THE SUNBIRD

Journal of the
QUEENSLAND ORNITHOLOGICAL SOCIETY
Birds Queensland

Volume 40 Number 2 December 2010

SUNBIRD 40(2)DECEMBER 2010

VOLUME 40 NUMBER 2

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THE SUNBIRD

Volume 40 No. 2 December 2010

DUCK DIVERSITY IN GREATER BRISBANE: NATIVE SPECIES, DOMESTIC RACES AND THE INFLUENCE OF FEEDING

RENEE CHAPMAN and DARRYL JONES

ABSTRACT

To investigate if feeding ducks affects their abundance and diversity in Greater Brisbane, 56 urban lakes were surveyed between December 2009 and February 2010. A total of 687 native ducks of seven species was recorded at 41 of the lakes (73.2%) surveyed. The commonest species was Pacific Black Duck *Anas superciliosa* which contributed 520 of all (75.7%) native ducks. A total of 101 domesticated ducks was counted at 15 lakes (26.8%) in flock sizes up to a maximum of 21.

No significant difference was found between the numbers of ducks at urban lakes associated with regular feeding by people and the numbers present at lakes where ducks were not fed, although, most ducks of domestic races were absent from lakes where no one fed them. Numbers of native ducks counted at lakes whether people fed them, or not, did not differ significantly. Compared with analogous surveys conducted in 2002-3 by Sinden *et al.* (2003) native ducks were approximately half as abundant. Possible reasons for these findings are explored.

INTRODUCTION

Although accelerating urbanisation is largely catastrophic for much local biodiversity, a proportion of native species have been able to tolerate the associated changes and, in some cases, adapt to the new conditions (Marzluff *et al.* 2001; DeStefano & DeGraaf 2003; Jones 2003; Garden *et al.* 2006; Shochat *et al.* 2006; Williams *et al.* 2006; Catterall *et al.* 2010). One such group are the ducks, certain species of which have been particularly

successful at exploiting the numerous opportunities provided in urban areas (Frith 1967). Most urban areas contain parklands and reserves set aside for passive recreation, green space and conservation, almost all of which contain ponds, streams and lakes. These urban water bodies vary greatly in area, design and purpose but many also attract native water birds with several duck species being among the most conspicuous (Sinden *et al.* 2003).

Large numbers of people utilise these areas for a variety of activities (Stoianov *et al.* 2000; Klessig 2001; Hadwen *et al.* 2005). Urban lakes are also the setting for one of the most universal and popular forms of human-wildlife interaction: wild bird feeding (Rollinson *et al.* 2003; Jones & Reynolds 2008; Chapman & Jones 2009). Duck feeding, in particular, appears to occur wherever these birds are encountered and involves both incidental and intentional forms of feeding (Howard & Jones 2004); the items provided may be surplus picnic food or large amounts of edible material purchased or prepared especially for the purpose (Chapman & Jones 2009; Chapman & Jones in press).

Despite the ubiquity of duck feeding, remarkably little is known about its effects or impacts, positive or negative, on ducks or on urban lake ecosystems more generally. Nonetheless, concern about the more general phenomenon of wildlife feeding continues to grow, with issues such as dependence, inadequate nutrition, the spread of disease and aggressive interactions with humans often being raised by opponents and management agencies (Orams 2002; Ishigame & Baxter 2007; Seeney 2010). Proponents, on the other hand, point out that none of these issues have been found to be common anywhere and that the benefits of such intimate contact with wild animals far outweigh any localised impacts (Ulrich 1981; Miller 2005; Dunn *et al.* 2006; Jones & Reynolds 2008). These debates are, however, almost always deficient in reliable data (Rollinson *et al.* 2003).

The potential impacts of duck feeding are of particular concern to managers of urban lakes (Seeney 2010). This issue joins two others on their agenda: the translocation of domestic ducks, and the risk of hybridization with native species (Braithwaite & Miller 1975; Skira & Smith 1991; Mallick & Driessen 2003; Sinden *et al.* 2003; Guay & Tracey 2009). All of these issues are relevant to the urban lakes of south-east Queensland, where human population growth is increasing visitation rates to parks and reserves (Queensland Government Department of Inrastructure and Planning 2010). Valuable base-line data on duck biodiversity and the presence of domestic

races was obtained during an extensive survey of the region's urban lakes during 2002-3 (Sinden *et al.* 2003). The occurrence of duck feeding was not, however, included in the earlier survey. More recent studies (Chapman & Jones 2009, 2010, in press), however, have demonstrated clearly that both duck feeding and the domestic ducks are widespread throughout Greater Brisbane. Any association between these two features has yet to be investigated.

The main objective of the present study was to undertake a comprehensive survey of duck biodiversity on urban lakes throughout Greater Brisbane, following the six-year interval since Sinden *et al.* (2003). Furthermore, attention was paid to the presence of domestic species and especially the occurrence of duck feeding. We were particularly interested in discerning any association between feeding activities and the abundance of ducks, both native and domestic.

METHODS

Accessible freshwater water bodies on public lands throughout the Greater Brisbane region were identified on Google Maps. From these a total of 56 lakes were selected and visited between December 2009 and February 2010. This included almost half (44.2%) of the lakes surveyed by Sinden *et al.* (2003)

Where possible the surface of the lake was surveyed from all angles to maximise coverage. All native and domestic waterfowl were identified and counted although only ducks (Anatidae) are reported here. Native species were readily identified but specification of domestic races was not attempted. Although Sinden *et al.* (2003) attempted to distinguish between these forms, our recent results suggest crossbreeding is widespread.

