; Kingsley 1990; Wirminghaus *et al.* 1999), and particularly the removal of large, old Yellowwood (*Podocarpus* spp.) trees that are their preferred nesting sites (Skead 1971; Brooke 1984; Wirminghaus *et al.* 1999). It breeds in afromontane mixed *Podocarpus* forests above 1000 m (Skead 1964, 1971, 1982); nesting occurs in holes in trees. Four round white eggs are laid and both sexes assist in incubation (LeVaillant in Stark & Sclater 1903). The earliest description of captive breeding in Cape Parrots was provided by Woodward & Woodward (1897). Breeding success is positively affected by the availability of very old trees, especially those showing signs of senescence and such trees are increasingly uncommon owing to continued exploitation of *Podocarpus* spp. (D. Johnson, pers. comm., pers. obs.). No reliable estimates of the size of the total population exist, and sub-populations are difficult to monitor because of the species' semi-nomadic habits (D. Johnson, pers. comm.). Apart from the work of Skead (1964, 1971), which focuses primarily on distribution and feeding in Cape Parrots, very little is known of their breeding habits in the wild.

Consequently, more detailed information on breeding behaviour, success and recruitment was required. As they are obligate secondary hole-nesters, dependent on natural degradation of wood in decaying tree trunks, parrot densities are likely limited by the number of available holes, as has been found in other hole-utilizing species (Lindenmayer *et al.* 1991; du Plessis 1992). It is also unknown whether young birds from previous seasons remain and assist their parents in raising chicks (cooperative breeding), before dispersing in subsequent seasons to find territories and nest-holes. It was hypothesized that Cape Parrots have a social system characteristic of similar psittacines, and are non-territorial except in the defence of the nest-hole. Nest site choice was examined and any observed breeding was recorded. Data are presented on the basic aspects of the breeding biology of the Cape Parrot, and its implications for management, conservation and future research.

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MATERIALS AND METHODS

Study sites, and nesting ecology and behaviour

Pairs of Cape Parrots were observed monthly from January 1993 to December 1995 at two forest study sites situated in southern KwaZulu-Natal, South Africa: Hlabeni Forest and Ingeli Forest. Information on the climate, topography, and vegetation of the sites are presented elsewhere (Wirminghaus *et al.* 2001).

Descriptions of behaviour and their frequency of occurrence included courtship, copulation, nesting and parental care (Maclean 1990). Daily observations from cliff and hill lookouts led to the discovery of nest sites. Nests in these and other forest localities were also found by following individuals or pairs and examining emergent dead (or senescent) trees and dead branches

Recognition of individuals was based on plumage markings, usually an aberrant yellow feather on the wing (Wirminghaus 1990) , which remained consistent during the breeding season. Sexes were differentiated using differences in plumage characteristics (Maclean 1993). Fledglings were distinguished from adults where possible; juveniles do not have red on the wing or tarsus, only on the frons, and bill size is smaller.

Breeding chronology

During the non-breeding and pre-laying (from first copulation until egg laying) periods, the behaviour of Cape Parrots was studied from nearby vantage points using a ×20 Kowa spottingscope. During the nesting period (incubation and rearing), the behaviour of the birds was recorded within a 100 m radius of the nesting site. Nests of five (three at Hlabeni, two at Ingeli) pairs were observed for >2-h periods for 25 days (17 at Hlabeni, eight at Ingeli) during 14 months (nine at Hlabeni, five at Ingeli).

Captive breeding

Information about the breeding of *P. robustus* in captivity was obtained from aviculturalists.

RESULTS

Courtship behaviour

Over two years, four pairs were observed in socio-sexual behaviour (Table 1); allopreening, courtship with wing-display, courtship feeding and copulation attempts were observed. Courtship involved allopreening between the sexes, particularly of the head. There were intermittent archangel displays, in which the wings are raised above the back (Wirminghaus *et al.* 2000), in both sexes, which were associated with duetting. The male often regurgitated food to the female. Pairs nibbled one another's bills, then rubbed shoulders which was sometimes

TABLE 1. Months in which Cape Parrot reproductive behaviour and activity were observed.

Behaviour	Month	Study site
Precopulation	08/93; 05/94; 04/96; 05/96; 07/96; 10/96	Hlabeni
Copulation	08/93; 09/93	Hlabeni
Nesting	10/93; 11/94; 12/94; 09/95; 10/95; 05/96; 10/95	Hlabeni
	11/95; 12/95	Ingeli
Fledgling emergence	11/93; 02/95	Hlabeni
	12/95	Ingeli

followed by a copulation attempt. During copulation, the male brought his tail over the dorsal side of the female and changed sides every 6–15 seconds for 2–3 min. The female's body was horizontal with the tail up. Copulation was usually attempted again 5–10 min later. In three pairs copulation was observed in the morning, while in the fourth pair it was recorded in the late afternoon. Precopulatory behaviour of captive pairs was similar to that observed in the wild. Captive pairs allopreened, particularly the head region, gave the archangel display and then the mate recognition call. The female, and sometimes the male, raised the wings above the head, then shrugged, and emitted a duet call. The male attempted to regurgitate food to the female who sometimes moved away.

