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WINTER DIET OF A BARN OWL AND A NANKEEN KESTREL IN DIAMANTINA NATIONAL PARK, WESTERN QUEENSLAND

S.J.S. DEBUS, A.J. LEY AND A.B. ROSE

SUMMARY

The diets of a Barn Owl Tyto alba and a Nankeen Kestrel *Falco cenchroides* were sampled by analysing pellets collected from a roost of each species in Diamantina National Park, western Queensland, in June 2006. By number (n = 93), the Owl's diet consisted of 27% mammals (17% dasyurids, 10% rodents), 4% reptiles and 69% insects, and by biomass (1184 g), 93% mammals (20% dasyurids, 73% rodents), 2% reptiles and 5% insects. The Kestrel's diet consisted entirely of insects (n = 90): 87 locusts (Acrididae, 97%), two beetles (Coleoptera, 2%) and one cockroach (Blattodea, 1%).

INTRODUCTION

A dietary sample for the Barn Owl Tyto alba at Diamantina National Park, in western Queensland, was detailed by Debus *et al.* (1999), who suggested that the recovery of the native mammal diversity could be monitored by further collections of owl pellets. This interpretation was challenged by Palmer (2001), who contended that the Barn Owl is a rodent specialist (even in the arid zone), that it would preferentially prey on rodents over dasyurids, and that owl pellets would therefore be of little use in assessing small-mammal diversity in the Park. Subsequently, Heywood & Pavey (2002) found that Barn Owls do indeed prey heavily on dasyurids rather than rodents on the Barkly Tableland (Northern Territory), under some circumstances.

In June 2006, eight years after the collection by Debus et al. (1999), AJL collected 17 Barn Owl pellets from a roost in Diamantina National Park,

during annual bird surveys based on one-minute grids. During 2006 the Park received little rain until February. The wet season was delayed but lingered on so that the Park was well watered in June and rain upstream had also maintained the river flow (per Park staff). Insects were noticeably abundant in 2006, and many more insectivorous birds were observed than in previous years. For instance, Brown Falcons *Falco berigora* were recorded in four times as many one-minute grids in 2006 as in the previous highest year (64 vs 16); Nankeen Kestrels *F. cenchroides* in three times as many (181 vs 62), and Little Crows *Corvus bennetti* in three times as many (36 vs 12). Long-haired Rats *Rattus villosissimus* were in normal background numbers in 2006, i.e. there had been no increase, and there has been no irruption for more than 10 years (per Park staff; AJL pers. obs.).

The diet of the Nankeen Kestrel is well known, though mainly in the breeding season in temperate southern Australia, with fewer studies in the arid zone or in the non-breeding season (reviewed by Marchant & Higgins 1993; recent studies by Aumann 2001 and Starr et al. 2004). The Kestrel takes a variety of small vertebrates (birds, mammals and especially reptiles), but is strongly insectivorous, taking many arthropods particularly in the non-breeding season, and is known to congregate at plagues of prey (Marchant & Higgins 1993). Only one study has directly compared the diet of the Kestrel with that of the Barn Owl living in the same area: the Kestrel was mainly insectivorous, and the Owl took mostly rodents (Dickman *et al.* 1991). Nankeen Kestrels, mainly juveniles, are winter migrants to arid and semi-arid plains in the Australian tropics and subtropics (Marchant & Higgins 1993, Baker-Gabb & Steele 1999). This note describes the contemporary winter diet of a Kestrel at the same site as the aforementioned Barn Owl pellet collection in 2006 in arid south-western Queensland.

STUDY SITE AND METHODS

In June 2006, AJL collected 14 Nankeen Kestrel and 17 owl pellets at the Diamantina National Park headquarters complex (former homestead, 23°45' S, 141°08'E). The owl had been roosting on the floor in the tight space between a refrigerator and a wall in a recessed veranda in a little-used building: a situation similar to Barn Owl roosts in the shower recesses in doggers' huts in arid South Australia (Debus *et al.* 2004). By 2006 there was no rubbish or permanent human occupancy at the site to attract or support large numbers of House Mice *Mus domesticus* around the buildings.

The owl pellets were referable to a Tyto owl by the dark, 'glazed' mucous coating on the fresher ones. In winter 2004 AJL observed Barn Owls at the homestead; a dependent, begging juvenile revealed that they had bred in the vicinity (cf. Courtney & Debus 2006). The pellets were analysed, and minimum numbers of prey individuals determined, by ABR as previously (Debus *et al.* 1999, 2004), with reference also to Thomas (1888) for dasyurids, and prey weights were obtained from Strahan (1995) and Debus et al. (2004).

The Kestrel had been roosting atop an external door, which had been left slightly ajar, in the recessed veranda occupied by the Barn Owl, though the roosts were on opposite sides of the veranda. There were Kestrel feathers below the roost on the door, and the pellets were readily distinguished from those of the Owl by being smaller, with a light rusty hue, and of a different consistency (finely macerated insect remains). The Kestrel pellets were analysed, and minimum numbers of prey individuals determined, by ABR. Prey items were identified with the aid of a manual (CSIRO 1970) and by comparison with ABR's private reference collection, and the minimum number of prey individuals was determined by counting mandibles.

RESULTS

Barn Owl

Fifteen intact pellets measured 30–79 mm × 21–33 mm (mean 49 × 27 mm), and the 17 pellets weighed 1.2–10.1 g (mean 5.9 g; total pellet mass 101 g). By number, the Owl's diet consisted of 27% mammals (17% dasyurids, 10% rodents), 4% reptiles and 69% insects (Table 1); that is, more dasyurids than rodents were captured and more insects than mammals were eaten. However, by biomass the Owl's diet was 93% mammals (20% dasyurids, 73% rodents), 2% reptiles and 5% insects (Table 1, which gives scientific names). Mammals occurred in 15 pellets (88%; dasyurids in 53%, rodents in 53%), reptiles in three (18%), and insects in 10 (59%); there were one to 16 prey items per pellet (mean 5.5).

The insects appeared to have been caught by the Owl (rather than being in the gut of the Owl's prey), as one pellet (the smallest) consisted only of the remains of two locusts, and seven pellets contained between four and 15 locusts each as well as the remains of mammals or a lizard. For example, two pellets each contained 15 locusts and a mammal; one pellet contained six locusts and three mammals; and one pellet contained six locusts and a lizard. In these cases the mammals were small (mouse or dasyurids).

The six largest pellets each contained a rat and, in some cases, also either a skink or a dasyurid; one other large pellet contained two dasyurids, a dragon, a skink and a locust. The dragon and skinks were small individuals, and the locusts were of two species, mostly subadults (i.e. possibly still 'hoppers'). Dietary profitability was 69.6 g of prey per pellet, intermediate between the previously obtained values for the site (57.9 and 96.1 g of prey per pellet in 1995 and 1998 respectively (Palmer 2001)).

Nankeen Kestrel

Eight intact pellets measured 23–31 mm × 13–15 mm (mean 26 × 14 mm), and weighed 0.8–1.1 g (mean 1.0 g; total pellet mass, including broken pellets, 13 g). The Kestrel's diet consisted entirely of insects (n = 90): 87 locusts (Acrididae, 97%), two beetles (Coleoptera, 2%) and one cockroach (Blattodea, 1%). The locusts were small hoppers, except for one gravid, winged adult. The 14 pellets contained 5–9 insects each (mean 6.4); 13 pellets contained only locusts, and one pellet contained two locusts, two beetles and a cockroach.

DISCUSSION

Barn Owl

This study detected two mammal species (dunnart, either Fat-tailed or Stripe-faced *Sminthopsis crassicaudata* or *S. macroura*, and Forrest's Mouse *Leggadina forresti*) not detected in the previous pellet samples of Debus et al. (1999) and Palmer (2001) for this site, thus suggesting that Barn Owl pellets can track small-mammal diversity (see also McNabb et al. 2005). Furthermore, this study and others (Heywood & Pavey 2002, Debus et al. 2004) support the view that the Barn Owl, a mammal specialist, does take some dasyurids and other terrestrial (non-mammalian) prey in the arid zone, sometimes at higher frequency than rodents.

This study represents another dietary shift by the Barn Owl at Diamantina, from mostly rodents (House Mice in 1995 and Long-haired Rats in 1998) to mostly dasyurids and insects in 2006, although rodents still contributed most of the dietary biomass. In this study, Levins' dietary niche breadth (for prey biomass) was 1.98 (cf. 1.79 in 1995 and 1.08 in 1998 (Palmer 2001)). Surprisingly, there were no House Mice in the latest sample, but populations may have been low since the homestead was vacated by humans and the Park's vegetation has progressed from a disclimax (grazing-induced) condition. The proportion of insects taken was much higher in this study

than in previous studies (cf. Higgins 1999, Palmer 2001), and the proportion of lizards recorded by Debus *et al.* (2004) was higher than in previous studies, suggesting some dietary flexibility in the Barn Owl in the Australian arid zone, as elsewhere (e.g. Sahores & Trejo 2004). Prey-switching, adaptability and mobility, together with a capacity for opportunism, may have facilitated the global spread of the Barn Owl species-complex.