The capacity of sites to allow or facilitate duck feeding was gauged by noting both direct and indirect signs of feeding (people distributing items, bread in the water etc) as well as the presence of structures typically associated with the activity such as picnic tables and lawns adjacent to the water body. Previous studies (Chapman & Jones 2009, in press) had found that feeding was frequently associated with urban lakes that facilitated picnicking and the edge of the water bodies was directly accessible. Conversely, lakes without access to the water's edge or without picnic facilities were rarely visited by people seeking to feed ducks. All lakes were classed in relation to the capacity of the site to facilitate duck feeding: Minimal (no picnicking

structures, access difficult, no evidence of feeding); Moderate (limited facilities, some access to the lake edge, some evidence of feeding); or High feeding capacity (extensive picnicking facilities, feeding observed directly, ducks seeking food).

RESULTS

A total of 56 urban lakes distributed widely throughout the entire Greater Brisbane region were surveyed during the study. Of these, 15 were found not to support any ducks at the time of the survey and were removed from further examination, leaving a total of 41 lakes. Of these, 40 (97.5%) supported native species and 15 (36.6%) supported domestic species. Only 14 lakes had both native and domestic ducks present.

Seven species of native duck were detected although the highest species richness for any individual lake was only four; on average a typical urban lake supported only two or three native species (Table 1). Pacific Black Duck were by far the most abundant and widespread species, making up 65.9% of all ducks recorded and being detected on all but one of the lakes. Australian Wood Ducks were the second most abundant (Table 1), comprising 14.9% of all ducks recorded but being found on only 17 of the lakes surveyed.

A total of 101 individual domestic ducks of various races was detected on 15 lakes, and made up 12.7% of all ducks detected. Most of these lakes supported relative small (1-8) numbers of domestic ducks with the largest aggregations being 15 (both Minnippi Parklands, Tingalpa and Underwood Park, Priestdale) and 21 present at Harold Kelly Park, Bracken Ridge.

The present survey recorded about half the number of native ducks detected in 2002-3 (Table 1), with all species occurring in lower numbers. Both Pacific Black Duck and Australian Wood Duck numbers were almost exactly half (49.4% and 50.6% respectively) that of the previous survey. Numbers of all other native species were dramatically lower compared to the previous survey: only 3.1% of Hardhead and 2.8% of Grey Teal numbers, both abundant species in 2003-9, were detected in 2009-10 (Table 1). The numbers of domestic ducks detected, however, were only slightly less than those recorded in the earlier survey (Table 1).

Feeding was detected at 33 of the 41 lakes surveyed, with 26 of these being classed as having High feeding capacity and the remaining seven as

Table 1. Comparison of two surveys in Greater Brisbane; this survey (2009-10) and the (2002-03) survey by Sinden (2003).

Survey	**2009-10**			**2002-3**		
Number of Lakes	Total			Total		
Surveyed	56	-	-	50	-	-
Native ducks present	40	-	-	40	-	-
Domestic ducks present	15	-	-	15	-	-
Native and domestic ducks	14	-	-	40	-	-
Ducks	**Total**	**Mean**	**Range**	**Total**	**Mean**	**Range**
Pacific Black Duck *Anas superciliosa*	520	12.67	0-78	1052	25.12	0-86
Australian Wood Duck *Chenonetta jubata*	118	2.87	0-20	233	5.55	0-30
Hardhead *Aythya australis*	30	0.73	0-7	965	22.91	0-92
Grey Teal *Anas gracilis*	8	0.19	0-5	282	6.64	0-192
Chestnut Teal *Anas castanea*	6	-	0-6	86	2.15	0-37
Wandering Whistling-Duck *Dendrocygna arcuata*	2	-	0-2	23	0.66	0-16
Plumed Whistling-Duck *Dendrocygna eytoni*	3	-	0-3	12	-	0-12
Total						
Native species	7	2.7	0-4	7	1.6	0-4
Native ducks	687	16.75	0-51	1422	33.91	0-223
Domestic ducks	101	2.46	0-21	149	3.55	0-43

Moderate; only eight lakes were classed as Minimal, with no evidence of feeding or associated facilities (Table 2). Fully 82.19% of domestic ducks detected were associated with High capacity feeding sites, with 16.83% being found at Moderate sites. Only a single domestic duck was detected at any Minimal site. For native ducks, 74.5% were found at High feeding sites, 10.3% at Moderate sites but 15.1% (104 ducks) were found at sites with little or no feeding. The proportions were significantly different ($x^2 = 15.91$, d.f. = 2, $p<0.05$) with the pertinent component of the comparison being the unexpectedly low numbers in Minimal feeding sites.

Table 2. Numbers of ducks counted at urban lakes where they were minimally, moderately or highly fed in Greater Brisbane.