Nest-site and nest cavity characteristics

Until 1994, only two nest records of Cape Parrots were listed in the 150 000 nest record cards of the Southern African Ornithological Society. These and further nest records obtained during the study are shown in Table 2. Most nests (93%) were observed in natural holes in dead emergent or canopy trees (snags); one was in a live Blackwood, *Acacia melanoxylon*. The majority (71%) were in *Podocarpus* spp. which remain standing long after death and frequently have holes in the trunk where branches have broken away. However, one was possibly an old woodpecker hole. Nest holes were usually 6–12 m above-ground in main trunks, branches or in the top of dead trees. At Ingeli and Hlabeni, only three active nests were found from 1993–1996. These hollows were used in consecutive years but the identities of the nesting pairs was unknown. One dead branch known as Braecroft (B) fell in strong winds in late July 1995. It was a 25 m-tall dead tree with a breast height diameter of 250 cm; the nest hole entrance faced east, was 10 m above ground level (where the tree circumference was 194 cm), and was 17 cm high and 7.5 cm wide. The nest chamber was 66 cm deep with a 20 cm diameter at the base and was unlined; containing only wood chips on the chamber floor.

Captive Cape Parrots excavated the entrance hole and soft decomposed heartwood of tree-trunk sections provided as nest-boxes, presumably as the artificial nest hole was not deep or wide enough. However, Cape Parrots chewed nest holes in captivity and in the wild.

Although a number of suitable trees were observed at both study sites, suitable nest sites appeared to be limiting, as the numbers of other hole-nesting species (excavators and non-excavators) (pers. obs.), including the Olive Woodpecker, *Mesopicos griseocephalus*, and Trumpeter Hornbill, *Bycanistes bucinator*, were also low. At Ingeli a pair of Cape Parrots used a nest hole beneath a Crowned Eagle, *Stephanoaetus coronatus*, nest

TABLE 2. Nest sites of the Cape Parrot.

Locality	Tree species	Tree position	Tree height (m)	Nest	Usage	Date	Comment
Mt Gilboa	*Podocarpus* sp.	In forest, over bank		In trunk in broken end	Yes	1991/2	
Mbona	*Podocarpus* sp.	Forest margin		Side of trunk	Yes	1991/2	Parents + chicks
Benvie	*Acacia melanoxylon*	Away from forest	12		Yes	1990/2	
Isidenge	*P. falcatus*				Yes	1993	D. Allan (pers. comm.), tree felled
Fort Knox	Alien sp.				Yes	1993	Tree alive
Hlabeni	*P. falcatus*	In forest	9	At old branch attachment	Yes	1993/5	Tree dead, three chicks raised Aug–Nov
Hlabeni	*P. falcatus*	In forest	25	Side of trunk	Yes	1993/4	Old woodpecker hole, one chick raised & fledged Nov 1993, dead tree blown over Aug 1994
Ingeli	*P. falcatus*	In forest	20	In broken side branch, top of tree; natural cavity on main stem	Yes	1991	Crowned eagle nest in same tree
Nxumeni	*Podocarpus* sp.	In forest	10	Hollow near top	?	15.10.92	Tree stump 10 m tall, pair in attendance
Balgowan		In forest	18	In trunk	Yes	1922	Four eggs
Balgowan						1922	Parent on nest, three eggs
Mpetyeni	*P. henkelii*	In forest			Yes	1995	D. Johnson (pers. comm.), tall, dead tree near drift
Hlabeni	*Podocarpus falcatus*	In forest (central)	15	Natural hole at the end of a broken side branch of a live tree	Yes	1997	
Eastern Cape	*Erythrina caffra*	In forest	15				C.J. Skead (pers. comm.). Gale broke head of tree at hole
Qacu Forest	*Podocarpus* sp.				Yes		K. Cooper (pers. comm.)
Hogsback	Pine tree						M. Courtney-Latimer (pers. comm.)

