J Ornithol (2008) 149:13–22
DOI 10.1007/s10336-007-0206-5

ORIGINAL ARTICLE

Response of avian nectarivores to the flowering of *Aloe marlothii*: a nectar oasis during dry South African winters

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Received: 13 March 2007 / Revised: 21 June 2007 / Accepted: 22 June 2007 / Published online: 21 August 2007

Abstract In southern Africa, *Aloe marlothii* flowers during the dry winter season and offers copious dilute nectar to a variety of birds. Avian abundance and community composition were monitored at an *A. marlothii* forest at Suikerbosrand Nature Reserve, South Africa. Sampling occurred during two summer months (February–March) when no flowers were present, and six months (May–October) that spanned the winter flowering. We hypothesized that an influx of occasional nectarivores to the *A. marlothii* forest during flowering would lead to significant changes in the avian community. Overall bird abundance increased 2–3 fold at the peak of nectar availability (August). We recorded 38 bird species, of 83 species detected during transects, feeding on *A. marlothii* nectar; this diverse assemblage of birds belonged to 19 families, including Lybiidae, Coliidae, Pycnonotidae, Sylviidae, Cisticolidae, Muscicapidae, Sturnidae, Ploceidae and Fringillidae. Surprisingly, only two species of sunbird (Nectariniidae) were observed feeding on *A. marlothii* nectar, and both occurred in low abundance. We predicted that competition for nectar resources would be high, but few aggressive inter- and intra-specific interactions occurred between birds while feeding on inflorescences. During peak flowering, insect feeders (insectivores, omnivores, nectarivores) fed on nectar during the cold morning when insect activity was low, whilst non-insect feeders (frugivores and granivores) fed on nectar in the middle of the day. Our study highlights the importance of *A. marlothii* nectar as a seasonal food and water source for a diverse assemblage of occasional nectarivores.

Keywords Nectarivore · Sunbird · Niche partitioning · Seasonal flowering

Communicated by F. Bairlein.

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Introduction

The structure and composition of avian communities change in space and time with the availability of food resources. Variation tends to be most pronounced among consumers that feed on patchy and ephemeral food resources such as nectar and fruit (Fleming 1992). The responses of nectarivores to variation in food availability are well documented, with increases in abundance and diversity being correlated with increased nectar availability (e.g., Brown and Hopkins 1996; Franklin and Noske 1999; Cotton 2006). In South Africa, sunbirds (Nectariniidae) respond to patchy nectar resources, e.g., *Protea* and *Leonotis* spp. (Skead 1967; Tree 1990; Craig and Simon 1991; Craig and Hulley 1994; Symes et al. 2001), and Gurney's Sugarbirds *Promerops gurneyi* are recorded using seasonally available nectar sources (de Swardt 1991; de Swardt and Louw 1994). Cape Sugarbirds *P. cafer* are also known to appear in greater numbers at flowering *Protea* spp., and movements up to 160 km within their restricted range have been recorded (Fraser et al. 1989; Fraser and McMahon 1992).

While the examples above concern specialist nectarivores, occasional nectarivory is recorded worldwide in

numerous bird families, with a predominance on the southern continents (Maclean 1990). In the Neotropics, honeycreepers (Coerebidae), the New World blackbirds (Icteridae), tanagers (Thraupidae) and finches (Fringillidae) are common nectar feeders (Stiles 1981; Gryj et al. 1990). In Australasia, a host of insectivores feed on nectar, with the number of species in monsoonal Australia given as 29 (from 15 families) (Paton 1986; Franklin 1999). Numerous birds have been recorded foraging on the nectar of *Erythrina* species, including generalist passerines (Steiner 1979; Raju and Rao 2004), parrots (Psittacidae) (Cotton 2001) and hummingbirds (Trochilidae) (Mendoça and dos Anjos 2006). In South Africa, at least 73 bird species in 24 families were recorded feeding on 14 *Aloe* species and 8 other flowering plants and trees, although this list is far from exhaustive (Oatley and Skead 1972). Occasional nectar-feeding is therefore more common than previously believed, and the 1,600 birds quoted by Peterson et al. (1968) may be no exaggeration.

In many southern African ecosystems, aloes (*Aloe* spp.) represent an important source of nectar for birds during dry winter months (Oatley 1964; Skead 1967; Oatley and Skead 1972). *Aloe marlothii* occurs in the northern and north-eastern summer rainfall regions of South Africa where winters are dry with warm days (>20°C) and cold nights (c.0°C). This species reaches a maximum height of c.8 m and produces a single inflorescence with up to 25 racemes in a flowering season, although not all plants flower each year (Symes and Nicolson, unpublished data). This study was conducted at Suikerbosrand Nature Reserve during 8 months that included the flowering period of *A. marlothii*. We investigated seasonal variation of the avian community, hypothesizing that bird abundance and diversity would increase with the availability of *A. marlothii* nectar. We predicted that the seasonal response would be most pronounced in true nectarivores, such as sunbirds (Nectariniidae). Occasional nectarivore species were also expected to increase in abundance during the flowering season, in proportion to their degree of nectarivory. We also expected competition for nectar during flowering, and investigated feeding behavior of birds throughout the day in order to identify temporal niche partitioning.