Nankeen Kestrel

The results of this study are similar to those of previous studies, particularly on the Kestrel's non-breeding diet, with the Diamantina individual having a more completely insectivorous diet than previously recorded for this species (cf. Marchant & Higgins 1993). The results are also consistent with a wintering individual foraging at an incipient locust plague in the arid subtropics.

The number of pellets for the Kestrel and Barn Owl at the Diamantina was below the threshold of sample size for statistical comparison (cf. Dickman *et al.* 1991). However, it is apparent that at this site a Kestrel was entirely insectivorous whereas a Barn Owl, although taking exceptional numbers of locusts and thus overlapping in diet with the Kestrel, obtained most of its food biomass from mammals.

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Species	n	Mass (g)	Biomass (g)	% number	% biomass
Narrow-nosed Planigale *Planigale tenuirostris*	1	6	6		1
Dunnart *Sminthopsis sp*	15	15	225		19
Total dasyurids	16		231	17	20
Forrest's Mouse *Leggadina*	3	20	60		5
Long-haired Rat *Rattus villosissimus*	6	134	804		68
Total rodents	9		864	10	73
Total mammals	25		1095	27	93
Dragon (Agamidae)	1	10	10		1
Skink (Scincidae)	3	5	15		1
Total lizards	4		25	4	2
Locust (Orthoptera:	64	1	64	69	5
Total prey	93		1184	100	100

Table 1: Prey items in 17 Barn Owl pellets from a roost in Diamantina NP in June 2006.

*Fat-tailed *S. crassicaudata* or Stripe-faced *S. macroura*

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GREEN TREE ANT *OECOPHYLLA SMARAGDINA* (FABRICIUS) (HYMENOPTERA: FORMICIDAE) USED FOR ANTING ACTIVITY BY CHESTNUT-BREASTED MANNIKIN.

PETER S. VALENTINE

I frequently observed individual and social anting behaviour in flocks of Chestnut-breasted Mannikin, *Lonchura castaneothorax*, that visited riparian areas of the upper Bohle River in Townsville regularly from May to December 2006. What is quite remarkable is that the behaviour involved both passive and active anting with the green tree ant (*Oecophylla smaragdina*) a very aggressive weaver ant confined to tropical coastal and sub-coastal environments across Australia (Lokkers, 1986). This is a first report of the green tree ant being used by an Australian bird and the first record of the Chestnut-breasted Mannikin engaging in anting.

The distinctive bird behaviour described as "anting" has been reported widely. Early reviews identified over 200 species engaging in anting including the direct use of ants (active anting) and the fluffing of feathers in the vicinity of ants (passive anting). An early history of anting in Australia (Chisholm, 1959) reports species of native birds across a wide range of taxa including Emu, Satin Bower-bird, Superb Fairywren, Yellow-tailed Thornbill, Lewin Honeyeater, Red-browed Finch, Pied Currawong and Turquoise Parrot. In some cases observers reported the use of other substances including garlic, lemons and various objects such as cigarettes. The speculation about possible beneficial outcomes has included an insecticidal role of formic acid. The ants most commonly involved are all in the sub-family Formicae. A recent review by Weldon (2004) develops the notion of defensive anointing and reports a range of examples from birds as well as other animals. Ehrlich *et al.* (1986) had earlier reported a number of possible explanations of anting that included an anti-ectoparasite function. More recently Revis and Waller (2004) tested secretions from several species of American ants on bacteria and fungi and found that at the concentrations of formic acid present there were no effects, in contrast with the pure formic acid inhibitions on the same organisms. Despite the longevity of these observations about anting, its function and adaptive significance remains unclear.

I first observed several individual birds actively jumping around on the top of a large (diameter 40cm) green tree ant nest. Any such disturbance normally

brings many ants rushing from the nest to bite and spray the intruders responsible. The finches would actively move around on the top of the nest before flying off to a nearby perch where they picked off the individual ants on their bodies and applied them to their underbelly areas. Even while still on the ant nest (and being rushed by ants) individual birds would adopt a typical posture with tail tucked under and between their legs exposing the undertail coverts while fluffing or sweeping with their wingtips. This stance was observed on many occasions and has been seen before in other finch species anting with black ants or with termites. Several finches at once, sometimes as many as four or five adults and juveniles, perched on the ant nest for approximately 15 seconds. This activity gradually damaged the surface of the nest until, eventually, it was abandoned by the ants. Other nearby green tree ant nests (one approximately 25 cm in diameter was used concurrently) and green tree ant trails in the tree canopy were also used. Birds perched on a branchlet forming the trail used by the green tree ants and picked at them, anointing their feathers or tucking their tails between their legs and fluffing or sweeping their wings. The activity concluded when birds flew to a nearby perch and continued preening. The original green tree ant nests were returned to on many different occasions over several weeks before taking on a distinctly tatty appearance. I have now observed this behaviour involving several different green tree ant nests (n>10) and along multiple trails of ants.

The vegetation community consisted largely of emergent eucalypt and other tree species with an understorey of bushy shrubs including *Harpullia pendula* and *Castanospermum australe* (Black Bean) in which several green tree ant nests were located. Occasional vines link much of the understorey vegetation enabling a strong network of green ant trails though the middle story canopy. Because the behaviour is intermittent I have not yet obtained any photographs. The range of green tree ant coincides broadly with the range of Chestnut-breasted Mannikin and their relationship could be very widespread but I have not investigated whether it occurs elsewhere in the northern Queensland coastal environments.

If the principal purpose of anting is to access various chemical solutions, the volume and complexity of such solutions may be relevant. Green tree ants seem ideal candidates for anting in that their defensive behaviour involves spraying targets with considerable volumes of formic-acid-containing solution. The source of these solutions is Dufour's gland which also

produces many other volatile secretions (Keegans *et al.* 1991, Lunt *et al.* 2004). Whether anting involves ectoparasite control (biocidal role), feather or skin maintenance, food preparation, or sensory stimulation (four broad categories summarised by Lunt *et al.* 2004), remains unclear but it is worth noting that these are not mutually exclusive roles.

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SEASONAL OCCURRENCE OF SPANGLED DRONGO IN SOUTH-EAST QUEENSLAND

PETER F. WOODALL

ABSTRACT

Analysis of Spangled Drongo, *Dicrurus bracteatus*, records from long-term surveys shows variation in seasonal occurrence of this species at different locations in south-east Queensland. In some coastal locations it is a winter visitor and in some suburban gardens it is present all year with a clear winter influx in others. Records from Chandler, 1965-1978, suggested it was a passage migrant with a peak from February to April and a lower peak from September to November but later records, 1979-1998, showed that it was present for most of the year with lowest frequency from October to December. In contrast to coastal areas it is always a summer visitor to the higher altitudes of Brisbane Forest Park and Toowoomba further inland and is largely absent in winter.

INTRODUCTION

Spangled Drongo *Dicrurus bracteatus* is widely distributed in northern and eastern Australia (Barrett et al. 2003). Schodde & Mason (1999) recognize four subspecies; a sedentary Kimberley-Arnhem Land form, and three forms in eastern Australia that "seem geographically progressive: southern migrants shift north to northeast Qld in winter, while many (though not all) in the northeast move on to south New Guinea." However, Higgins *et al.* (2006) recognise a more complex situation, in which its movements are not fully known, "partly resident or sedentary, and partly migratory".

Jack (1963) reported Spangled Drongo in south-east Queensland "appears to be a migrant but has been noted most of the year", while Roberts (1979) described it as "More numerous in summer months". Storr (1984) referred to it in Queensland as a "partial migrant, moving northwards and coastwards in February-May and back to breeding quarters in September-November.... Wintering on coastal lowlands and islands (including southern New Guinea)" and Blakers *et al.* (1984) cited I.J. Mason (pers.comm.) "in eastern Australia the Drongo is partly migratory, some birds moving north in winter, others south, possibly some moving altitudinally and some apparently not

migrating". Here I present new information on the species occurrence in south-east Queensland.

METHODS

Records of Spangled Drongo taken from studies at locations over long periods or geographically widespread studies that reported regularly year round are used. They are described below by location in order of altitude (asl) and record the species presence or absence (as described below) observed during a day; a week; ten days or a month. Seasonal occurrence of Spangled Drongo is expressed here as a percentage frequency of the observations recorded in a particular month.

Wellington Point (153° 14.5c E, 27° 29.2c S) c.5m asl
J.S. (Jack) Robertson recorded birds near his home "Terete" at Wellington Point in a loose-leaf notebook in 10-day periods for every month from 1963 to 1976 (n = 504). Further information on these records is given in Robertson & Woodall (1983). His suburban home block bordered a large area of native coastal vegetation.