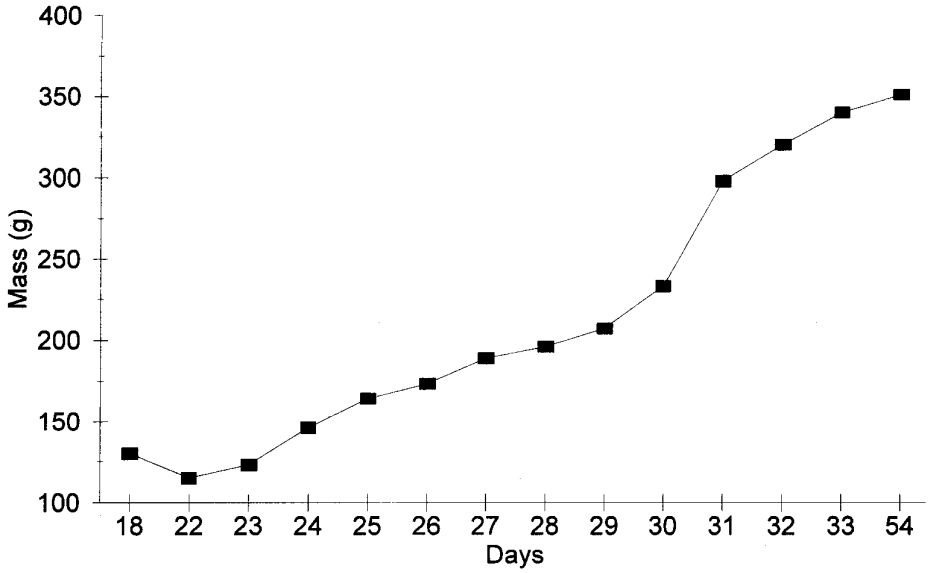

FIG. 1. Growth rate of a captive Cape Parrot nestling (F. Hylton, pers. comm.).

higher in the same dead tree.

Cape Parrots showed no change in habitat preference during the breeding season, as the same foraging habitat was used throughout (Wirminghaus *et al.* 2001). There appeared to be a positive association between nest site and tree (*Podocarpus* sp.) but this may reflect the dominance of the emergent canopy species (Wirminghaus *et al.* 2001). No nest sites were located >1 km from afromontane forest.

Dueting pairs did not appear to defend nest sites, but occasionally chased other frugivores away. There was no destruction of any observed clutches or broods by predators.

Incubation and fledging

Clutch size of Cape Parrots in the wild was unknown, but 1–5 chicks were successfully raised by parents. In captivity 2–5 eggs (usually 3–4) are laid from April to August and in December (pers. obs.; W. Horsfield, L. Arnot. pers. comm.), but eggs have been laid in other months (W. Horsfield, F. Hylton, pers. comm.). A captive pair, wild-caught and donated to the Cape Parrot Breeding Programme, University of Natal, bred during June 1997. The female laid four eggs over a period of five days (3, 4, 5 and 7 June) then resumed incubation. Generally three eggs are laid with asynchronous hatching spread over 48 h (W. Horsfield, L. Arnot, pers. comm.). Incubation period was 30 days. Three of the four eggs hatched and the chicks were fed by both parents. The first nestling fledged at 63 days of age, followed by the other two nestlings a few days later. At first nestlings had a pink appearance, covered with a sparse white down which got thicker as the nestlings grew older. Bills had a distinct egg-tooth. When the oldest nestling was 15 days old, pin feathers began appearing on its forehead. At about 35 days of age, green tail feathers began to break free of the quills. When chicks emerged from the nest, each resembled an adult female in colouring, with coral pink foreheads. First moult began after 5–7 months. The time taken to moult into mature plumage is variable in both sexes. In captivity, the sex ratio is very variable with some clutches all female, others 2♀:1♂; 1♀:2♂; 2♀:2♂, or all male (pers. obs.; W. Horsfield, F. Hylton, pers. comm.). Usually there are more males than females (Parks 1994).

Precise information on incubation period, number of young hatched, hatching interval, number of young fledged, age at fledgling and fledgling interval could not be obtained at the study sites. However, the eggs of one female were incubated for 28–30 days and fledged 55–79 days later. Both parents attended the nest and regurgitated food to the young. The female spent more time in the nest than the male. Chicks solicited food by chirping continually until fed. When leaving the nest, both parents appeared cautious before flying off. As chicks grew, they appeared at the hole entrance and gave 'zeek-zeek' calls (Wirminghaus *et al.* 2000). When chicks were almost fledged, both parents were observed regurgitating food 10–11 times per chick per feeding bout. Pairs usually gave loud 'squawk' calls (Wirminghaus *et al.* 2000) when returning to the nest. Both parents entered the nest hole to feed chicks but females fed the brood more frequently than males. After fledging, chicks remained in groups with their parents and continued to be fed by regurgitation by both parents. During this period, fledglings played with siblings and nibbled at fruit. Food given to chicks included the kernels of *P. falcatus* and seeds of *Acacia mearnsii.* There was much vocal contact between fledglings and adults. Growth rate of a captive-raised Cape Parrot is shown in Fig. 1 (F. Hylton, pers. comm.).

Most wild-caught *Poicephalus* species are shy and nervous and do not adapt well to captivity (Allwright 1993; pers. obs.). Consequently, there has been poor breeding success in captivity until recently. In captivity, time to first breeding age is usually 4–6 years, although the ovaries are mature at 2.5 years and birds are adult after a year (C. Kingsley pers. comm.; pers. obs.).