Methods

Our study site was an *A. marlothii* "forest" in the western part of Suikerbosrand Nature Reserve, 60 km south-east of Johannesburg, where large numbers of *A. marlothii* plants occur mainly on rocky north-facing slopes. Data were collected during a 6-month period (May–October 2006) that spanned the entire 2006 winter flowering event, and during the summer non-flowering season (February–March 2006). Additional feeding and behavioral observations were also recorded during the 2005 flowering season (July–September).

Diversity and abundance censusing

The avian community was censused in the western portion (26°31′50″S, 28°10′07″E, c.1,600–1,700 m a.s.l.) of the *A. marlothii* "forest". Each census session involved a combination of point counts and transect sampling along a disused vehicle track. Following an initial 10-min point count, an observer (C.T.S.) walked along the 300-m transect route for 20 min. Thereafter, a second 10-min point count was conducted at the end of the transect route. After a delay of 10 min, this procedure was then repeated in the reverse direction, so that each session comprised four 10-min point counts and two 20-min transects (i.e., a total of 80 min). Sampling took place in the morning (0600–1000 hours), at midday (1000–1400 hours), or in the afternoon (1400–1800 hours), with only one session being conducted during each period in a day. Two sessions were conducted for each period in a month, and bird census sampling was completed over 3–5 days. Total census time each month was thus 8 h.

During each census period, all birds detected visually or by sound in the aloe "forest" were recorded. Resightings during each point count and transect were not included. We also recorded all instances of feeding behavior on aloes during the flowering season (i.e., probing flowers and feeding on buds, open flowers or seed pods). Birds feeding on nectar out of transect periods were also recorded (including pilot transects walked in 2005). Each species was classified into a broad feeding guild, i.e., frugivore, granivore, insectivore, nectarivore, omnivore, and also as a seasonal migrant or not, following Maclean (1993) and Hockey et al. (2005).

Some bird species occur in greater numbers than others and we calculated an abundance index for each species that accounted for inter-species abundance variations. This was the number of individuals of a species recorded each month as a proportion of the total number of individuals recorded for that species.

Pollen loads and visitation rates

To confirm the presence of *A. marlothii* pollen on particular species, we trapped birds using mist nets at two sites, 250 m apart, along a portion of the disused vehicle track in the aloe forest. Six nets (12 × 2.4 m, 4 shelf, 16 mm mesh 210 d/1 ply nets) were erected (0.6–3.0 m) on aluminium

poles (3 m) along a single stretch during each trapping session. Bird capture took place throughout the day (59.6 h during 9 days). Each bird was ringed and inspected visually for pollen deposited on the bill and feathers of the facial region. During flowering months, pollen swabs were collected from representatives of all species on which pollen was not immediately visible, using a piece of transparent adhesive tape that was dabbed on the bill, frons and throat region and then placed on a slide. The slide was later scanned for pollen under a light microscope at 10× magnification.

To determine visitation rates of birds to flowering *A. marlothii*, we selected 3–8 aloes of varying height within 15 m of a randomly chosen observation point. For each visitor, the time and species was recorded, whether or not it fed, and any interactions with other birds. Observations lasted for 10–45 min at each station, with sampling periods throughout the day during peak flowering in late August. For each species, we calculated the proportion of individuals that were observed feeding at different times of the day.

Results

Seasonal variation in community composition

We observed 83 species during censuses (Appendix), with both diversity and abundance peaking in August when nectar availability was greatest (Symes and Nicolson, unpublished data; Table 1, Fig. 1). Eight seasonal migrant species were present during summer and only one migrant species was present during the flowering period in August. During May–October, abundance was higher during the morning and afternoon sampling periods than at midday, whereas this pattern was not evident during February or March (Fig. 1). During flowering (August–September) the number of nectar feeding observations for each species was correlated with the overall abundance of each species (Spearman's $R = 0.836$, $P < 0.05$).

When we accounted for inter-species differences in abundance, there was no significant difference in abundance between months for all birds detected in the aloe forest during transects (Kruskal–Wallis, $P = 0.07$) (Fig. 2). However, when nectar feeders were treated separately there was a significant difference in abundance between months (Kruskal–Wallis, $P = 0.002$; Fig. 2).