Feeding Rate	Minimal	Moderate	High
Numbers of lakes (n=40)	8	7	26
Native ducks	104	71	512
Domestic ducks	1	17	83
Total ducks	105	88	587

DISCUSSION

The urban lakes of Greater Brisbane surveyed during the present study supported large numbers of native ducks of seven species, although no individual lake contained more than four species. The Pacific Black Duck was by far the most abundant of the native species, although both Australian Wood Duck and Hardhead were also present in good numbers though much patchier in distribution. The other native species detected occurred in considerably lower numbers. The species encountered and their relative proportions were similar to the findings of Sinden *et al.* (2003) conducted six years earlier, though the total number of all species were only half that of the earlier study. Australian waterbirds are well known for their nomadic and unpredictable movements, especially in response to rain (Frith 1967). The most plausible immediate explanation for the greatly reduced numbers of ducks between the two studies is climatic, with the 2002-3 survey being conducted at the height of a prolonged drought while the present study was undertaken several years after the drought had broken. During periods of extended drought urban areas represent oases of relative abundance and often attract significant numbers of birds normally found further inland (Marchant & Higgins 1990). This was certainly the case with waterbirds with many inland water sources including farm dams drying up during the early part of the decade. With the return of water to the inland, large proportions of most species left the urban environment presumably to disperse to many of newly filled water bodies now located through the region and beyond. The fact that relatively large proportions of both Pacific Black Ducks and Australian Wood Ducks remained in Greater Brisbane (Sinden *et al.* 2003; Chapman & Jones 2009) supports numerous indications that these are among the most successfully urbanised waterbirds in Australia.

The survey found that many urban lakes continued to support various domestic duck races, with similar numbers being detected as were present six

years earlier. As was suggested by Sinden *et al.* (2003), the source of most or all of these clearly domesticated (as opposed to feral) ducks is almost certainly that of farms with the birds being translocated possibly following the drying up of farm dams. What is not known is the capacity for these birds to disperse away from the places where they have been deposited. While domesticated forms of the Mallard appear not to move away from urban areas, their capacity for hybridization with Pacific Black Ducks remains a significant concern (Braithwaite & Miller 1975; Sinden *et al.* 2003; Guay & Tracey 2009).

As with our recent studies from Brisbane (Chapman & Jones 2009, in press) the feeding of ducks was found to be a common and widespread past-time in the surveyed lakes, with over 80% having direct evidence of feeding. Significantly, a clear majority of domestic ducks occurred on lakes with high levels of feeding, while lakes without feeding were effectively devoid of domestics. In contrast, while native species – especially Pacific Black Ducks – were seen in large numbers at high feeding sites, this species were also abundant at moderate and minimal feeding sites. This certainly suggests a positive relationship between high levels of feeding and the presence of domestic ducks. However, while tempting to suggest a causal association between feeding and these birds, the complete explanation is likely to be more complex that expected.

First, the co-occurrence of high levels of feeding and large numbers of domestic ducks may simply be a result of the popularity or accessibility of the site to both prospective feeders and people seeking a location to 'dump' their unwanted waterfowl. Indeed, witnessing people actively feeding ducks may be a strong incentive to deposit the birds at such a site. Second, the presence of domestic ducks may actually encourage increased levels of feeding. Certainly, our observations and anecdotal accounts strongly suggest that many people are particularly attracted to 'farmyard' ducks, especially the white races.

Finally, the presence of domestic ducks at locations where feeding by people is frequent and predictable may be indicative of places where these probably domesticated and likely human-dependant birds are more likely to have survived. If our contention that many of these ducks are reluctant refugees from local farms is correct, they will almost certainly have been raised on food supplied daily by humans. While these ducks obviously do forage on naturally occurring foods as well (Chapman & Jones in press), equally they

are demonstrably able to dominate access to the bread that is provided by willing feeders.

The findings of this study further emphasises the many issues that remain to be addressed with respect to the influence of feeding on the ecology and survival of native and domestic ducks.

ACKNOWLEDGEMENTS

This study was undertaken as part of a summer scholarship provided by the Environmental Futures Centre, Griffith University. Thanks to James Wilson and David Rounsevell for comments on early versions of this paper and Mrs Dawn Muir who refereed the manuscript.

REFERENCES

BRAITHWAITE, L. W. & MILLER, B. (1975). The Mallard, *Anas platyrhynchos,* and Mallard-Black Duck, *Anas superciliosa rogersi,* Hybridization. *Australian Wildlife Research* **2**(1): 47-61.

CATTERALL, C. P., COUSIN, J. A., PIPER, S. & JOHNSON, G. (2010). Long-term dynamics of bird diversity in forest and suburb: decay, turnover or homogenization? *Diversity and Distributions*.

CHAPMAN, R. & JONES, D. N. (2009). Just Feeding the Ducks: Quantifying a Common Wildlife-Human Interaction. *Sunbird* **39**(2): 19-28.

CHAPMAN, R. & JONES, D. (2010). Should we be worried about all that duck feeding? *Rosella Ramblings*: 4.

CHAPMAN, R. & JONES, D. N. (in press). Foraging by native and domestic ducks in urban lakes: behavioural implications of all that bread. *Corella*.

DeSTEFANO, S. & DeGRAAF, R. M. (2003). Exploring the ecology of suburban wildlife. *Frontiers in Ecology and the Environment* **1**(2): 95-101.

DUNN, R. R., GAVIN, M. C., SANCHEZ, M. C. & SOLOMON, J. N. (2006). The Pigeon Paradox: Dependence of Global Conservation on Urban Nature. *Conservation Biology* **20**(6): 1814-1816.