Nesting success

Observations of nestlings at Hlabeni and Ingeli suggest that breeding was successful. At Hlabeni, only one observed fledgling disappeared, presumably from predation. Death of chicks and failure of a nesting attempt occurred at Ingeli after heavy rains and cold weather. No predation on nestlings was observed. On one occasion at the Ingeli nest site a Trumpeter Hornbill was observed inspecting the nest cavity while chicks were present, but it made no attempt to kill or eat the chicks.

DISCUSSION

Sexual dimorphism

Sexual dimorphism evolves as a result of sexual selection; ecological factors, however, may then act secondarily to enhance the degree to which the dimorphic character is expressed (Jehl & Murray 1986). Plumage dichromatism is not fully understood

TABLE 3. Summary of reproductive characteristics of African Parrots (Forshaw 1989).

Species	Body mass (g)		Clutch size	Egg (mm)		Incubation period (days)	Incubation	Nestling/fledgling period
	Min	Max		Length	Width			
Psittacus erithacus	402	407	–	38.7–39.4–39.7	30.7–31.0–31.5	30	♂ and ♀	Jan–Feb (Africa)
Poicephalus robustus	310	401	2(4)	30.4–34.1–39.2	26.0–27.9–30.2	28	–	Aug (Transvaal, S.A.)
Poicephalus gulielmi	200	227	4	34.0, 34.5	28.5, 28.5	26	–	Jun/Nov (Kenya)
Poicephalus cryptoxanthus	120	156	–	27.2	22.9	26	♀	Apr/Jun
Poicephalus senegalus	155	–	3	29.4	26.4	25	♂ and ♀	Apr–May
Poicephalus rufiventris	113	142	–	26.6–26.8–27.0	22.7–23.1–23.4	–	–	Oct/Jan/Mar
Poicephalus crassus	–	–	–	–	–	–	–	–
Poicephalus meyeri	100	135		24.7–25.4–27.8	19.3–20.0–21.0	30		Jun–Dec
Poicephalus rueppellii	105	132	–	27.3	24		♀	May (Humbe, Angola)
Poicephalus flavifrons	–	–	–	–	–	–	–	–
Agapornis swinderniana	39	41	–	–	–	–	–	–
Agapornis roseicollis	46	63	–	21.0–23.8–26.3	16.8–17.6–19.0	23	–	Feb/Mar
Agapornis fischeri	42	58	–	20.2–23.3–24.5	16.5–17.0–18.0	23	–	Dry months
Agapornis personata	43	47	–	22.4–23.3–24.0	16.7–17.0–17.2	23	–	Mar–Apr
Agapornis cana	25	28	–	18.0–19.2–21.2	14.1–16.0–16.5	23	–	Nov–Apr (Morocco)
Agapornis pullaria	43	–	–	20.0–21.4–22.4	16.0–16.8–18.0	22	♀	Apr, Jun, Oct (Africa)
Agapornis taranta	–	–	–	23.7–24.3–25.0	18.6–18.9–19.0	25	–	Apr, Mar, May–Nov

(Owens & Short 1995). Generally, species of parrots have both sexes brightly coloured although sexually dichromatic. The *Poicephalus* genus is unusual as it has some species in which the female is more colourful than the male (Cape Parrot and Rüppell's Parrot, *P. ruppellii*), others which have a brighter male than female (Red-bellied Parrot, *P. rufiventris*), and yet others which are monomorphic (Senegal Parrot, *P. senegalus*). Generally, males of sexually dichromatic or dimorphic species participate less in nesting activities than males of monochromatic or monomorphic species. Greater differences in nesting behaviour are evident between males of monogamous and males of polygynous or promiscuous species, especially when the latter are also sexually dimorphic (Venner & Willson 1969). Cape Parrots, however, are not territorial and appear to have a monogamous mating system.

Breeding season

Although African psittacids breed aseasonally, synchronization of breeding activity and a loose colony structure with a common site for socio-sexual activities is significant, particularly when food availability is limited, as described for *P. rufiventris* (Massa 1995). The reproductive characteristics of African parrots are summarized in Table 3. Several African parrot species, including the Grey-headed Parrot, *P. fuscicollis suahelicus*, (Mackworth-Praed & Grant 1962; Benson *et al.* 1971; Kemp 1974; Benson & Benson 1977; Irwin 1981; Tarboton *et al.* 1987), the Red-bellied Parrot (Allwright 1993), Jardine's Parrot, *P. gulielmi* (Chapin 1939, Brickell 1987), Senegal Parrot and Rüppell's Parrot (Brickell 1985) breed throughout the year. Cape Parrots were also found to breed at different times of the year but pairs in the same area showed synchronization (Mackworth-Praed & Grant 1962; Clancey 1964; Dean 1971; present study).