Table 1 Number of bird species and individuals detected during transects (total and excluding migrants, $n = 9$) during February–March and May–October 2006

Month	Number of species		Number of individuals	
	Migrants included	Migrants excluded	Migrants included	Migrants excluded
February	52	46	954	771
March	48	44	980	802
May	48	48	892	892
June	42	42	694	694
July	45	44	1,074	1,065
August	**53**	**52**	**1,746**	**1,746**
September	47	45	745	727
October	50	46	632	579
Cumulative total	89	83		

Peak flowering month italicized. Totals also include unidentified species, e.g., francolin, cisticola, weaver, waxbill or canary species (see "Appendix")

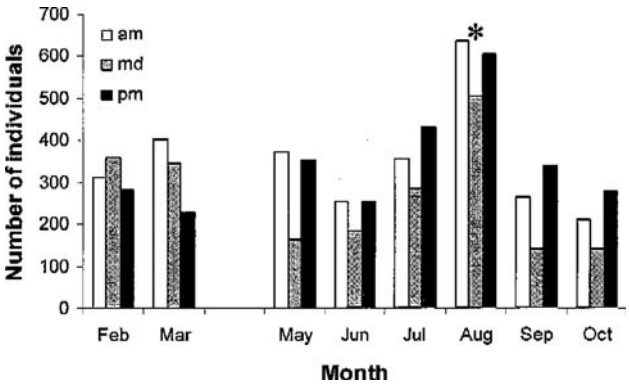

Fig. 1 Monthly bird abundance in an *Aloe marlothii* forest at Suikerbosrand Nature Reserve. Sampling took place in the morning (*am* 0600–1000 hours), midday (*md* 1000–1400 hours) or afternoon (*pm* 1400–1800 hours). An *asterisk* indicates *A. marlothii* peak flowering

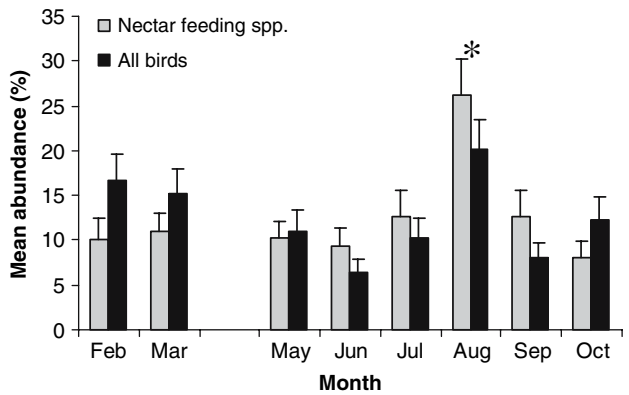

Fig. 2 Mean abundance (% ±SE) of birds recorded each month in the aloe forest at Suikerbosrand Nature Reserve. Monthly abundance for each species calculated as a percentage of total abundance for that species. *All birds* all species detected during transects; *Nectar feeders* only species recorded as *Aloe marlothii* nectar feeders. An *asterisk* indicates *A. marlothii* peak flowering

Floral visitors

During transects, 21 species were observed feeding on nectar. Another three species were recorded feeding on nectar out of transect periods and an additional seven species were seen feeding on nectar in 2005. Of 30 species caught, individuals of 26 species were found to have pollen on the facial area (15 with visible pollen, and 11 species with pollen detected from swabs). Seven species were classed as nectarivores from pollen swabs alone (Appendix); no pollen from other plant species was visible on the slides. A total of 38 species representing 19 families were thus recorded feeding on *A. marlothii* nectar during the study (Appendix). An additional four species known to feed on *A. marlothii* nectar, but not recorded doing so during the study, are also included in the Appendix (Oatley 1964; Oatley and Skead 1972). This gives a total of 42 occasional nectar feeders at the Suikerbosrand aloe "forest", representing 59.2% of the bird community present at the site in winter (migrants and transients excluded).

The proportion of individuals of various feeding guilds (frugivores, granivores, insectivores, nectarivores and omnivores) feeding on *A. marlothii* nectar varied significantly among sampling periods (Kruskal–Wallis, $P < 0.05$; Fig. 3). Overall visitation rates to aloes were highest in the morning for insectivores, nectarivores and omnivores (all insect eaters) but higher at midday for frugivores and granivores (Fig. 3). For all species combined there was a general decrease in feeding through the day.

The following seven species accounted for 86.4% of individuals seen feeding on nectar: African Red-eyed Bulbul *Pycnonotus nigricans* (36.6%), Cape Weaver *Ploceus capensis* (18.6%), Cape White-eye *Zosterops capensis* (9.0%), Red-faced Mousebird *Urocolius indicus* (7.9%), Southern Masked Weaver *Ploceus velatus* (5.7%), Fiscal Flycatcher *Sigelus silens* (4.3%) and Streaky-headed Seedeater *Serinus gularis* (4.3%). Three species (African Red-eyed Bulbul, Chestnut-vented Tit-babbler *Parisoma subcaeruleum* and Streaky-headed Seedeater) were observed feeding on *A. marlothii* fruit, and ten species were observed drinking water from *A. marlothii* leaves (Laughing Dove *Streptopelia senegalensis*, Fiscal Flycatcher, Black-throated Canary *Serinus atrogularis*, Black-collared Barbet *Lybius torquatus*, Common Scimitarbill *Rhinopomastus cyanomelas*, Ashy Tit *Parus cinerascens*, African Red-eyed Bulbul, Streaky-headed Seedeater, Cape Bunting *Emberiza capensis* and Black-faced Waxbill *Estrilda erythronotos*). A further two species were observed probing unopened flowers (unidentified canary species and Black-chested Prinia *Prinia flavicans*).