FRITH, H. J. (1967). Waterfowl in Australia. Sydney, Angus & Robertson.

GARDEN, J., McALPINE, C., PETERSON, A., JONES, D. & POSSINGHAM, H. (2006). Review of the ecology of Australian urban fauna: A focus on spatially explicit processes. *Austral Ecology* **31**: 126-148.

GUAY, P. J. & TRACEY, J. P. (2009). Feral mallards: a risk of hybridisation with wild Pacific black ducks in Australia. *Victorian Naturalist* **126**: 87-91.

HADWEN, W. L., ARTHINGTON, A. H., BOON, P. I., LEPESTEUR, M. & McCOMB, A. J. (2005). Rivers, streams, lakes and estuaries: hot spots for cool recreation and tourism in Australia. CRC for Sustainable Tourism, Southport.

HOWARD, P. & JONES, D. N. (2004). A qualitative study of wildlife feeding in south-east Queensland. In: *Urban Wildlife: More than Meets the Eye*. (Eds. M. D. Chassell & D. Lunney). Royal Zoological Society of New South Wales, Sydney.

ISHIGAME, G. & BAXTER, G. S. (2007). Practice and attitudes of suburban and rural dwellers to feeding wild birds in Southeast Queensland, Australia. *Ornithological Science* **6**: 11-19.

JONES, D. N. (2003). Contemporary urban ecology: the view from the Antipodes. In: *Ecosystems and Sustainable Development IV Volume 2*. (Eds. Tezzi, E., Brebbia, C. A. and Uso, J. L.), WIT Press, Southampton. Pp**.** 745-753.

JONES, D. N. & REYNOLDS, S. J. (2008). Feeding birds in our towns and cities: a global research opportunity. *Journal of Avian Biology* **39**: 265-271.

KLESSIG, L. L. (2001). Lakes and Society: The contribution of lakes to sustainable societies. *Lakes and Reservoirs: Research and Management* **6**: 95-101.

MALLICK, S. A. & DRIESSEN, M. M. (2003). Feeding of Wildlife: How Effective are the 'Keep Wildlife Wild' signs in Tasmania's National Parks? *Ecological Restoration and Management* **4**(3): 199-204.

MARCHANT, S. & HIGGINS, P. J. (1990). *Handbook of Australian, New Zealand & Antartctic Birds Vol. 1B*. Oxford University Press, Melbourne.

MARZLUFF, J. M., BOWMAN, R. & DONNELLY, R. (2001). A historical perspective on urban bird research: trend, terms, and approaches. In: *Avian ecology and conservation in an urbanizing world*. Eds. Marzluff, J. M., Bowman, R. and Donnelly, R. Kluwer Academic**,** Norwell. Pp**.** 1-17.

MILLER, J. R. (2005). Biodiversity conservation and the extinction of experience. *Trends in Ecology & Evolution* **20**(8): 430-434.

ORAMS, M. B. (2002). Feeding wildlife as a tourism attraction: a review of issues and impacts. *Tourism Management* **23**(3): 281-293.

QUEENSLAND DEPARTMENT OF INRASTRUCTURE AND PLANNING. (2010). *South East Queensland* Retrieved 06/07/2010, on http://www.dip.qld.gov.au/seq.

ROLLINSON, D. J., O'LEARY, R. & JONES, D. (2003). The Practice of Wildlife Feeding in Suburban Brisbane. *Corella* **27**(2): 52-58.

SEENEY, B. (2010).Wild ducks killed by kindness. *South-East Advertiser*. 17 March 2010.9

SHOCHAT, E., WARREN, P. S., FAETH, S. H., McINTYRE, N. E. & HOPE, D. (2006). From patterns to emerging processes in mechanistic urban ecology. *Trends in Ecology and Evolution* **21**: 186-191.

SINDEN, K., O'LEARY, R. & JONES, D. (2003). Domestic and Native Ducks within Brisbane City: Interbreeding and other Implications. Report for Environment and Parks Brisbane City Council. Surburban Wildlife Research Group, Griffith University, Nathan.

SKIRA, I. & SMITH, S. (1991). Feeding Wildlife in National Parks. 5th Australasian Regional Seminar in National Parks and Wildlife Management. Cradle Mountain National Park.

STOIANOV, I., CHAPRA, S. & MAKSIMOVIC, C. (2000). A framework linking urban park land use with pond water quality. *Urban Water* **2**(1): 47-62.

ULRICH, R. S. (1981). Natural Versus Urban Scenes: Some Psychophysiological Effects. *Environment and Behaviour* **13**: 523-556.

WILLIAMS, N. S. G., McDONNELL, M. J., PHELAN, G. K., KEIM, L. D. & REE, R. V. D. (2006). Range and expansion due to urbanization: Increased food resources attract Grey-headed Flying-foxes (*Pteropus poliocephalus*) to Melbourne. *Austral Ecology* **31**: 190-198.

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ON THE PATTERNS OF PARENTAL PROVISIONING BY PURPLE SUNBIRD *NECTARINIA ASIATICA*

VINAYA KUMAR SETHI, DINESH BHATT & AMIT KUMAR

ABSTRACT

The bird fauna of the Indian subcontinent is well documented but few studies on the provisioning behaviour of Indian birds exist. We studied patterns of parental provisioning exhibited by Purple Sunbird (*Nectarinia asiatica*) in 18 nests in relation to brood size and nestling age during March to July 2009 in Haridwar (29^0N), India. Both parents fed nestlings but the rate of feeding trips by females was significantly higher than for males. Parental provisioning rates for both males and females were unaffected by brood size but positively correlated with the age of their nestlings.