Rainfall and photoperiod affect the onset of breeding in psittacid species in Australia, (Immelmann 1963; Putnam & Hinde 1973) and the late breeding season of the Bahama Parrot, *Amazona leucocephala bahamenisi*, coincides with peak abundance and availability of its food resources (Gnam 1991). Young Cape Parrots are fed almost entirely on *Podocarpus falcatus* endocarps, and the duration of the breeding season is likely determined by fruit availability. *Podocarpus* species, although erratic in fruiting phenology, have extended fruiting episodes (Wirminghaus *et al.* 2001). The kernels of *P. falcatus* are high in fat and energy compared with other available forest fruits (Downs, unpubl. data). Parent birds access this food source and regurgitate it when feeding young.

Nest sites

Nest sites provide safety, may aid the insulation of eggs and contribute warmth for nidicolous chicks (Maclean 1990). Cape Parrots nest in cavities in trees at considerable heights (8–10 m) from the ground (Roberts 1940; Mackworth-Praed & Grant 1962; this study), and use them repeatedly in successive seasons. The majority were located in trunks where branches had broken off and few were in tree stumps open above.

Nest site characteristics influencing reproductive success of cavity nesters include height, foliage concealment, and the nature and species of the nearest neighbouring tree (Li & Martin 1991). Use of natural cavities for several seasons, i.e. traditional nest sites, has also been recorded in the Hawk-headed Parrot, *Deroptyus accipitrinus* (Strahl *et al.* 1991). Limited availability of cavity-nest sites prevents some pairs from nesting (Cline *et al.* 1980; Li & Martin 1991) which has selected for delayed breeding (Von Haartman 1971; Brawn 1987). Since cavity-nesting parrots have a large non-breeding component in the adult population (20–80% of the individuals) (Snyder *et al.* 1987; Munn 1991; Beissinger & Bucher 1992a), competition between pairs for nest sites is common, and nest takeovers after infanticide occur (Beissinger & Waltman 1992; Munn 1991; Beissinger & Stoleson 1991).

However, this was not observed in the Cape Parrot. A long-term study on the provision and use of artificial nest sites by the Cape Parrot has been initiated.

Most psittacid species are obligate secondary hole nesters (Forshaw 1989) with specific nesting requirements making them susceptible to habitat degradation (Marsden & Jones 1997) and conservation status is affected by the availability of dead trees (Joseph *et al.* 1991). Availability of suitable dead trees, the preferred nest sites of the Cape Parrot, is subject to a variety of dynamic factors including forest status and the nature of dead wood creation and degradation.

Courtship and copulation

Courtship behaviour includes ritualized elements of agonistic displays, displacement activities and intention movements enhanced by the visual reinforcement of bright or distinctively; coloured or shaped plumage (Maclean 1990). In the Cape Parrot

the orange colour on the underwing is displayed during their archangel display posture (Wirminghaus *et al.* 2000).

Cape Parrot courtship comprised several behaviour patterns including switch-sidling displays, wing displays, allopreening, and head bobbing which parallels that of other African parrot species, particularly the Brown-headed Parrot, *P. cryptoxanthus* (Brickell 1984), Red-bellied Parrot (Allwright 1993; Massa 1995) and Senegal Parrot (Brickell 1987). Other components are displacement preening, a ritualized wing-display, and calling (in the exposed branches of a favoured roosting tree). All adults show pairing during courtship and there is little flocking during the ensuing breeding periods.

Clutch size and parental care

The Cape Parrot has a variable clutch size (2–5 eggs) (Dean 1971; this study). Eggs are glossy white and rounded and measure 34.1 (30.4–39.2) × 27.9 (26.0–30.2) mm (n = 27) (Maclean 1993); 32–34 × 26–28 mm (Roberts 1940; Mackworth-Praed & Grant 1962); 33.8–39.2 × 26.5–30.2 mm; average 35.1 × 28.8 mm (Winterbottom 1971). This is similar to other *Poicephalus* species: Rüppell's Parrot (3–4 eggs, Brickell 1985), Jardine's Parrot (2–4 white eggs, Brickell 1987), Red-bellied Parrot (three eggs, Allwright 1993) and Senegal Parrot (3–4 white, glossy eggs, Brickell 1987).

Large psittacids, including African parrots, share a common parental care pattern in which the females incubate the eggs (Saunders 1982; Snyder *et al.* 1987; Rinke 1989; Gnam 1991; present study) and both sexes feed nestlings (Saunders 1982; Snyder *et al.* 1987; Gnam 1991; present study). The 30-day incubation period of the Cape Parrot falls within the range (26–30 days) recorded for other African parrots, e.g. Rüppell's Parrot (Brickell 1985), Jardine's Parrot (Brickell 1987), Red-bellied Parrot (Allwright 1993) and Senegal Parrot (Brickell 1987)).