We did not observe any aggressive inter- or intra-specific interactions during sampling periods, but did observe male malachite sunbirds *Nectarinia famosa* chasing a female sunbird, an Ashy Tit, a Cape White-eye and a Laughing Dove at the study site during 2005 and 2006. Several bird species were often observed feeding on the same inflorescence, with larger species tending to displace smaller species.

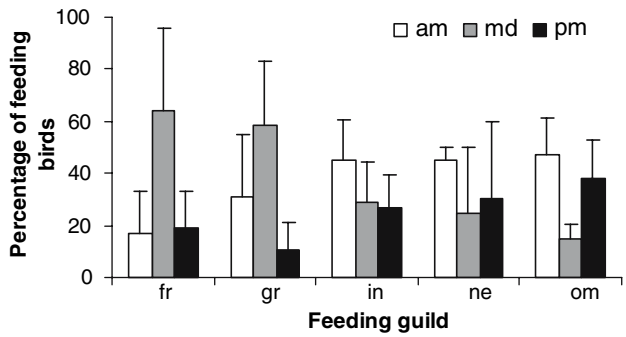

Fig. 3 Percentage of individuals belonging to various feeding guilds that were observed feeding on *Aloe marlothii* nectar at different time periods in a day at Suikerbosrand Nature Reserve (feeding guilds: *fr* frugivore, *gr* granivore, *in* insectivore, *ne* nectarivore, *om* omnivore). Values given as mean ±SE. Refer to Fig. 1 for times

Discussion

Nectar-feeding at a mass flowering event

The occurrence of numerous bird species, with half observed feeding on nectar at the mass flowering of *A. marlothii*, indicates that nectar is an important source of food and/or water for many occasional nectarivores during dry winters. The abundance of nectar-feeding bird species increased significantly when aloes flowered, with some species being present only during flowering months; e.g., Wattled Starling *Creatophora cinerea*, Red-winged Starling *Onychognathus morio* and Malachite Sunbird, which are known to migrate locally while tracking food resources (Skead 1967; Craig 1996; Fraser 1997; Symes et al. 2001). Also, the presence of Fairy Flycatcher *Stenostira scita*, Red-billed Oxpecker *Buphagus erythrorhynchus*, Cut-throat Finch *Amadina fasciata* and Golden-breasted Bunting *Emberiza flaviventris* only when aloes were in flower suggests that their arrival in the area was as occasional nectarivores.

Surprisingly, true nectarivores (sunbirds) did not respond significantly to the seasonal availability of *A. marlothii* nectar, possibly because the nectar concentration is too low to be attractive to specialist nectar feeders (Johnson and Nicolson, unpublished data). Moreover, populations of sunbirds may be equally distributed

throughout the range of flowering *A. marlothii*, resulting in more dispersed populations. Despite this, the occurrence of sunbirds in high densities at other patchy and transitory flowering events in South Africa is well recorded (see Harrison et al. 1997).

Other aloe species are likely to drive seasonal changes in avian communities like those we observed in *A. marlothii*. *Aloe ferox*, for instance, occupies a similar ecological niche and also offers large amounts of nectar to visitors during dry winter months when few other plants are flowering (Reynolds 1969; van Wyk and Smith 2003). The vertical racemes of *A. ferox* and the horizontal to slanting racemes of *A. marlothii* both offer copious volumes of dilute nectar (180 µl, 12.5% w/w and 250 µl, 12% w/w, respectively) (Hoffman 1988; Symes and Nicolson, unpublished data). Oatley and Skead (1972) recorded 28 and 26 bird species visiting *A. marlothii* and *A. ferox*, respectively. In both plants, the inflorescences are robust enough to support birds as large as Grey Go-away-birds *Corythaixoides concolor* and columbids (>250 g) (Oatley and Skead 1972; Symes and Nicolson, unpublished data). At least 360 *Aloe* species occur throughout the Afrotropical region (Jeppe 1969; Reynolds 1969; Glen and Hardy 2000). Flowering occurs at different times of the year, although in southern Africa there is a dominance of winter flowering aloes (Jeppe 1969; Reynolds 1969). Aloe nectar provided during seasonal mass flowering events is an important food and water source for a wide range of bird species (Oatley 1964; Skead 1967; Oatley and Skead 1972; Botes 2007).

A distinct bird community during flowering

In addition to an increase in avian diversity during the flowering period (up to 20%), there was a 2–3 fold increase in overall bird abundance. This occurred despite the absence of seasonal migrants, which were only present at the aloe forest in summer months when there was no nectar. Our data thus support the hypothesis that the availability of nectar in the *A. marlothii* forest is associated with significant changes in avian community diversity and abundance.