Minnippi and Bulimba Creek (153° 6.5c E, 27° 28.8c S) c.10m asl
PFW recorded birds on a Saturday morning, generally between 0800 and 1000, from 2000 to 2006. The route taken was approximately 10km by footpath alongside Bulimba Creek (from near Carindale Shopping Centre) to Minnippi Wetlands and return. There are 187 records spread evenly over the seven years, with each month having at least 12 surveys. Joanna and Barry Morgan also collected bird records from Minnippi Wetlands and the immediate surrounds from 1997 to 2007 (n = 322) independently of PFW.

Chandler and Capalaba (153° 10.5c E, 27° 31.4c S) c. 30-50m asl
Joanna and Barry Morgan recorded birds monthly from 1965 to 1998 in Chandler. A change in the pattern of occurrence of Spangled Drongos at this location in 1979, led to the data has been analysed in two sections 1965-1978 (n= 168) and 1979-1998 (n = 168, records missing from 1985-1990). The Morgans also provided records from Capalaba (an adjacent suburb) from 2002 to 2007 (n = 178).

Garden Bird Surveys c. 20-100m asl
These surveys conducted by Birds Queensland (Queensland Ornithological Society) in 1979/80 and 1999/2000 Woodall (1995, 2002) were re-analysed to focus on this species. Records of Spangled Drongo in the garden (IN), in

the next garden (NG) and flying over (FO) were summed and treated as one record (in the previous analyses only birds in the garden were included). The analysis included only recordings from gardens in Brisbane and the Gold Coast that observed Spangled Drongos and extended over 40 or more weeks. In 1979/80 this was 25 gardens with a total of 1264 records and in 1999/2000 it was 26 gardens with a total of 1296 records.

Brisbane Forest Park (152° 48c E, 27° 24c S) c. 450-600m asl
PFW recorded birds in Brisbane Forest Park (BFP) twice a month from August 1991 to July 1994 and then bi-monthly or monthly in the summer months only (October – March) from 1994 to 2000 (n = 122). The records were made whilst walking (Maiala to Alex Road, via Greene's Falls and return to Maiala on the western track; Mt Tenison-Woods; Boombana circuit; Boombana to Jolly's Lookout,). The route was 12 km and included 4.7 km of notophyll closed forest, 3.9 km of sclerophyll closed forest, 2.8 km of sclerophyll closed/open forest, 0.3 km of microphyll closed forest, and 0.1 km of sclerophyll open forest (vegetation categories based on Young (1982)). Birds observed while travelling the c. 3 km between sections of the route were also recorded (Woodall 1997).

Toowoomba (151° 57c E, 27° 33.6c S) c. 600-700m asl
Toowoomba Bird Club usually publishes annually in their newsletter the summary of members' sightings (reported monthly), within a 10km radius of the (Toowoomba) Margaret St. Post Office (n = 300). Unpublished summaries were provided by Mick Atzeni and Pat McConnell. Twenty-five annual counts, from 1976 to 2000 were analysed.

RESULTS

Wellington Point (Figure.1) is a seaside suburb clearly favoured by Spangled Drongo during winter. In summer many birds have departed and the species remains only in low frequencies (< 10%). Records of Spangled Drongo at Minnippi Wetlands and Bulimba Creek from two separate sources (PFW and Joanna and Barry Morgan) (Figure. 2) follow seasonal changes that are almost identical to one another with high percentage frequency from February to September and very low occurrence in November and December.

The results from the two Garden Bird Surveys conducted in 1979/80 and 1999/2000 are similar to each other (Figure. 3) but differ from the results reported here from other localities in that the maximum percentage frequency is less that 50%. This indicates that many suburban gardens in this

Seasonal Presence	Number of Gardens	
Garden Bird Survey	**25 (1979/80)**	**26 (1999/2000)**
All year	10	10
Autumn, Winter, Spring	10	11
Spring & Autumn	1	1
Summer	2	2
Autumn	1	2
Spring	1	0

Table 1. Seasonal presence of Spangled Drongos in 51 gardens in Brisbane and Gold Coast.

region are probably marginal habitat for Spangled Drongos. Figure. 3 contains records from the 51 gardens shown in Table 1. Table 1. indicates that Spangled Drongos were recorded in the gardens either throughout the year, or predominantly in winter.

The Morgans' data for Capalaba show a spring (July-September) and autumn (February-May) presence of Spangled Drongo with none recorded in the other months (Figure 4).

The Morgans' data for Chandler (Figure 4) shows two patterns, one up to and including 1978 records, when Spangled Drongos were recorded from only February-April (May) and from September-November, and another including records from 1979 onwards. In the later period (1979-1998) there remains an indication of a peak of frequency in February-March and September but it is much less obvious due to the higher frequency persisting through winter.

Toowoomba and Brisbane Forest Park (Figure 5) records show the reverse pattern, highest percentage frequencies in spring and summer (September to April), and very low frequencies or total absence of Spangled Drongos in winter (May to August).

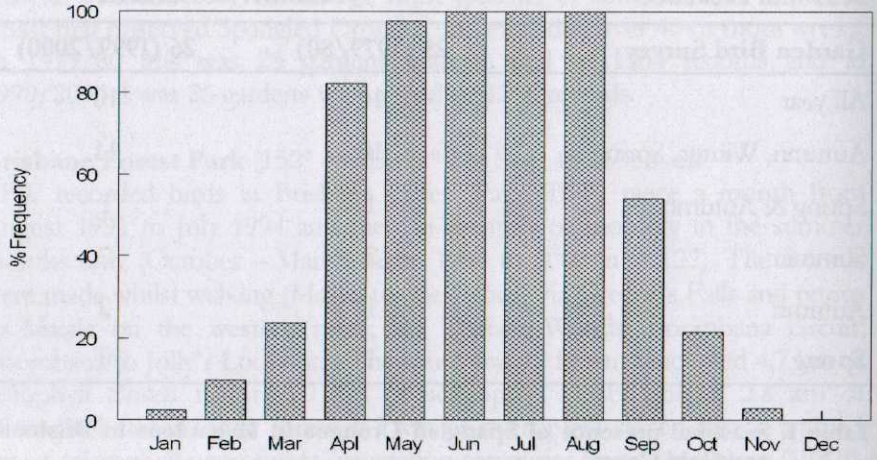

Figure 1. Monthly percentage frequencies of Spangled Drongo records from Wellington Point by J.S. Robertson, 1963-1976 (n = 504).

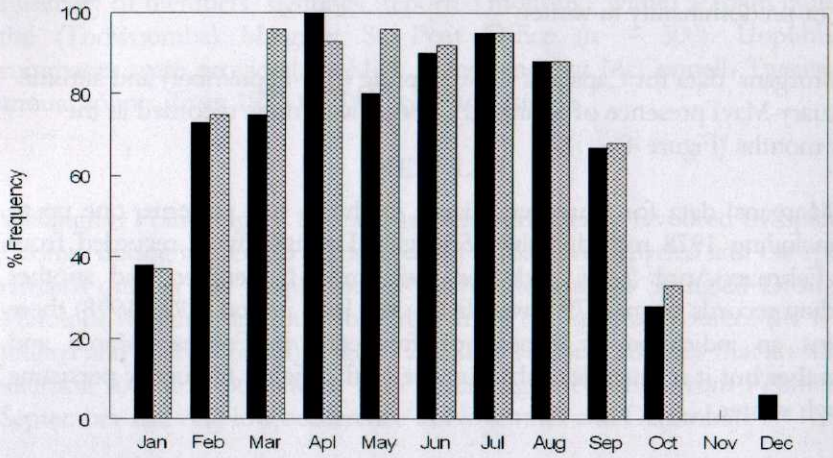

Figure 2. Monthly percentage frequencies of Spangled Drongo records from Minnippi Parklands and Bulimba Creek, (solid bars = PFW, 2000-2006, n = 187) and Minnippi Parklands (hatched bars – Morgans' records, 1998-2007, n = 322).