Nestlings

Asynchronous hatching has been observed in Cape Parrots (Isert & Isert 1980; Lang 1969; Low 1982; present study). Nestlings are covered in very short white down until three weeks which changes to golden yellow (Low 1982, present study), as in other African parrot species (W. Horsfield, pers. comm.). Fledglings are initially fed by the male in captivity but at 100 days become independent feeders (Low 1982). Juvenile plumage includes the appearance of a brick-red colouring on the forehead which disappears at about five months and is replaced in females by a bright red (Lang 1969; present study) and is lost in males.

Cape Parrots defend the nest by making a growling sound similar to small carnivores which may deter predators (Maclean 1990).

Family groups

Cape Parrots showed no cooperative breeding behaviour (Armstrong & Juritz 1996), although they form family groups and forage and roost in groups, in the same way as obligate cooperative breeders (du Plessis *et al.* 1995). Food provisioning of the chicks was only undertaken by the parents. Family groups often evolve when limitations are placed on breeding opportunities of adults (Koenig *et al.* 1992). Cape Parrot fledglings remain in their natal territory and show interactions and behaviour enabling them to act as a coordinated group. This is an important learning phase, and continued flocking behaviour reflects the significance of socialization in the ecology and survival of the species. Cape Parrots show much inter-group movement (Wirminghaus *et al.* 1999, 2000), and socializing in large flocks allows for bonding between individuals of different groups. This may also function as a form of incest avoidance behaviour (Craig & Jamieson 1990). Similarly, juvenile Puerto Rican Parrots remained in their nest valley for 1–3 months following fledging; thereafter they integrated with adult flocks participating in inter-forest movements (Lindsey *et al.* 1991). In this study similar observations were made of juvenile Cape Parrots.

Although parrot populations often contain large numbers of non-breeding individuals, Beissinger & Bucher (1992a) cautioned against the harvesting of birds; non-breeders act as social facilitators (Snyder *et al.* 1987), as a population buffer against the effects of environmental variation, and may be breeders in following years (Beissinger & Bucher 1992b). Female Cape Parrots probably first breed at age two in the wild (Brooke 1984). In captivity, however, they first breed when 4–6 years old (W. Horsfield, C. Kingsley pers. comm.). Breeding frequency appears to be erratic and the overall recruitment rate is low. Consequently, if Cape Parrots are removed from the wild, their longevity and K-selected breeding pattern no longer functions to maintain stable population levels.

Breeding success and conservation

Sustainable harvesting has been proposed to encourage local communities to protect and care for wild populations of parrots, together with the provision of additional nest sites to increase productivity (Bessinger & Bucher 1992a). Sustainable harvesting, however, cannot guarantee survival if a population is in decline, and likely represents an additional threat. Continued monitoring of reproductive success, post-fledgling survivorship and adult mortality are essential components of any viable conservation plan for the Cape Parrot. Planned research includes the monitoring of nests, supplementary nest hollow schemes, long-term monitoring of population trends and overseeing a captive breeding programme.

There have been no studies of dead tree abundance and characteristics in southern African forests. Dead trees were a scarce resource in the study areas, which has important conservation implications. If the regeneration of young *Podocarpus* spp. is prevented (e.g. through trampling by cattle and cutting of poles), or if old trees are selectively felled and removed (for furniture production), there will be serious consequences for the Cape Parrot.

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REFERENCES

Allwright, D.M. 1993. The Red-bellied Parrot. Avizandum July 1993: 8–9.

Armstrong, A.J. & Juritz, J. 1996. Prediction of cooperative breeding by terrestrial bird species in South Africa. Ostrich 67: 1–8.

Beissinger, S.R. & Bucher, E.H. 1992a. Sustainable harvesting of parrots for conservation. In: Beissinger, S.R. & Snyder, F.R. New World parrots in crisis: solutions from conservation biology: 73–115. Washington, D.C.: Smithsonian Institution Press.

Beissinger, S.R. & Bucher, E.H. 1992b. Can parrots be conserved through sustainable harvesting? BioScience 42: 164–173.

Beissinger, S.R. & Stoleson, S.H. 1991. Nestling mortality patterns in relation to brood size and hatching asynchrony in green-rumped parrotlets. Proceedings of the XX International Ornithological Congress. New Zealand: Christchurch.

Beissinger, S.R. & Waltman, J.R. 1992. Extraordinary clutch size and hatching asynchrony of a Neotropical parrot. Auk 108: 863–871.