Species like African Red-eyed Bulbul, Cape Weaver, Cape White-eye, Red-faced Mousebird, Southern Masked Weaver, Fiscal Flycatcher and Streaky-headed Seedeater that accounted for most feeding observations were the species that increased in abundance during flowering. Chestnut-vented Titbabbler and Black-chested Prinia also increased in abundance during flowering, but because they were less common, were seen feeding less often. The importance of nectar for these species is supported by stable carbon isotope analysis, which indicates that nectar contributes up to 15% of their dietary carbon intake during the aloe flowering period (Symes, Woodborne, McKechnie and Nicolson, unpublished data).

The seasonal variation in avian diversity and abundance associated with nectar availability is similar to that observed in other systems. Woinarski and Tidemann (1991), for instance, identified distinct bird communities between the dry season, transitional months and wet season months in a Northern Australian woodland bird community. They also found that nectarivore density was strongly correlated with flower availability (Woinarski and Tidemann 1991). In monsoonal Australia, opportunistic nectarivory amongst birds occurs predictably at mass flowering events and during the cool dry season (Franklin 1999). In Perth (western Australia), a guild of honeyeaters (five species) responded to peaks in nectar production of a single plant species, *Banksia menziesii* (Proteaceae), with significantly more birds being observed during winter flowering (Ramsey 1989), and in a lowland Amazonian rainforest, seasonal fluctuations in resource abundance were closely correlated with variation in hummingbird species richness (~17 species) and abundance (Cotton 2006).

Niche partitioning and defending nectar resources

Insectivores are more likely than other guilds to practice occasional nectarivory (Paton 1986). A greater proportion of insect-eating birds (i.e., insectivores, omnivores, nectarivores) fed on nectar of *A. marlothii* in the morning. Frugivores and granivores (non-insect eaters) fed later, and although for each guild the differences are not statistically significant, the trend indicates some degree of temporal niche partitioning between insect and non-insect eaters in a day. Timewell and MacNally (2004) showed similar patterns for a guild of honeyeaters (ten species) feeding on winter flowering *Eucalyptus tricarpa*; the birds progressed from an almost exclusive nectar diet in the morning to increased insectivory later in the day. During cold mornings nectar is abundant but birds relying on insects are likely to experience difficulty finding food. Peak flowering of *A. marlothii* occurs at a time of low insect numbers, which possibly accentuates this separation (Symes and Nicolson, unpublished data). Different temporal feeding patterns between insect and non-insect eating guilds in a day, together with an abundant supply of nectar, lead to reduced competition for nectar and possible inter and intra-species aggressiveness.

There were more flowers available in the aloe forest than could be probed by birds; a flowering aloe produced,

on average, at least 860 ml of nectar (not accounting for destroyed flowers or replenished nectar in emptied flowers) (Symes and Nicolson, unpublished data). This mass flowering event is similar to the Jarrah forest site in Western Australia where the production of nectar of six plant species (e.g., Jarrah *Eucalyptus marginata*) between October and December could have supported more honeyeaters than were actually present (Collins and Newland 1986). In the aloe forest, few inter- and intra-specific aggressive interactions were observed; in contrast to those at other nectar sources frequented by sunbirds, honeyeaters and hummingbirds (e.g., Gill and Wolf 1975; Frost and Frost 1980; Ford 1981; Armstrong 1991; Cotton 1998). Temporal resource partitioning in nectarivores feeding at an *Agave marmorata* nectar oasis has been interpreted as a way to reduce risk of injury (Ornelas et al 2002). At our study site, temporal feeding patterns in a day were probably caused by responses to daily insect activity, rather than competition for nectar resources.

Concluding remarks

Community changes at our study site contrast with other studies in that the birds that arrived in the area in response to increased nectar availability were almost all occasional or generalist nectarivores rather than specialist nectarivores such as sunbirds. This observation may be related to nectar preferences: whereas specialist avian nectarivores tend to prefer nectars of relatively low volume (c.10–30 µl) and high concentration (c.15–25% w/w), generalist nectarivores prefer nectar of large volumes (c.40–100 µl) and low concentrations (c.8–12%) (Johnson and Nicolson, unpublished data). A second, and not mutually exclusive, possibility is that these patterns reflect variation in avian nectarivore species richness at a global scale: whereas the Neotropical (324 hummingbird species) and Australasian (159 honeyeaters) regions have large, speciose nectarivore radiations, the Afrotropical (78 sunbirds and 2 sugarbirds) and Indomalayan (39 sunbirds and 10 honeyeaters) regions do not (Maclean 1990).