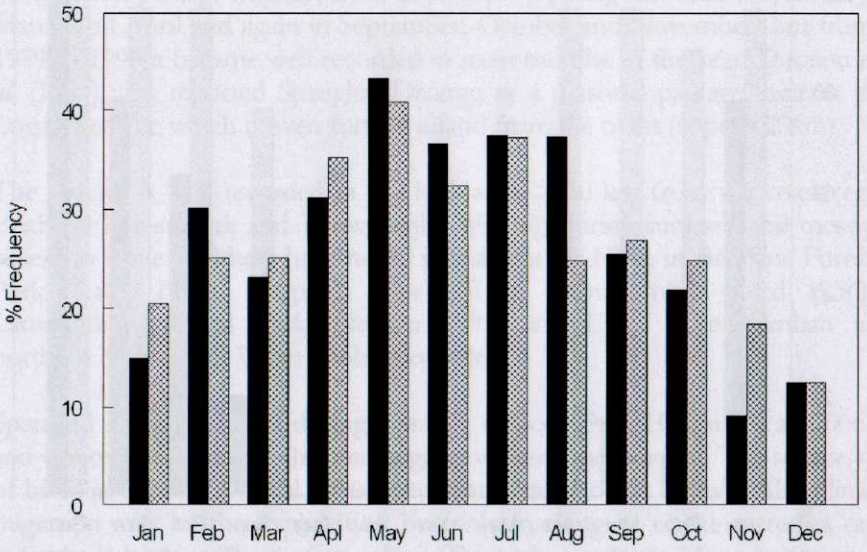

Figure 3. Monthly percentage frequencies of Spangled Drongo recorded from Garden Bird Surveys. Solid bars = 1979/1980, n= 1264; hatched bars = 1999/2000, n = 1296.

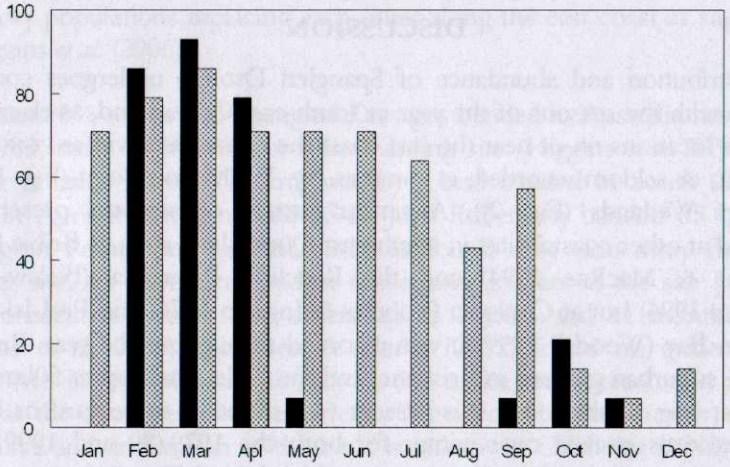

Figure 4. Monthly percentage frequencies of Spangled Drongo records from Chandler (Morgans' records). Solid bars = 1965-1978 (n=168); hatched bars = 1979-1998 (n=168).

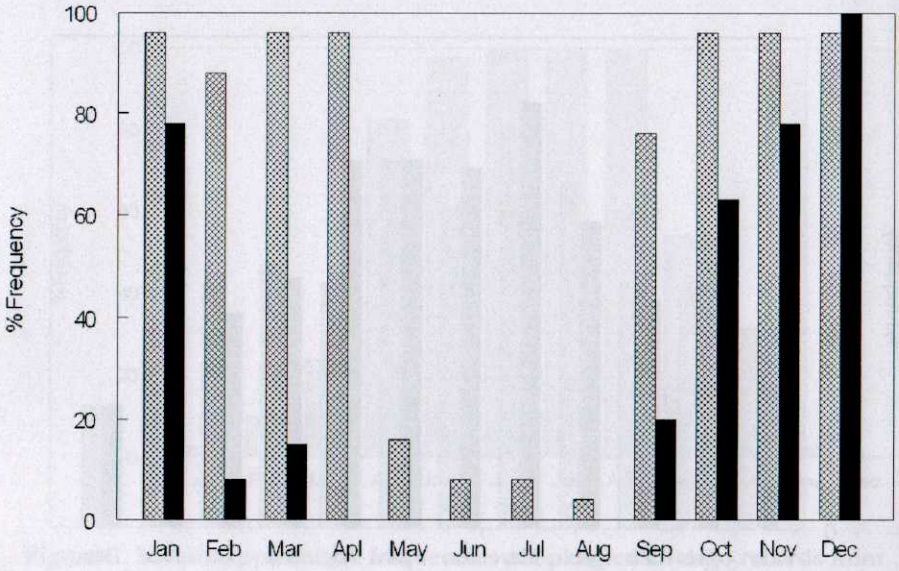

Figure 5. Monthly percentage frequency of Spangled Drongo records at Toowoomba, 1976-2000 (n=300, hatched bars) and at Brisbane Forest Park 1991-2000 (n= 122, solid bars).

DISCUSSION

The distribution and abundance of Spangled Drongo undergoes complex changes with the seasons of the year in south-east Queensland, as elsewhere. At some locations on or near the east coast the species is a winter visitor and is absent, or seldom recorded, in summer (eg. Wellington Point (Fig. 1) and Minnippi Wetlands (Fig. 2)). A similar pattern of seasonal presence is recorded at other coastal sites in south-east Queensland such as Bribie Island (Durrant & MacRae 1994) and the Redcliffe Peninsula (Bielewicz & Bielewicz 1996) but at Cooloola (Roberts & Ingram 1976) and Peel Island in Moreton Bay (Woodall 1999) it was recorded throughout the year. Records from 51 suburban gardens in Brisbane, and the Gold Coast up to 50km from the coast (Fig. 3) show that it is present year round in some gardens but in others records peaked over winter for both the 1979/80 and 1999/2000 surveys. Unusually, at Chandler, approx. 15 km inland (Fig. 4), it seems to

have been a passage migrant from 1965 to1978 (being recorded in February, March and April and again in September, October and November) but from 1979 to 1998 it became well recorded in most months of the year. Dawson *et al.* (1991) also reported Spangled Drongo as a seasonal passage migrant at Logan Reserve which is even further inland from the coast (approx 20km).

The species is well recorded in the highlands > 50 km from the coast (eg. Brisbane Forest Park and Toowoomba (Fig. 5)) during summer and mostly absent in winter. Others have noted this also at Mt Nebo in Brisbane Forest Park (Slater 1995), Murphy's Creek (E of Toowoomba) (Lord 1956), Lamington National Park (Neilsen 1991) and E of Murwillumbah in northern New South Wales (Robertson 1967).

Spangled Drongos breed during summer (Wood 1996; Higgins et al. 2006) and where birds from the highlands go in winter is not known. The source(s) of birds in adjacent coastal areas over winter are also not known. Altitudinal migration may be the explanation but only marking or tracking studies on individual birds will confirm this. There is evidence, based on size differences, of a northward movement to north Queensland in winter (Higgins *et al.* 2006) but also of a southern movement to areas south of the normal breeding range in winter (Wood cited in Higgins *et al.* 2006). Year round reports of Spangled Drongo in a locality do not necessarily mean that individual birds are sedentary, there could be progressive migration – with migratory populations replacing each other along the east coast as suggested by Higgins *et al.* (2006).

Less than 10% of the 603 Spangled Drongos banded in Australia have been recovered, most < 10 km from the banding site (Higgins *et al.* 2006). The longest distance moved (70 km) was by a bird banded in South Grafton, NSW in April that had moved SS-E. Jack Robertson banded 35 birds at Wellington Point. One banded bird was found shot 6km away from his banding site, six were retrapped in subsequent winters at the site (one for four consecutive winters and others up to 7 years and 11 months later) (Higgins et al. 2006). Griffioen & Clarke (2002) found no evidence for movements in this species. This may be due to the spatial resolution of their study, as the data presented here clearly is evidence to the contrary, even if the source and destination of the birds is unknown. Chisholm (1945) wrote, as cited in Robertson (1967), "There is no accounting for the caprices of this curious bird". Sixty years later, with no great deal more quantitative data available, there is still much to be learnt about the species and its movements.

The detailed nature of the movements of individuals and populations of these birds remains to be discovered.

ACKNOWLEDGEMENTS

I am very grateful to the many birdwatchers who provided records for the Garden Bird Surveys conducted by Birds Queensland in 1979/80 and again in 1999/2000. This paper demonstrates the value of their contributions. My thanks go to Joanna and Barry Morgan whose records added greatly to the analysis, Dawn Muir for access to the Toowoomba Bird Club newsletters and Mick Atzeni and Pat McConnell for providing the data missing from some. The National Rainforest Conservation Program supported the Brisbane Forest Park surveys from 1991 to 1993. Referee Kevin Wood provided sound criticism of an earlier draft of this paper. I dedicate it to JS (Jack) Robertson who was interested in the antics of Spangled Drongos for many years and whose meticulous records make an important contribution to this paper.