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

Mountfort Press.
Benson C.W., Brooke, R.K., Dowsett, R.J. & Irwin, M.P.S. 1971. The birds of Zambia. London: Collins.
Brawn, J.D. 1987. Density effects on reproduction of cavity nesters in northern Arizona. Auk 104: 783–787.
Brickell, N. 1984. Notes on the Brown-headed Parrot *Poicephalus cryptoxanthus*. Aviculturalist Magazine 90: 215–218.
Brickell, N. 1985. The feeding and breeding of three *Poicephalus* parrots in captivity and the wild. Aviculturalist Magazine 91(3): 162–165.
Brickell, N. 1987. Three *Poicephalus* parrots in captivity and the wild. Aviculturalist Magazine 93(3): 162–167.
Brooke, R.K. 1984. South African red data book – birds. South African National Scientific Programmes Report No. 97. C.S.I.R: Pretoria.
Chapin, J.P. 1939. Birds of the Belgian Congo Part 2. Bulletin of the American Museum of Natural History 75: 1–632.
Clancey, P.A. 1964. The birds of Natal and Zululand. London: Oliver and Boyd.
Clancey, P.A. 1997. The Cape Parrot: an additional valid species. Honeyguide 43: 61–62.
Cline, S.P., Berg, A.B. & Wight, H.M. 1980. Snag characteristics and dynamics in Douglas fir forests, Western Oregon. Journal of Wildlife Management 44: 773–786.
Craig, J.L. & Jamieson, I.G. 1990. Pukeko: different approaches and some different answers. In: Stacey, P.B. & Koenig, W.D. (eds). Cooperative breeding in birds: 387–412. Cambridge: Cambridge University Press,
Dean, W.R.J. 1971. Breeding data for the birds of Natal and Zululand. Durban Museum Novitates 9: 59–91.
Downs, C.T. 2000. Cape Parrot Poicephalus robustus. In: Barnes, K.N. (ed.) The Eskom Red Data book of birds of South Africa, Lesotho and Swaziland: 48-49. Johannesburg: BirdLife South Africa.
du Plessis, M.A. 1992. Obligate cavity-roosting as a constraint on dispersal of green (red-billed) woodhoopoes: consequences for philopatry and the likelihood of inbreeding. Oecologia 90: 205–211.
du Plessis, M.A., Siegfried, W.R. & Armstrong, A.J. 1995. Ecological and life-history correlates of cooperative breeding in South African birds. Oecologia 102: 180–188.
Forshaw, J.M. 1989. Parrots of the world (3rd edn). Melbourne: Weldon.
Gnam, R. 1991. Nesting behaviour of the Bahama parrot *Amazona leucocephala bahamensis* on Abaco Island, Bahamas. Proceedings of the XX International Ornithological Congress, Vol. II, Symposium 8: 673–679. New Zealand: Christchurch.
Immelmann K. 1963. Drought adaptations in Australian desert birds. Proceedings of the VXIII International Ornithological Congress: 649–657.
Irwin, M.P.S. 1981. The birds of Zimbabwe. Salisbury: Quest Publishing.
Isert, G. & Isert, H. 1980. Breeding the western race of the Cape parrot *Poicephalus robustus fuscicollis* (Kuhl). Avicultural Magazine 86: 205–209.
Jehl, J.R. & Murray, B.G. 1986. The evolution of normal and reverse sexual dimorphism in shorebirds and other birds. In: Johnstone F. (ed.) Current ornithology, Vol. 3: 1–86.. New York: Plenum Press.
Joseph, L., Emison, W.B. & Bren, W.M. 1991. Critical assessment of the conservation status of Red-tailed Black-cockatoos in South-eastern Australia with special reference to nesting requirements. Emu 91: 46–50.
Kemp, A.C. 1974. The distribution and status of birds in the Kruger National Park. Koedoe 2: 1–352.
Kingsley, C. 1990. The South African Cape Parrot, can it survive? Magazine of the Avicultural Council of Southern Africa 1/2: 9.
Klomp, H. 1970. The determination of clutch-size in birds: a review. Ardea 58: 1–124.
Koenig, W.D., Pitelka, F.A., Carmen, W.J., Mumme, R. & Stanback, M.T. 1992. The evolution of delayed dispersal in cooperative breeders. Quarterly Review of Biology 67: 11–150.
Lang, E.M. 1969. Some observations on the Cape Parrot *Poicephalus robustus robustus*. Avicultural Magazine 75: 84–86.
Lindenmayer, D.B., Cunningham, R.B., Tanton, M.T., Nix, H.A. & Smith, A.P. 1991. The conservation of arboreal marsupials in the montane ash forests of the central highlands of Victoria, south-east Australia: III. The habitat requirements of Leadbeater's possum *Gymnobelideus leadbeateri* and models of the diversity and abundance of arboreal marsupials. Biological Conservation 56: 295–315.
Lindsey, G., Arendt, W.J., Kalina, J. & Pendleton, G.W. 1991. Home range and movements of juvenile Puerto Rican parrots. Journal of Wildlife Management 55: 318–322.