INTRODUCTION

The prevalence of monogamy in birds has been explained by the need for biparental care (Lack 1968, Wittenberger 1979). Moreover, the division of labour between the sexes in biparental systems has been conceptualized as an evolutionary game that depends upon the relative costs and benefits of investment for both sexes of parents (Chase 1980). In many monogamous bird species, both males and females invest substantial amounts of time and energy in various parental duties such as nest building, incubation, food provisioning, vigilance, and brooding (Skutch 1976, Clutton-Brock 1991). Nevertheless, these efforts are energy-demanding and potentially risky for parents and their lifetime reproductive success (Curio 1988).

In several studies, predation has been assumed as a single most important factor affecting breeding success of most passerine birds in the tropics (Ricklefs 1969) as well as in the temperate zone (Nolan 1963). However, parental care may be equally important. For example, quantity of food delivered can influence nestling survival as measured by brood reduction due to starvation in many passerine birds (Magrath 1990) and by starvation of entire broods (Sherry & Holmes 1992). Young can also attract predators by their loud begging calls, if not fed well which may lead to nest loss from predation (Skutch 1949, Martin 1992).

The behaviour of parents providing food for nestlings may be influenced by several factors. For example, differences in brood size and nestling age may

contribute to changes in feeding rates or the size and type of prey delivered to nestlings (Royama 1966, Pinkowski 1978, Bedard & Meunier 1983, Schadd & Ritchison 1998, Sethi & Bhatt 2007). There are interspecific differences in how parents respond to changes in these variables and what causes such differences in parental provisioning behaviour is not known (see Schadd & Ritchison 1998). Further studies appear essential to elucidate those factors contributing to such interspecific variation (Haggerty 1992).

The Indian subcontinent is amongst the biologically better known parts of the tropics and its bird fauna has been well documented (Ali & Ripley, 1998). However, studies on the parental provisioning behaviour of Indian birds are rare (Sethi and Bhatt 2007). This study compares provisioning behaviours of male and female Purple Sunbird in relation to brood size and nestling age.

MATERIAL AND METHODS

Purple Sunbird is a small (10 cm) sexually dimorphic passerine of family Nectariniidae. It is a common resident species of light deciduous forest, semi-cultivated land, gardens and compounds across India. It chiefly feeds on flower nectar; however, small insects or larvae are also consumed occasionally (Ali & Ripley1998, Grimmett *et al.* 1998, Ghadirian *et al.* 2007). Females build nests and lay two eggs, usually (clutch size: 1-3 eggs), which they incubate for 14-15 days. Nestlings remain in the nest for about 13-15 days (Kumar et al. 1999) and both males and females feed the young (Ali & Ripley 1998, Kumar *et al.* 1999).

This study was conducted in the Himalayan foothills at Haridwar (29^0 55' N, 78^0 08' E) Uttarakhand, India from March to July 2009. Systematic searches were made during morning and evening to locate nests. Thirty one nests were discovered: 21 during building, 7 during egg laying and 3 during incubation. All nests were inspected almost daily. Four nests were rejected before completion. Five nests were predated during incubation and four during the 2^{nd}, 4^{th}, 7^{th} and 8^{th} day post hatching. These thirteen nests were excluded from the analysis. Thus, data were collected from 18 nests during the nestling period of 13 days.

Parental feeding rates were measured by observing nests from a distance of 10-20 m from blinds. Binoculars (10X50) were also used sometimes. Parents were observed as they approached the nest and fed the nestlings. We counted this event as a single feeding trip. Observations were made in

Image 1: Nest of Purple Sunbird *N. asiatica* with young

Image 2: Female Purple Sunbird *N. asiatica* feeding young

Image 3: Young of Purple Sunbird *N. asiatica* ready to fledge

TABLE 1. Comparison of parental provisioning trips/hour for 18 pairs of the Purple Sunbird *N. asiatica*

	Average provisioning trips/hour			
Nest	**Male**	**Female**	**M+F**	**Brood Size**
1	4.53	8.46	12.99	2
2	3.84	7.84	11.68	2
3	4.46	8.38	12.84	2
4	4.46	7.15	11.61	2
5	4.07	8.38	12.45	2
6	4.07	8.23	12.30	2
7	4.23	8.76	12.99	2
8	4.30	8.38	12.68	2
9	5.07	7.84	12.91	3
10	4.38	8.15	12.53	3
11	3.69	8.23	11.92	3
12	4.53	7.76	12.29	3
13	5.00	8.38	13.38	3
14	4.30	8.15	12.45	3
15	4.23	8.76	12.99	3
16	4.07	8.23	12.30	3
17	4.69	8.38	13.07	3
18	3.92	7.92	11.84	3
Mean	**4.32**	**8.19**	**12.51**	
SD	**1.93**	**3.03**	**0.51**	

the morning during 06.00-09.00 hours and each observation period was one hour in length. Purple Sunbird is nectivorous and in most of the cases parents visited nests with closed bills not projecting any food item beyond the bill-margins. Because this species builds hanging and oval-shaped (enclosed) nests food item identification and nestling behaviour during provisioning could not be observed. Data were analysed statistically using Spearman's rho correlation, and two-tailed t-tests (Baily 1995). Results are reported as means ± SD.