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DIET OF THE AUSTRALIAN PELICAN *PELECANUS CONSPICILLATUS* BREEDING AT KERR ISLET, NORTH-WESTERN TORRES STRAIT

GARRICK HITCHCOCK

The Australian Pelican *Pelecanus conspicillatus* was first reported breeding at Kerr Islet 130 years ago (Anonymous 1877). This islet, sometimes called Kiss Islet (9° 37' S, 141° 34' E), lies 45 km south of Papua New Guinea (PNG) and 72 km south-west of Boigu Island, in north-western Torres Strait. I visited it on 22 September 1999 during an investigation of the natural and cultural values of nearby Deliverance Island (Kwan et al. 1999, 2001). Together with Turu Cay to the south, the islands are important nesting sites for three species of sea turtle (*Chelonia mydas*, *Eretmochelys imbricata* and *Natator depressa*) (Limpus et al. 1989). Deliverance Island and Kerr Islet are called Warul Kawa ('Island of Turtles') and Awaial Kawa ('Island of Pelicans') by Boigu people. (For locations of places mentioned in text see SC54-07 Boigu 1:250,000 topographic map sheet Ed 3).

Kerr Islet is a low-lying sand cay, approximately 1.8 ha in area, sparsely covered with grasses, shrubs, vines and coconut palms (Plate 1). On landing at 16:40 hrs I walked up the beach and counted approximately 70 pelicans, adults and large young, in the centre of the islet (Plate 2).

The attending adults took flight almost immediately and the 30-40 uniformly large fledglings, as yet unable to fly, stumbled away to the south-west side of the islet. The deserted colony contained 32 broken eggs (from hatching), three intact eggs (apparently abandoned) and several dozen piles of freshwater fish regurgitated by the retreating birds, adults, fledglings, or both (Vestjens 1977). In October 1987 the pelican colony contained 'chicks and eggs in the nests' (Limpus *et al.* 1989).

Knowing the fish fauna of the nearby Bensbach River in PNG (Hitchcock 2002), I recognized that the pelicans in the colony had preyed collectively on at least ten freshwater species. I identified five species to specific level and allocated the remainder to genera. They were Grunter *Varia* sp., (probably Lake Grunter *V. lacustris*); Freshwater Longtom *Strongylura kreffti*; Barramundi *Lates calcarifer*; Saratoga *Scleropages jardinii*; Fel-Tailed Catfish (probably *Neosilurus* sp.); Fork-Tailed Catfish (probably *Arius* sp.); Gudgeon *Oxyeleotris* sp.; Mullet *Liza* sp.; Climbing Perch *Anabas testudineus*; and Tilapia *Oreochromis*

Plate 1. Aerial view of Kerr Islet and surrounding reef looking NE, 22 June 2002. Photo: John Burton

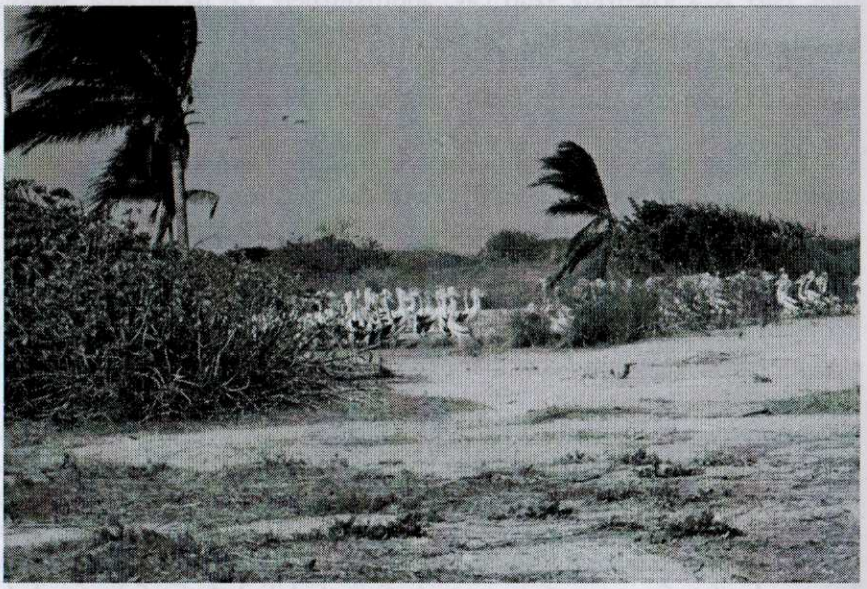

Plate 2. Australian Pelican *P. conspicillatus* colony containing 70 adults and large non-flying fledglings at Kerr Islet, NW Torres Strait, 22 Sept. 1999. Photo: Garrick Hitchcock

mossambica. All the regurgitated fish were undecomposed and had retained their life, or fresh, colouration.

This suite of prey was obtained almost certainly from the freshwater streams draining southern New Guinea such as the Bensbach River (81 km NW, also known as the Torassi) or the Morehead River (58 km NNW) in PNG's Western Province. Saratoga is a fish that does not tolerate salt water (Hitchcock 2006) and the birds must have fished for them in fresh water far from estuaries or brackish tidal areas. Climbing Perch and Tilapia are both introduced to New Guinea and recorded from the Bensbach, Fly and other PNG rivers (Allen 1989; Hitchcock 2002). Recently, the former has been found on Saibai Island, located only 4 km from the New Guinea coast in north-western Torres Strait (Hitchcock *in press*). Climbing Perch is tolerant of brackish waters and was probably able to colonize the island naturally; salinity levels in this part of Torres Strait fall during the monsoon rains, when a freshwater feature occurs along the PNG coastline due to riverine outputs (Pitcher *et al.* 2005).

The presence of Climbing Perch in the diet of Australian Pelicans at Kerr Islet is worthy of note because villagers living along the Bensbach River have reported that other piscivorous birds, cormorants *Phalacrocorax* spp. and darters *Anhinga melanogaster* have died after consuming this fish. When ingested by a predator, Climbing Perch extends its sharp dorsal and operculum spines, which can lodge in the throat or rupture the stomach. Storey *et al.* (2002) documented mortalities among piscivorous fish in the Fly River system caused by *A. testudineus*, and noted local reports of a dramatic decline in the numbers of Arafura File Snakes *Acrochordus arafurae* since the appearance of this exotic species. Storey *et al.* (2002) does not mention any impacts on waterbirds. Further research is required to assess the impact, if any, of Climbing Perch on populations of Australian Pelicans and other piscivorous waterbirds in the region.

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A DYNAMIC NUPTIAL DISPLAY BY MISTLETOEBIRD *DICAEUM HIRUNDINACEUM* AND FURTHER CALL MIMICRY

BRIAN VENABLES

The courtship and nuptial display of the Mistletoebird *Dicaeum hirundinaceum* can be elaborate, incorporating complex actions and sounds, and include mimicking the songs of a wide variety of other birds (Higgins et al. 2006). My observations of a courting pair at Magnetic Island (146° 52' E, 19° 8' S) on 8 August 2006 confirm and complement this view and add the song of a further species to the list of those mimicked.

I heard a Mistletoe bird duet whilst walking in Magnetic Island National Park from Nelly Bay to Horseshoe Bay through open eucalypt and *Acacia* woodland at about 8:30am. It included calls of a fairy-wren (either Variegated *Malurus lamberti* or Lovely Fairy-wren *M. amabilis*, which first attracted my attention, because I had not recorded fairy-wrens on the island in several years of observations. The nearest singing bird was a male Mistletoebird perched on a thin horizontal branch approximately 40cm above the ground. Its repertoire also included mimicry of White-eared Monarch *Monarcha leucotis* song, one not previously recorded (Higgins *et al.* 2006), as well as the misplaced fairy-wren song that had first attracted my attention.

I witnessed the final 30secs of the display which included Mistletoebird calls, call mimicry and an elaborate dance. The singing male shuffled to and fro, approximately 20cm, from a central point on the branch with its body horizontal. It swayed from side to side fluttering its wings and flicking its tail and displaying flashes of red. The choreography was reminiscent of a riflebird *Ptiloris* spp. on a smaller scale. The display ended when a female Mistletoebird flew to a branch approximately 1m above the male. She fluttered her wings in the manner of a juvenile begging for food. The male flew up, mated with her immediately and they departed the locality together.

The repeated shuffling actions of the male, back and forth along the branch are not clearly described as a part of the nuptial display in Higgins *et al.* (2006). Other observers appear to have described the Mistletoebird's nuptial display as a mainly static performance (Higgins *et al.* 2006) and using approximately 40cm of a branch as a stage has not been previously reported.

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NOVEL OBSERVATIONS OF PRE-BREEDING DISPLAY STRUCTURES USED BY LAGE-BILLED GERYGONE

BRIAN VENABLES, JOHN PRITCHARD AND STEPHEN MURPHY

The Large-billed Gerygone, *Gerygone magnirostris*, is a small insectivorous passerine of the Australian tropics and New Guinea (Higgins & Peter 2002). A variety of display movements are recorded but are associated with nest building (Higgins & Peter 2002). We observed elements of pre-breeding displays and also the building of a display structure not used for nesting which has not been reported previously. Our observations were made between 1988 and 2007 at Cape Weymouth on Cape York Peninsula (E 143° 26' 05.8" S 12° 36' 55.8") in and around several open-plan houses built in vegetation adjacent to mangroves, which is typical *G. magnirostris* habitat (Higgins & Peter 2002).