Li, P. & Martin, T.E. 1991: Nest-site selection and nesting success of cavity-nesting birds in high elevation forest drainages. Auk 108: 405–418.
Low, R. 1982 Breeding of the Cape Parrot. Avicultural Magazine 88: 1–11.
Mackworth-Praed, C.W. & Grant, C.H.B. 1962. Birds of the southern third of Africa, Ser II, Vol. 1. London: Longmans.
Maclean, G.L. 1990. Ornithology for Africa. Pietermaritzburg: University of Natal Press.
Maclean, G.L. 1993. Roberts' birds of southern Africa (6th edn). Cape Town: John Voelcker Bird Book Fund.
Marsden, S.J. & Jones, M.J. 1997. The nesting requirements of the parrots and hornbills of Sumba, Indonesia. Biological Conservation 82: 279–287.
Massa, R. 1995. Performance of socio-sexual activity at a communal site in the African Orange-bellied Parrot *Poicephalus rufiventris*. Ostrich 66: 41.
Moreau, R.E. 1966. The bird faunas of Africa and its islands: 1–424. Academic Press, New York.
Munn, C.A. 1991. Macaw biology and ecotourism, or 'when a bird in the bush is worth two in the hand'. In: Beissinger S.R. & Snyder N.F.R. (eds) New world parrots in crisis: solutions from conservation biology: 47–72. Washington, D.C.: Smithsonian Institution Press.
Owens, I.P.F. & Short, R.V. 1995. Hormonal basis of sexual dimorphism in birds: implications for new theories of sexual selection. Tree 10: 44–47.
Parks, C. 1994. African Cape Parrots. African Ark 3: 5–6.
Putnam, R.J. & Hinder R.A. 1973. Effects of light regime and breeding experience on budgerigar reproduction. Journal of Zoology (London) 170: 475–491.
Rinke, D. 1989. The reproductive biology Red Shining Parrot *Prosopeia tabuensis* on the island of 'Eua, Kingdom of Tonga. Ibis 131: 238–249.
Roberts, A. 1940. The birds of South Africa. Johannesburg, Trustees of S.A. Bird Book Fund.
Rowan, M.K. 1983. The doves, parrots, louries and cuckoos of southern Africa. Cape Town, David Phillip.
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.
Skead, C.J. 1964. The overland flights and the feeding habits of the Cape Parrot, *Poicephalus robustus* (Gmelin) in the eastern Cape Province. Ostrich 35: 202–223.
Skead, C.J. 1971. The Cape Parrot in the Transkei and Natal. Ostrich Supplement 9: 165–78.
Skead, C.J. 1982. Brown-necked Parrots (R326) on 'Fairview' Farm, N.E. Port Alfred. Diaz Diary 110 (Oct.): 140–141.
Snyder, N.F.R., Wiley, J.W. & Kepler, C.B. 1987. The parrots of Luquillo: natural history and conservation of the Puerto Rican Parrot. Los Angeles: Western Foundation of Vertebrate Zoology.
Stark, A. & Sclater, W.L. 1903. The birds of South Africa. Picarians, parrots, owls and hawks, Vol III: 1–416. London: Porter.
Strahl, S.D., Desenne, P.A, Jimenez, J.L. & Goldstein, I.R. 1991. Behavior and biology of the hawk-headed parrot *Deroptyus accipitrinus*, in southern Venezuela. Condor 93: 177–180.
Tarboton, W.R., Kemp, M.I. & Kemp, A.C. 1987. Birds of the Transvaal. Pretoria: Transvaal Museum.
Venner, J. & Willson, M.F. 1969. Mating systems, sexual dimorphism, and the role of North American passerine birds in the nesting cycle. Ornithological Monographs 9: 1–76.
Von Haartman, L. 1971. Population dynamics. In: Farner, D.S & King J.R. (eds) Avian biology, Vol. 1: 391–459. New York: Academic Press.
Winterbottom J.M. 1971. Priest's eggs of southern African birds. Johannesburg: Winchester Press.
Wirminghaus, J.O. 1990. Colour variation and anomalies in South African parrots. Birding in Southern Africa 47: 76–77.
Wirminghaus, J.O. 1997. Cape Parrot *Poicephalus r. robustus*. In: Harrison, J.A., Allan, D.G., Underhill, L.G, Herremans, M., Tree, A.J., Parker, V. & Brown, C.J. (eds) The atlas of southern African birds, Vol. 1: non-passerines: 526–527. Johannesburg: BirdLife S.A.
Wirminghaus J.O., Downs, C.T., Symes, C.T. & Perrin M.R. 1999. Conservation of the Cape Parrot in southern Africa. South African Journal of Wildlife Research 29: 118–129
Wirminghaus, J.O., Downs, C.T., Symes, C.T., Perrin, M.R. & Dempster, E.R. 2000 Vocalisations, and some behaviours of the Cape Parrot *Poicephalus robustus*. Durban Museum Novitates 25: 12–17
Wirminghaus, J.O., Downs, C.T., Symes, C.T. & Perrin, M.R. 2001 Fruit-fall of two afromontane forests in KwaZulu-Natal, South Africa: the habitat type of the Cape Parrot *Poicephalus robustus*. *South African Journal of Botany.*
Woodward, R.B. & Woodward, J.D.S. 1897. Description of our journeys in Zululand, with notes on its birds. Ibis 3: 400.

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