Zusammenfassung

Reaktion von nektarivoren Vögeln auf das Blühen von *Aloe marlothii*: Eine Nektaroase während trockener südafrikanischer Winter

In Südafrika blüht *Aloe marlothii* während der trockenen Wintermonate und bietet reichlich Nektar für eine Vielzahl von Vögeln. Abundanz und Zusammensetzung der Vogelgesellschaften wurde untersucht in einem *A. marlothii* Wald im Suikerbosrand Nature Reserve in Südafrika. Die Datenaufnahme fand in zwei Sommermonaten (Februar–März) statt, wenn keine Blüten vorhanden sind und während sechs Monaten im Winter (Mai–Oktober) zur Zeit der Winterblüte. Unsere Hypothese war, dass ein Zustrom von zeitweilig nektarivoren Vögeln in den *A. marlothii* Wald während der Blüte zu signifikanten Veränderungen in der Vogelgesellschaft führen würde. Die Abundanz von Vögeln stieg auf das 2- bis 3-fache zu Spitzenzeiten der Verfügbarkeit von Nektar im August. 38 der insgesamt 83 Vogelarten bei den Transektenzählungen nutzen *A. marlothii* Nektar. Diese Vögel gehörten 19 verschiedenen Familien an, unter anderem Lybiidae, Coliidae, Pycnonotidae, Sylviidae, Cisticolidae, Muscicapidae, Sturnidae, Ploceidae und Fringillidae. Erstaunlicherweise wurden nur zwei Arten von Nektarvögeln (Nectariniidae) bei der Nahrungsaufnahme an *A. marlothii* beobachtet, und beide waren nicht häufig. Wir nahmen an, dass der Wettbewerb um Nektar-Ressourcen hoch sein sollte, doch beobachteten wir nur wenige aggressive inter- und intraspezifische Interaktionen zwischen Vögeln bei der Nahrungsaufnahme an den Blüten. Während der Hauptzeit der Blüte gingen Vögel, die Insekten fressen (Insektivore, Omnivore und Nektarivore) während des kalten Morgens an die Blüten, wenn die Aktivität der Insekten niedrig war. Vögel, die keine Insekten fressen (Frugivore und Granivore) gingen dagegen am Mittag an die Blüten. Unsere Studie unterstreicht die Wichtigkeit von *A. marlothii* Nektar als eine saisonale Nahrungs- und Wasserquelle für verschiedenste zeitweilige nektarivore Vogelarten.

Acknowledgments Bird ringing was conducted under authority of Safring and permit from the Gauteng Department of Agriculture, Conservation and the Environment (GDACE; permit number: 0454 and 0472); GDACE are also thanked for access to the study site. Bird handling techniques were approved by the University of Pretoria Ethics Committee (Ref: EC 050912-019). The South African National Research Foundation and University of Pretoria are thanked for project funding. Darren Pietersen and Tracy Young gave invaluable assistance in the field. Professor Adrian Craig and an anonymous referee gave valuable input into revising the paper for publication.

Appendix

Table 2

Table 2 Bird species (n = 85) recorded during transects (February–March, May–October) in the *Aloe marlothii* forest, western Suikerbosrand Nature Reserve

Species	Nectar	Status	Feb	Mar	May	Jun	Jul	*Aug*	Sep	Oct	Total
Phasianidae											
Swainson's Spurfowl *Pternistis swainsonii*	–	–	4	3	17	5	23	*0*	1	1	54
Numididae											
Helmeted Guineafowl *Numida meleagris*	–	–	0	1	0	–	–	–	–	1	2
Anatidae											
Egyptian Goose *Alopochen aegyptiaca*	–	tr	–	–	–	–	2	–	–	–	2
Spur-winged Goose *Plectropterus gambensis*	–	tr	–	–	–	–	–	–	–	1	1
Indicatoridae											
Greater Honeyguide *Indicator indicator*	–	–	–	–	–	–	–	–	–	0	0
Lesser Honeyguide *Indicator minor*	s,2	–	–	1	–	–	–	*1*	–	–	2
Picidae											
Red-throated Wryneck *Jynx ruficollis*	–	–	1	2	0	0	0	*1*	0	2	6
Cardinal Woodpecker *Dendropicos fuscescens*	s	–	0	0	2	0	4	*0*	0	4	10
Lybiidae											
Acacia Pied Barbet *Tricholaema leucomelas*	t,p,1,2	–	11	12	7	6	4	*9*	2	12	63
Black-collared Barbet *Lybius torquatus*	p,1,2	–	0	3	0	1	7	*0*	1	0	12
Crested Barbet *Trachyphonus vaillantii*	t,2	–	2	16	4	4	0	*6*	5	1	38
Upupidae											
African Hoopoe *Upupa africana*	–	mig	–	1	–	–	–	–	–	–	1
Phoeniculidae											
Green Wood-Hoopoe *Phoeniculus purpureus*	–	–	–	–	–	–	–	–	–	1	1
Rhinopomastidae											
Common Scimitarbill *Rhinopomastus cyanomelas*	t,1,2	–	4	3	2	6	2	*6*	9	2	34
Coliidae											
Speckled Mousebird *Colius striatus*	t,p,1,2	–	0	–	–	1	0	*6*	–	–	7
Red-faced Mousebird *Urocolius indicus*	t,p,1,2	–	0	31	96	0	5	*166*	43	13	354
Cuculidae											
Diderick Cuckoo *Chrysococcyx caprius*	–	mig	1	–	–	–	–	–	–	–	1
Apodidae											
Little Swift *Apus affinis*	–	tr	2	–	–	–	–	–	10	6	18
White-rumped Swift *Apus caffer*	–	mig	29	–	–	–	9	–	3	2	43
Columbidae											
Rock Dove *Columba livia*	–	tr	–	–	–	–	7	*1*	–	–	8
Speckled Pigeon *Columba guinea*	–	tr	59	1	2	2	5	–	–	–	70
Laughing Dove *Streptopelia senegalensis*	s,1,2	–	327	323	380	424	736	*561*	310	191	3,252
Cape Turtle-Dove *Streptopelia capicola*	1	–	–	–	0	4	0	*1*	0	–	5
Red-eyed Dove *Streptopelia semitorquata*	–	–	–	–	1	–	–	–	–	–	1
Charadriidae											
Crowned Lapwing *Vanellus coronatus*	–	tr	–	–	–	–	–	–	0	–	0
Laridae											
Grey-headed Gull *Larus cirrocephalus*	–	tr	–	–	2	–	–	–	–	–	2
Accipitridae											
Black-shouldered Kite *Elanus caeruleus*	–	–	3	2	–	–	–	*1*	–	2	8
Pallid Harrier *Circus macrourus*	–	tr	–	4	–	–	–	–	–	–	4
Steppe Buzzard *Buteo vulpinus*	–	mig	2	–	–	–	–	–	–	1	3
Jackal Buzzard *Buteo rufofuscus*	–	–	4	–	1	1	1	–	–	–	7