RESULTS

Parents of the Purple Sunbird made a total of 2,930 provisioning trips at 18 nests during this study. The provisioning rate for males was 4.32±1.93

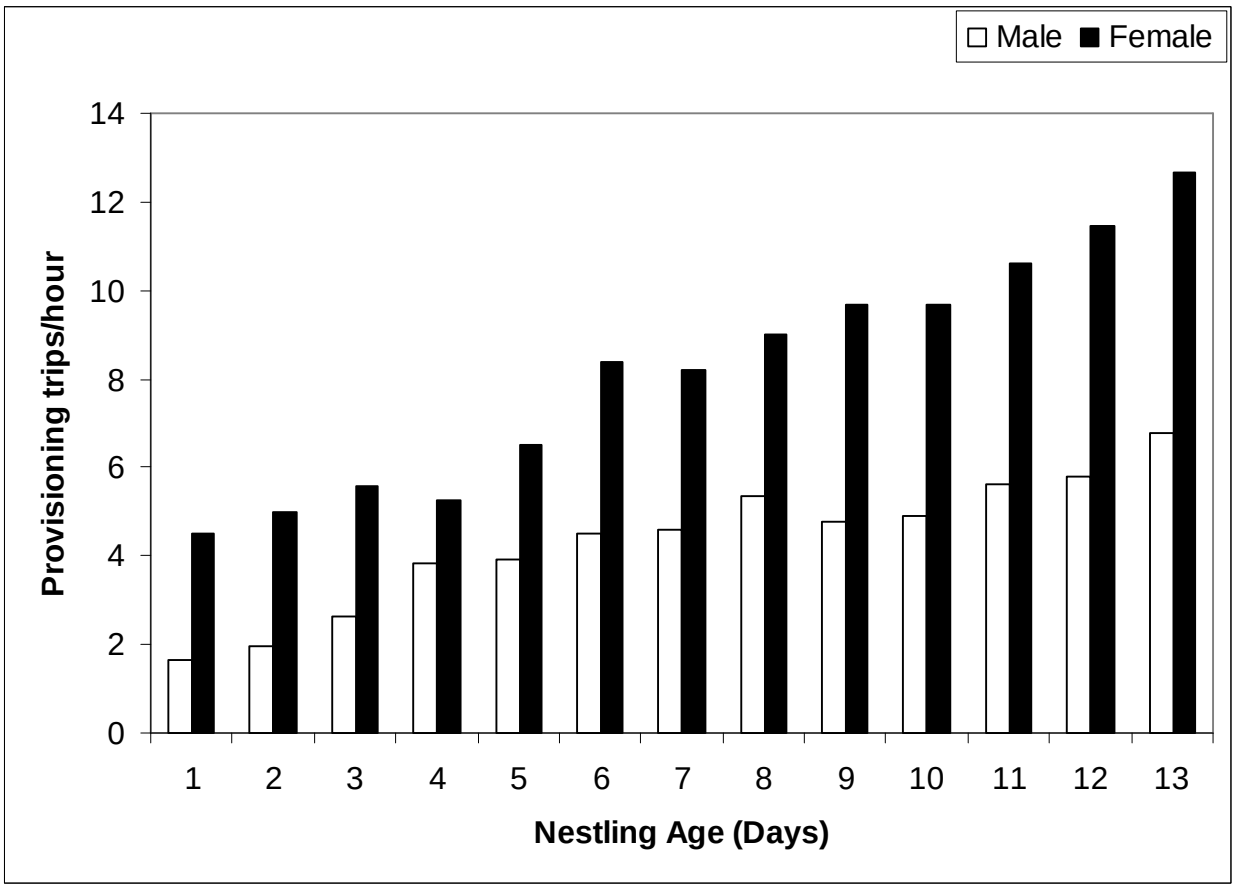

Figure 1. Relationship between nestling age and provisioning trips in the Purple Sunbird *N. asiatica*

trips/hr and 8.19±3.03 trips/hr for females (Table 1). Females had significantly ($t = 23.70$, d.f. = 233, $P<0.001$) more feedings trips to nestlings (65.43%) than males (34.57%).

Eight of 18 nests had 2 nestlings and 10 had 3 nestlings. Males made an average of 4.30 ± 1.93 and 4.34 ± 1.93 provisioning trips/hour to nests with 2 and 3 nestlings, respectively. Corresponding figures for females were 8.23 ± 3.17 and 8.16 ± 2.92 trips/hour. Brood size had no effect on parental feeding rates ($t= 0.05$, d.f. = 434, $P>0.05$). Nestlings were fed more often as they aged and there was a correlation between parental provisioning trips and nestling age (Spearman's rho = 0.98 for all trips). Provisioning trips of males (Spearman's rho = 0.95) and females (Spearman's rho = 0.98) increased progressively throughout the nestling period (Figure 1, Table 2).