A typical nest of Large-billed Gerygone in the Cape Weymouth area is built in summer (Nov. – Feb.) of fine vegetation and spider web, normally on a vertical but sometimes on a horizontal support. When complete it is an untidy pendant of varying length with an egg chamber near the bottom. We have watched ten entirely different structures being built, for which pre-breeding display appears to be the only function. They were triangular, curtain-like structures smaller than nests, without a clearly defined shape and all were built on horizontal supports (e.g. an internal phone line etc. Figure 1).

Two structures were 15 cm wide along the horizontal support and extended downwards 12 cm. All were constructed using similar materials to those used for building nests. We cannot say with certainty whether only one or both birds built the display structures as members of pairs were not readily distinguishable.

Ritualized display was observed at the structures both during and after building. The first bird to arrive landed next to the structure and displayed by swinging backwards to an upside down position with tail fanned, wings ajar, and emitting soft whistles on the arrival of the second bird (Figure 2). The later sometimes added material to the structure but usually reciprocated by imitating song and action of the first bird.

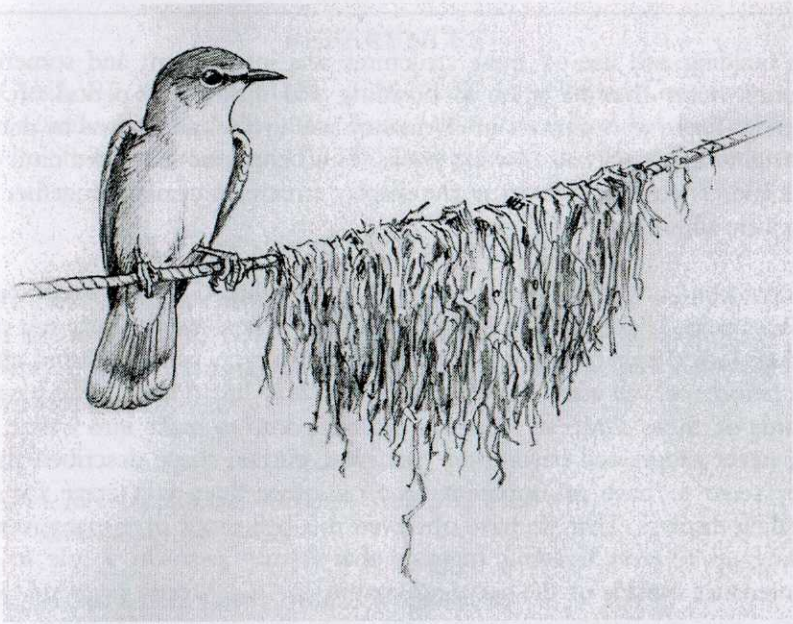

Figure 1. The first bird to arrive at the display station usually sings loudly awaiting the arrival of the second.

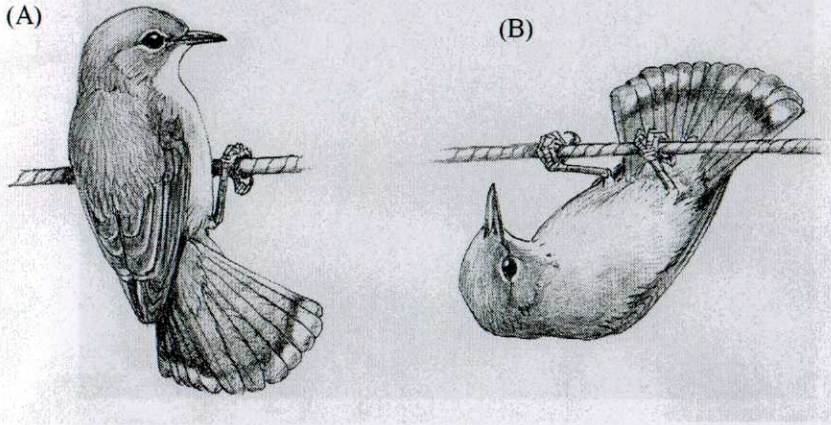

Figure 2. (A and B) Two positions adopted by the first bird at a display station, and usually copied by the second. They are initiated on the arrival of the second bird and may be accompanied by a duet of soft whistles

The building and use of these structures was intermittent and sometimes spanned many months prior to breeding and during the period of nest building. There were periods of dormancy lasting weeks, followed by periods of heightened activity also lasting weeks. This behaviour continued until eggs were laid. Thereafter, activity at the display structures ceased altogether and they were allowed to disintegrate.

We could find no similar observations of Large-billed Gerygones reported in the literature. The display structures we describe here were clearly not nests as they lacked egg chambers, and their construction usually started either, well before, or well after breeding, usually in May-July (Plate 1). We have no records of these *display* structures being built onto to make into a nest, and they never progressed beyond the triangular, curtain shape described above. They seem to have no apparent function other than as a stage for pre-breeding displays. That we have observed this behaviour over many months leading up to nest building suggests that it may perform a role in pair maintenance outside of the breeding season.

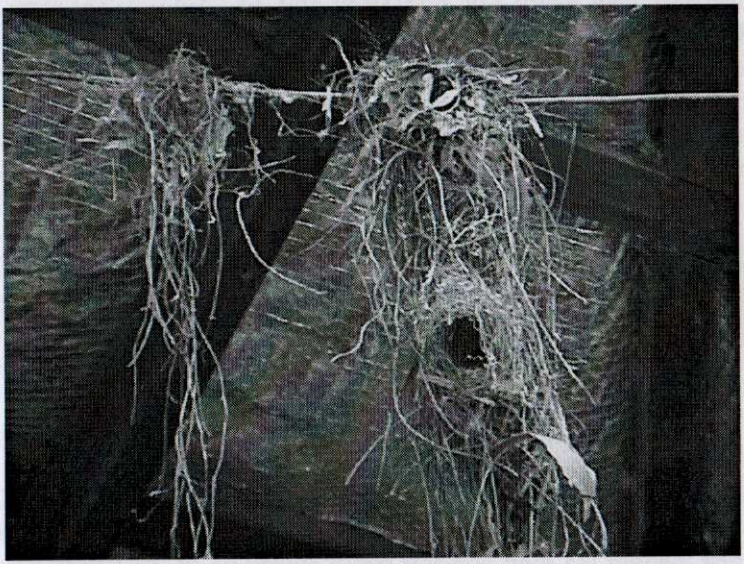

Plate 1 Large-billed Gerygone display structure (left) and normal nest (right). Photo J. Pritchard

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PICTORELLA MANNIKIN *HETEROMUNIA PECTORALIS* IN COASTAL CAPE YORK PENINSULA

GLENN HOLMES AND DENNIS GOSPER

Three observations of the Pictorella Mannikin *Heteromunia pectoralis* made in the period from 2002 to 2005 at Knifehole Lagoon (143° 55'E, 14° 36' S), Lakefield National Park, in coastal north-east Queensland are described here. They are some of the first records for the species from the north-east coast and are well beyond the previously recorded range for this species in Queensland which until now has included mainly Gulf Country and Western-Central Regions. The species is endemic to northern Australia and its conservation status is listed as Near Threatened (Garnett & Crowley 2000). The population status, distribution and movements of the species are not well understood (Higgins *et al.* 2006).

Knifehole Lagoon is on Nifold Plain approximately 13 kms south of Princess Charlotte Bay. It is surrounded by expansive tussock grasslands on a depositional plain and, though ephemeral, it is an important source of water for finches and other birds (G. Holmes, pers. obs.; M. Todd, pers. comm.). Small trees *Melaleuca viridiflora* and *Petalostigma banksii* and the spectacular palm *Corypha utan* occur sparsely on its margins.

A party of 14 birds, together with three Star Finches *Neochmia ruficauda*, were first observed by us (J. Holmes, G. Holmes, D. Gosper, A. Nahkola (Finland) and E. Rogers (USA)) at Knifehole Lagoon on 12 August 2002. Two adult Pictorella Mannikins (a male and female) and 12 birds in immature plumage were seen at 1130hrs sitting quietly in low shrubbery bordering a drying waterhole. The party was subsequently flushed several times, each time moving to shrubs farther along the waterhole.

Subsequently, a single immature Pictorella Mannikin was photographed by Michael Todd (M. Todd, pers. comm.) at Knifehole Lagoon on 11 July 2004 and one of us (G. Holmes) observed a flock of 12 Pictorella Mannikins on 16 June 2005.

The nearest previously documented occurrences of Pictorella Mannikins were from the vicinity of Pompuraaw (formerly known as Edward River Settlement) where two flocks of about 20 birds (including immatures) were

seen in May 1980 (Garnett & Bredl 1985, Blakers *et al.* 1984). Pompuraaw, on the west coast of Cape York Peninsula, lies at a similar latitude to Knifehole Lagoon. The distance between the locations is approximately 240 km. There have been no subsequent reports of Pictorellas from Cape York Peninsula (Garnett & Crowley 2000, Barrett *et al.* 2003, Higgins *et al.* 2006).