Table 2 continued

Species	Nectar	Status	Feb	Mar	May	Jun	Jul	*Aug*	Sep	Oct	Total
Falconidae											
Amur Falcon *Falco amurensis*	–	mig	3	83	–	–	–	–	–	–	86
Threskiornithidae											
Hadeda Ibis *Bostrychia hagedash*	–	–	–	–	–	–	–	*0*	0	1	1
Malaconotidae											
Brubru *Nilaus afer*	–	–	–	0	0	0	–	*0*	0	1	1
Brown-crowned Tchagra *Tchagra australis*	s	–	10	8	3	1	6	*1*	12	3	44
Bokmakierie *Telophorus zeylonus*	–	–	0	0	4	1	2	*1*	5	4	17
Chinspot Batis *Batis molitor*	–	–	–	–	1	0	0	*0*	0	0	1
Corvidae											
Pied Crow *Corvus albus*	2	–	–	–	–	–	–	*5*	0	1	6
Laniidae											
Common Fiscal *Lanius collaris*	o	–	–	1	0	2	1	*3*	4	5	16
Paridae											
Ashy Tit *Parus cinerascens*	–	–	5	1	4	3	6	*1*	3	4	27
Hirudinidae											
Barn Swallow *Hirundo rustica*	–	mig	143	92	–	–	–	–	–	21	256
Greater Striped Swallow *Hirundo cucullata*	–	mig	5	–	–	–	–	–	15	29	49
Pycnonotidae											
African Red-eyed Bulbul *Pycnonotus nigricans*	t,p,2	–	51	73	87	50	59	*403*	65	96	884
Sylviidae											
Fairy Flycatcher *Stenostira scita*[a]	–	mig	–	–	–	–	–	*2*	–	–	2
Cape Grassbird *Sphenoeacus afer*	s	–	–	–	–	–	–	–	–	–	–
Long-billed Crombec *Sylvietta rufescens*	s,1	–	0	–	–	–	–	–	1	0	1
Willow Warbler *Phylloscopus trochilus*	–	mig	–	2	–	–	–	–	–	–	2
Chestnut-vented Tit-Babbler *Parisoma subcaeruleum*	t,p,2	–	3	6	1	6	3	*14*	7	8	48
Zosteropidae											
Cape White-eye *Zosterops capensis*	t,p,1,2	–	10	2	18	6	21	*63*	14	25	159
Cisticolidae											
Rattling Cisticola *Cisticola chiniana*	o,1	–	7	9	2	1	–	–	4	1	24
Neddicky *Cisticola fulvicapilla*	s,1	–	–	–	5	6	3	*4*	4	8	30
Black-chested Prinia *Prinia flavicans*	t,p	–	23	22	17	6	9	*19*	17	8	121
Bar-throated Apalis *Apalis thoracica*	t,p	–	0	2	5	1	2	*6*	2	0	18
Muscicapidae											
Cape Rock-Thrush *Monticola rupestris*	t	–	4	–	–	–	1	*2*	4	0	11
Karoo Thrush *Turdus smithi*	–	–	1	–	–	–	–	–	–	0	0
Marico Flycatcher *Bradornis mariquensis*	–	–	–	1	–	–	–	–	–	–	1
Fiscal Flycatcher *Sigelus silens*	t,p,1,2	–	27	74	59	29	32	*93*	68	71	453
Cape Robin-Chat *Cossypha caffra*	tp	–	4	16	5	7	6	*6*	5	18	67
Kalahari Scrub-Robin *Cercotrichas paena*	–	–	–	–	1	–	1	–	–	–	2
Familiar Chat *Cercomela familiaris*	–	–	–	1	2	–	–	–	1	–	4
Sturnidae											
Red-winged Starling *Onychognathus morio*	1,2	–	–	–	–	–	–	*2*	–	–	2
Cape Glossy Starling *Lamprotornis nitens*	o,2	–	–	–	–	–	–	–	–	–	–
Wattled Starling *Creatophora cinerea*	t,p	–	–	–	–	–	–	*3*	–	–	3
Red-billed Oxpecker *Buphagus erythrorhynchus*	–	–	–	–	–	–	–	*1*	–	–	1
Nectariniidae											
Malachite Sunbird *Nectarinia famosa*	t	–	–	–	–	–	–	*18*	5	–	23