DISCUSSION

The results clearly indicate that female Purple Sunbirds made significantly more feeding trips than males. On several occasions, we witnessed males perching on tree tops in the territory and delivering songs probably to

TABLE 2. Average parental provisioning trips/hour (male+ female) in relation to nestling age for 18 pairs of Purple Sunbird *N. asiatica*

Nestling age (days)	Parental provisioning trips/hour	
	Average	SD
1	6.16	2.06
2	6.94	1.51
3	8.16	1.38
4	9.11	2.34
5	10.44	2.17
6	12.88	1.64
7	12.83	2.17
8	14.33	1.74
9	14.44	1.88
10	14.55	1.78
11	16.22	3.04
12	17.22	2.07
13	19.44	2.52

maintain the established territory, while females at that time continued to feed the young. Males, but not females, were observed chasing intruders from territories which also would contribute to their lower provisioning rates.

Trivers (1972) suggested that female birds should invest more in raising offspring than their mates because their investment up to the point that eggs are laid is greater than that of males. Also, selection may favour reduced investment by males because they can not be certain of their paternity as females are certain of their maternity (Davies 1985). However, the relative roles males and females adopt in feeding their young vary among species and there appears no consistent pattern. For example, similar to the Purple Sunbird, females of other species have also been reported providing more food to the nestlings than males (Nolan 1978, Pinkowski 1978, Sethi & Bhatt 2007) while in others, males provide more food (Tamatha & Breitwisch 1977, Biermann & Sealy 1982). In some species both parents feed nestlings at similar rates (Nolan 1978, Knapton 1984, Breitwisch *et al.* 1986, Dittami *et al.* 1991, Cooper & Ritchison 2005).

Feeding rates generally increase with an increase in brood size (Royama 1966, Morehouse & Brewer 1968). However, in the present study feeding trips of the Purple Sunbird were not affected by the brood size and each young in nests containing three nestlings received fewer provisioning trips than those in nests with two nestlings. However, this does not necessarily mean that young in nests containing three nestlings received less food than those in nests with two nestlings. Because young were fed liquid nectar it

was not possible for us to estimate the quantity of nectar they delivered to nestlings. Whether parents can provide larger quantities of food to nests with three young without increasing the number of provisioning trips needs determining. Pinkowski (1978) also found no positive relation between brood size and feeding rate by either male or female Eastern Bluebirds (*Sialia sialis*). Other investigations have also found similar trends in Savannah Sparrow (*Passerculus sandwichensis*) (Bedard & Meunier 1983), Nashville Warbler (*Vermivora ruficapilla*) (Knapton 1984), Northern Mockingbird (*Mimus polyglottos*) (Breitwisch *et al.* 1986) and Western Bluebird (*Sialia mexicana*) (With & Balda 1990).

The positive relationship between nestling age and number of provisioning trips in the Purple Sunbird probably relates to increasing energy demands of the young. A similar linear relationship between parental provisioning trips and nestling age has been reported in other avian species (Morehouse & Brewer 1968, Nolan 1978, Biermann & Sealy 1982, Bedard & Meunier 1983, Breitwisch *et al.* 1986, Haggerty 1992). However, in some species parents feed the young at almost constant rates throughout the nestling period (Schadd & Ritchison 1998, Knapton 1984).

ACKNOWLEDGEMENTS

Authors are thankful to Head, Department of Zoology and Environmental Science, Gurukul Kangri University Haridwar, India for providing infrastructural facilities to carry out this research. Many thanks to Mr. Shivchand Arora for his valuable assistance during field observations. We thank Swami Shivanand Ji and his disciples to allow us to conduct a part of this study in their premises at Matri Sadan Ashram, Jagjeetpur, Haridwar, India. An anonymous referee kindly helped us improve the final manuscript.

REFERENCES

ALI, S. & RIPLEY, S.D. (1998) *Handbook of the Birds of India and Pakistan*. Oxford University Press, Mumbai, India.

BAILY, N.T.J. (1995) *Statistical Methods in Biology*. Cambridge University Press, Cambridge, United Kingdom.

BEDARD, J. & MEUNIER, M. (1983) Parental care in the Savannah Sparrow. *Canadian Journal of Zoology 61*: 2836–2843.

BIERMANN, G.C. & SEALY, S.G. (1982) Parental feeding of nestling Yellow Warblers in relation to brood size and prey availability. *Auk 99*: 332–341.

BREITWISCH, R., MERRITT, P.G. & WHITESIDES, G.H. (1986) Parental investment by the Northern Mockingbird: male and female roles in feeding nestlings. *Auk 103*: 152–159.

CHASE, I.D. (1980) Cooperative and noncooperative behavior in animals. *American Naturalist 115*: 827-857.

CLUTTON-BROCK, T.H. (1991) *The Evolution of Parental Care*. Princeton University Press, Princeton, New Jersey, USA.

COOPER, S.W. & RITCHISON, G. (2005) Nestling provisioning by male and female Yellow-breasted Chats: no relation between morphology and parental care. *Journal of Field Ornithology 76*: 298–302.

CURIO, E. (1988) Realized life span and delayed cost of parental care. *American Naturalist 131*: 825–836.

DAVIES N.B. (1985) Cooperation and conflict among Dunnocks, *Prunella modularis*, in a variable mating system. *Animal Behaviour 33*: 628-648.

DITTAMI, J., HOI, H. & SAGEDAR, G. (1991) Parental investment and territorial/ sexual behaviour in male and female Reed Warblers: are they mutually exclusive? *Ethology 88*: 249–255.