Pictorella Mannikins have not been reported from east of the Great Dividing Range for nearly a century. The species was recorded from the upper Burdekin River (145° E, 20° S) around 1900, but is presumed to have been present or persisted in that area for less than a decade (Higgins *et al.* 2006).

The nature of movements undertaken by Pictorella Mannikins is poorly known. Higgins *et al.* (2006) conclude that Pictorellas disperse according to the availability of water. Storr (1984) states that there is a regular movement to drier regions during the wet season.

The origin and status of the birds observed in Lakefield NP is unclear. Their presence over successive years suggests the existence of a population in central Cape York Peninsula. Immature birds indicate that it is either permanent or a 'relic' following a previous irruption. Alternatively they could simply be regular seasonal visitors from the Gulf Country to an area of reliable water and food in the dry season.

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PILOT STUDY OF AQUATIC WEED DISPERSAL BY WATERBIRDS IN SOUTH-EAST QUEENSLAND

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ABSTRACT

In an initial survey of six water bodies in south-east Queensland, birds were observed feeding on, foraging amongst, or swimming through aquatic weeds, specifically the Weeds of National Significance *Salvinia molesta* and *Cabomba caroliniana*, and the Queensland Declared Plants *Eichhornia crassipes* (water hyacinth) and *Pistia stratiotes* (water lettuce). Intensive observations were then made at a pond in Kolora Park, Palmwoods from late summer to early autumn 2006. Purple Swamphen, Eurasian Coot, Pacific Black Duck, Hardhead and exotic ducks foraged amongst *Cabomba*, *Salvinia* and water hyacinth at many of the survey sites. Australasian Grebe, Comb-crested Jacana, Chestnut-breasted Mannikin, Great Egret and Little Pied Cormorant swam or alighted upon dense floating mats of aquatic weeds. At Kolora Park Pond, Dusky Moorhens were observed eating *Cabomba* fragments. The potential role of waterbirds in aquatic weed dispersal is discussed. More research on the movements of waterbirds, the timing of aquatic weed outbreaks and the genetic composition of aquatic vegetation communities is recommended.

INTRODUCTION

In south-east Queensland many water bodies are dominated by one or several Weeds of National Significance (WONS) (*Salvinia molesta* and *Cabomba caroliniana*) or Declared Plants (water hyacinth *Eichornia crassipes*, and water lettuce *Pistia stratiotes*) (Queensland Government 1998). Aquatic weeds are listed because they reduce biodiversity, lower water quality and cause economic loss. The National Weeds Strategy 1999, *Queensland Land Protection (Pest and Stock Route Management) Act 2002* and local government Pest Management Plans are in place to manage and control these weeds (Department of Natural Resources and Mines 2005). It is useful to know whether waterbirds play a significant role in dispersing weeds locally to modify future management and control strategies.

Waterbirds act as dispersers of aquatic organisms by transporting plant and invertebrate propagules internally (endozoochory) via their digestive tract or externally (ectozoochory) by attachment to feathers, feet or bills (Darwin 1859, Green *et. al.* 2002). Anatidae (ducks, geese and swans) are of particular interest due to their abundance, widespread distribution, long distance movements, and the importance of plant seeds and aquatic invertebrates in their diet (Green *et. al.* 2002, Frith 1982). Dietary studies of Anatidae, Rallidae and coots *Fulica* spp. in Australia and elsewhere show that they eat seeds and leaves from aquatic plants (eg. spike rush *Eleocharis* spp., bulrush *Scirpus* spp., willow primrose *Ludwigia* spp., pond weed *Potamogeton* spp, smart weed *Polygonum lapathifolium*, hornwort *Ceratophyllum* sp, water lily *Nymphoides indica*, and duck weed *Spirodela* spp or *Chara* sp.) (Cramp & Simmons 1977, Frith 1959, Frith *et. al.* 1969, Goodrick 1979, Lavery 1971, Taylor 1978). Some birds feed almost exclusively on aquatic plants, others sporadically (Lavery 1966, Frith 1982).

Aquatic birds in Queensland do not undergo the large scale regular seasonal movements of waterfowl in the northern hemisphere. Many species are sedentary on permanent water bodies, dispersing locally according to availability of food, water and suitable habitat (Marchant & Higgins 1990). There is dispersion from inland areas during drought (Draffan *et. al.* 1983) and isolated long distance movements for some banded Purple Swamphens *Porphyrio porphyrio*, Dusky Moorhens *Gallinula tenebrosa* and Pacific Black Ducks *Anas superciliosa* (Frith 1959, Lavery 1965, Schodde *et. al.* 1983). It is interesting to note that some species (eg. Dusky Moorhen) move away from wetlands that have been drained, filled or covered in water hyacinth (Marchant & Higgins 1990). This pilot study monitored the behaviour of waterbirds to assess their potential as vectors in the dispersal of aquatic WONS and Queensland Declared Plants.

METHODS

The six water bodies were selected for the presence of WONS and waterbirds of interest using expert advice from local councils and bird watching groups. They were Eagleby Wetlands, Lake MacDonald, Ewan Maddock Dam, Kolora Park Pond, Chancellor Park Lakes and Wappa Dam. All sites were surveyed between December 2005 and January 2006. The composition and distribution of aquatic weed communities at each site was recorded and weed cover was rated as low, medium or high (Table 1). Aquatic weed samples were identified with the assistance of Queensland Herbarium staff, then pressed and dried using the method outlined by Department of Environment and Heritage (2006).

Water body	Weeds	Cover
Eagleby Wetlands	water hyacinth	Medium
Lake Macdonald	Cabomba	High
Ewan Maddock Dam	Cabomba, Salvinia	High
Kolora Park Pond	Cabomba, Salvinia	High
Chancellor Park Lakes	Salvinia	Low
Wappa Dam	water lettuce, water hyacinth	Medium

Table 1 Weed presence in water bodies

Birds were counted on water bodies and their behaviour was recorded after sunrise or before sunset. Interactions with aquatic weeds were classified accordingly as direct, indirect, or none. Direct interactions included all observations of birds ingesting, fighting over weeds and fragmenting weeds in order to access alternative food sources within the weed (eg. fish, shrimp and other invertebrates). Indirect interactions included walking or running over floating mats as well as grooming in, swimming through and landing in densely infested areas. Interactions classed as 'none' included all activities observed in areas without weed infestations.

A suitable water body was selected from the survey sites for intensive monitoring. Criteria used for selection were travelling distance, weed species presence and abundance, and bird species presence and abundance. Kolora Park Pond in Palmwoods received the highest rank and was used for the monitoring study. Aquatic vegetation composition and distribution were recorded four times over a twelve week period (21/01/06, 17/02/06, 10/03/06, and 31/03/06). For each bird species, the number observed on the water, the embankment and in surrounding vegetation, was observed from 4pm to dusk. The behaviour of the birds, especially their direct and indirect interactions with WONS was recorded. The data was analysed and graphed using the Statistical Package for Social Science (SPSS).

RESULTS.

In the initial survey of six water bodies, 180 bird observations were made representing 32 species (Figure 1a). Few birds and bird-weed interactions were observed at Ewan Maddock Dam, Lake MacDonald and Wappa Dam, and they were difficult to observe unobtrusively. Direct interactions were observed at four water bodies and most frequently at Kolora Park Pond. Dusky Moorhens, Eurasian Coots *Fulica atra*, Pacific Black Ducks, Purple Swamphens, Hardheads *Aythya australis* and exotic ducks were seen feeding on, shaking or breaking apart fragments of *Cabomba*, *Salvinia* or water hyacinth (Figure 1b).

Indirect interactions occurred at all sites, with higher frequencies at Eagleby Wetlands, Ewan Maddock Dam and Chancellor Park Lakes. The birds involved were Australasian Grebes *Tachybaptus novaehollandiae*, Comb-crested Jacanas *Irediparra gallinacean*, Chestnut-breasted Mannikins *Lonchura castaneothorax*, Great Egrets *Egretta alba* and Little Pied Cormorants *Phalacrocorax melanoleucos*.

At Kolora Park Pond, 157 observations of 13 species were made, in approximately 40 observation periods every three weeks. Dusky Moorhen, Purple Swamphen, Pacific Black Duck, Little Pied Cormorant and Hardhead Duck were present amongst a large population of exotic ducks and interacted directly with *Cabomba* and *Salvinia* (25.3% of the observations shown) (Figure 2).

More bird interactions were recorded with *Cabomba* than with *Salvinia* (Figure 3). All of the dominant water birds were observed directly and/or indirectly interacting with *Cabomba* (Figure 4). All bird interactions observed with *Salvinia* were of indirect nature as the birds mainly swam past or through the weed infested water body.