Table 2 continued

Species	Nectar	Status	Feb	Mar	May	Jun	Jul	*Aug*	Sep	Oct	Total
White-bellied Sunbird *Cinnyris talatala*	t	–	–	–	–	–	3	*8*	–	0	11
Ploceidae[b]											
Cape Weaver *Ploceus capensis*	t,p,2	–	–	–	–	–	1	*76*	38	0	115
Southern Masked-Weaver *Ploceus velatus*	t,p,1	–	12	1	33	25	18	*55*	6	6	156
Southern Red Bishop *Euplectes orix*	–	–	2	–	–	–	–	–	–	–	2
Red-collared Widowbird *Euplectes ardens*	t	–	22	2	1	–	–	*3*	–	–	28
Estrildidae											
Cut-throat Finch *Amadina fasciata*	–	–	–	–	–	–	–	*2*	–	–	2
Black-faced Waxbill *Estrilda erythronotos*	t,p	–	5	2	2	21	14	*16*	–	–	60
Common Waxbill *Estrilda astrild*	2	–	4	–	–	3	–	–	–	–	7
Violet-eared Waxbill *Granatina granatina*	s	–	–	1	1	8	–	*2*	1	–	13
Green-winged Pytilia *Pytilia melba*	s	–	8	3	1	10	3	*1*	0	3	29
Jameson's Firefinch *Lagonosticta rhodopareia*	s	–	–	–	4	0	1	*1*	–	–	6
Viduidae[b]											
Dusky Indigobird *Vidua funerea*	–	–	3	–	–	–	–	–	–	–	3
Pin-tailed Whydah *Vidua macroura*	–	–	11	17	2	–	–	–	–	–	30
Long-tailed Paradise-Whydah *Vidua paradisaea*	–	–	8	12	2	–	–	–	–	–	22
Passeridae											
Southern Grey-headed Sparrow *Passer diffusus*	s,2	–	4	5	10	2	12	*4*	2	7	46
Fringillidae											
Black-throated Canary *Serinus atrogularis*	t	–	22	15	4	3	19	*4*	2	6	75
Yellow Canary *Serinus flaviventris*	–	–	5	9	4	2	–	*4*	4	–	28
Streaky-headed Seedeater *Serinus gularis*	t,1,2	–	–	3	5	1	1	*10*	13	17	50
Cinnamon-breasted Bunting *Emberiza tahapisi*	–	–	–	–	–	–	0	–	–	–	0
Cape Bunting *Emberiza capensis*	t	–	15	16	11	13	12	*10*	17	4	98
Golden-breasted Bunting *Emberiza flaviventris*	–	–	–	–	–	–	–	*1*	–	–	1
Total species	42	17	48	45	45	39	42	*51*	44	48	83

Abundance (total number) of birds indicated, 0 indicates species was heard only. August italicized as peak flowering time. Taxonomy follows Hockey et al. (2005)

[a] Fairy Flycatcher *Stenostira scita* is recorded as a migrant, but included in calculations since it arrives in the region (aloe forest) during the winter months

[b] Decreases in abundance of certain Ploceidae and Viduidae are likely due to certain species being less conspicuous in non-breeding eclipse plumages during the non-breeding season

Nectar: *t* feeding on nectar during transects, *s* pollen recorded on captured birds from swabs of facial area, *p* pollen observed on facial area of birds in aloe forest, *o* birds observed feeding on nectar out of transect times, and species known to feed on aloe nectar, *1* Oatley (1964), *2* Oatley and Skead (1972). Birds with pollen visible on the face were not swabbed. Status: *tr* all birds were observed perched in the aloe forest unless indicated as transients flying over, *mig* or seasonal migrants

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