GHADIRIAN, T., QASHQAEI, A.T. & DADRAS, M. (2007) Notes on feeding and breeding habits of the Purple Sunbird *Nectarinia asiatica* (*Cinnyris asiticus*) in Bandar Abbas, Hormozgan, Southern Iran. *Podoces 2*: 122-126.

GRIMMETT, R., INSKIPP, C. & INSKIPP, T. (1998) *Birds of the Indian Subcontinent*. Oxford University Press, New Delhi.

HAGGERTY, T.M. (1992) Effects of nestling age and brood size on nestling care in the Bachman's Sparrow (*Aimophila aestivalis*). *American Midland Naturalist 128*: 115–125.

KNAPTON, R.W. (1984) Parental feeding of nestling Nashville Warblers: the effects of food type, brood-size, nestling age, and time of day. *Wilson Bulletin 96*: 594–602.

KUMAR, A., BHATT, D. & JOSHI, V.D. (1999) Breeding ecology of Purple sunbird *Nectarinia asiatica* with special reference to song behaviour. *Annals of Forestry 7*: 192-198.

LACK, D. (1968) *Ecological Adaptations for Breeding in Birds*. Methuen, London.

MAGRATH, R.D. (1990) Hatching asynchrony in altricial birds. *Biological Reviews 65*: 587–622.

MARTIN, T.E. (1992) Interaction of nest predation and food limitation in reproductive strategies. *Current Ornithology 9*: 163–197.

MOREHOUSE, E.L. & BREWER, R. (1968) Feeding of nestling and fledgling Eastern Kingbirds. *Auk 85*: 44–54.

NOLAN, V.J. (1963) Reproductive success of birds in a deciduous scrub habitat. *Ecology 44*: 305-313.

NOLAN, V.J. (1978) The ecology and behavior of the Prairie Warbler *Dendroica discolor*. *Ornithological Monographs 26*.

PINKOWSKI, B.C. (1978) Feeding of nestling and fledgling Eastern Bluebirds. *Wilson Bulletin 90*: 84–98.

RICKLEFS R.E. (1969) An analysis of nesting mortality in birds. *Smithsonian Contributions to Zoology 9*: 1-48.

ROYAMA, T. (1966) Factors governing feeding rate, food requirement and brood size of nestling Great Tits *Parus major*. *Ibis 108*: 313–347.

SCHADD, C.A. & RITCHISON, G. (1998) Provisioning of nestlings by male and female Yellow-breasted Chats. *Wilson Bulletin 110*: 398–402.

SETHI, V.K. & BHATT, D. (2007) Provisioning of young by the Oriental Magpie -Robin (*Copsychus saularis*). *The Wilson Journal of Ornithology 119*: 356–360.

SHERRY, T.W. & HOLMES, R.T. (1992) Population fluctuations in a long-distance neotropical migrant: demographic evidence for the importance of breeding season events in the American Red start. In: *Ecology and Conservation of Neotropical Migrant Landbirds*. (Eds. HAGAN, J.M. & JOHNSTON, D.W.). Smithsonian Press, Washington D.C., USA, Pp. 431–442.

SKUTCH, A.F. (1949) Do tropical birds rear as many young as they can nourish? *Ibis 91*: 430–455.

SKUTCH, A.F. (1976) *Parent Birds and Their Young*. University of Texas Press, Austin, USA.

TAMATHA, S.F. & BREITWISCH, R. (1997) Nestling provisioning by the extremely dichromatic Northern Cardinal. *Wilson Bulletin 109*: 145–153.

TRIVERS, R.L. (1972) Parental investment and sexual selection. In: *Sexual Selection and the Descent of Man. (Ed. CAMPBELL, B.) Aldine Press, Chicago.*

WITH, K.A. & BALDA, R.P. (1990) Intersexual variation and factors affecting parental care in Western Bluebirds: a comparison of nestling and fledgling periods. *Canadian Journal of Zoology 68*: 733–742.

WITTENBERGER, J.F. (1979) The evolution of mating systems in birds and mammals. In: *Handbook of Behavioral Neurobiology*. (Eds. MARLER P. & VANDENDERGH, J.) Plenum Press, New York:, Pp. 271-349.

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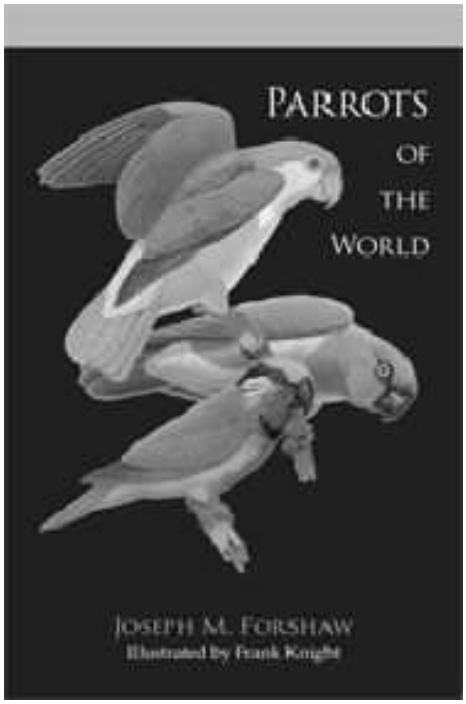

Published by CSIRO Publishing, 2010, Paperback, 336 pages,
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