Dusky Moorhens frequently ate *Cabomba* (Figure 4). The Pacific Black, Hardhead and exotic ducks interacted directly with *Cabomba* by breaking, shaking and nibbling into the weed to find alternative food sources such as shrimp, fish and other invertebrates thus fragmenting it and facilitating its spread (Figure 4). Most of this activity occurred near (<2m) the overflow outlet and, despite the presence of a boom, large infestations of *Cabomba* occur downstream in Paynters Creek along Jubilee Drive, Palmwoods. Some birds swam about with pieces of *Cabomba* up to 10cm in length draped over their heads or hanging off their beaks.

Few carnivorous birds were observed. Little Pied Cormorants used the edges of the Kolora Park Pond and were often seen flying overhead, roosting in the trees, or diving for food in weed free water. A breeding colony of Little Pied Cormorants, Cattle Egrets *Ardeola ibis* and Sacred Ibis *Threskiornis aethiopica* in a pond a kilometre W of Kolora Park Pond contained < 20 active nests. This pond was weed free, except for a small amount of *Salvinia* near the drain flowing under a road. Surveys of other local water bodies demonstrated that *Cabomba* only occurred downstream of Kolora Park Pond whereas *Salvinia* was abundant and widespread.

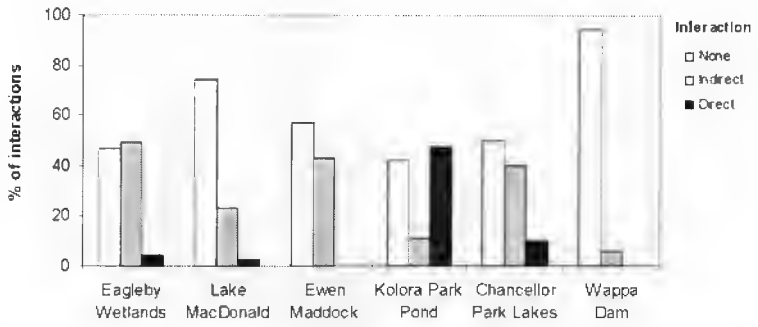

Figure 1a: Bird –weed interactions by water body in the initial survey

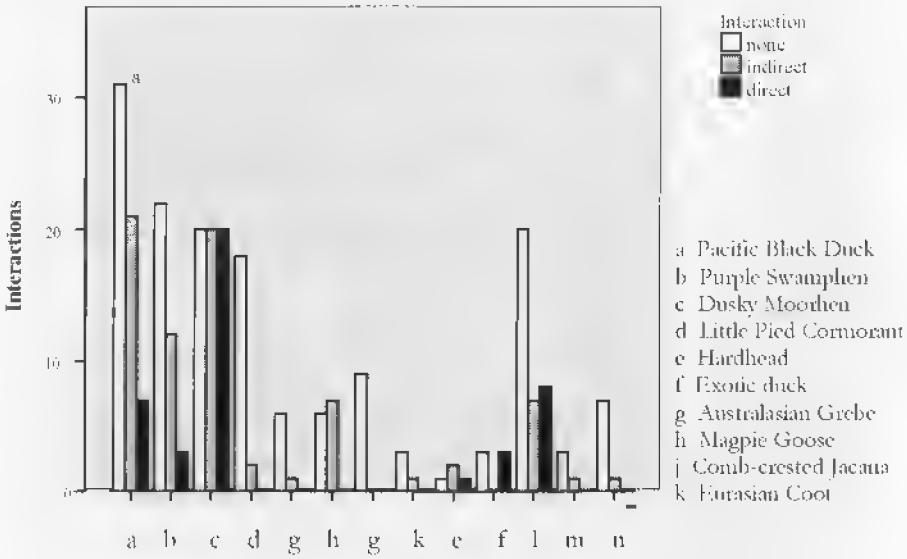

Figure 1b: Bird-weed interactions by species in the initial survey

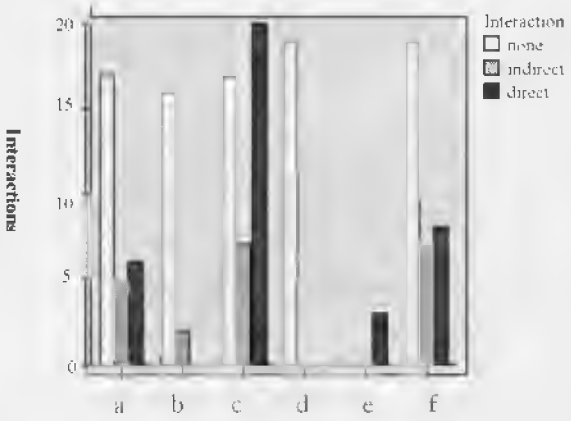

Figure 2: Bird-weed interactions at Kolora Park

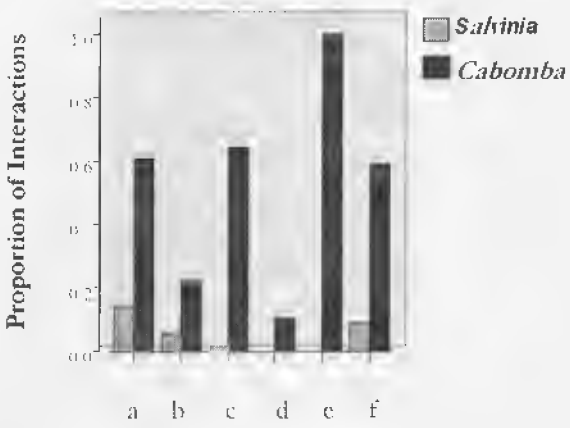

Figure 3: Species interactions with *Cabomba* and *Salvinia* at Kolora Park Pond.

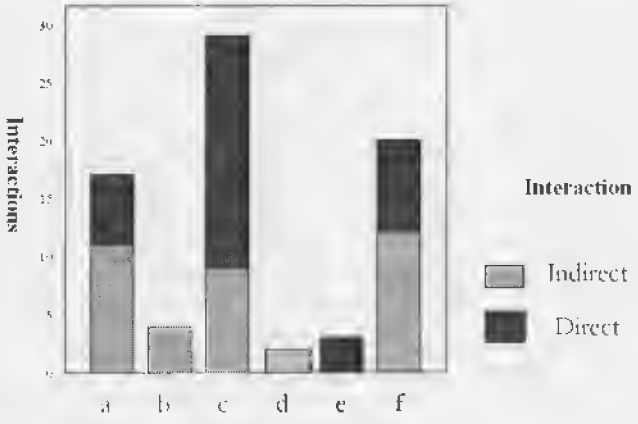

Figure 4: Bird interactions with *Cabomba* at Kolora Park Pond

DISCUSSION

Our results show that it is possible for birds to carry plant propagules and transport aquatic weeds, internally and externally. However, the regional distribution of the four aquatic in Queensland does not suggest any relationship with the movements of birds (Department of Natural Resources, Mines and Energy 2004). Weed infestations occur in large, slow moving drinking water impoundments along the coastal strip, where human population centres are located.

Cabomba and *Salvinia* only reproduce vegetatively from stem nodes. *Cabomba* fragments were eaten regularly by Dusky Moorhens and fragments of both weeds became attached to other foraging birds using dense stands of floating vegetation. Nevertheless *Salvinia* is locally widespread and abundant in contrast to *Cabomba* which had a surprisingly limited local distribution. This suggests that, contrary to our observations, *Salvinia* is more readily dispersed and able to colonise a water body than *Cabomba*. *Cabomba* propagulues are small, soft, easily digested and unlike to remain viable for long. They are coated in a gelatinous mucous which may prevent them adhering to feathers, feet or bills for long distances. *Salvinia* has hairy water-resistant upper leaves and long fibrous lower leaves, which are more likely to attach to birds such as the Comb-crested Jacana, Pacific Black Duck and Eurasian Coot, which swam, or foraged, amongst floating mats, or used them as feeding platforms.

Salvinia also resists desiccation, can survive out of the water for several days and produces layers of reproductive nodes, some of which are deep in the plant tissue (Jacano 2005). While this feature is considered to be a strategy to resist the effects of desiccation in times of drought, it could also protect the nodes against digestion. More research is required to quantify the frequency and distance of potential dispersal as this will depend on: the retention time in the birds digestive system; the potential for the weeds to stay attached for long or short distances; and each species homing range (Charalambidou & Santamaria 2002, Figuerola & Green 2002).

Water lettuce and water hyacinth produce small seeds that may remain viable for a long period of time and are therefore ideal propagules for ingestion and transport by birds (Department of Natural Resources and Mines 2005). Small seeds tend to resist digestion better than large seeds (De Vlaming & Proctor 1968) and accidental ingestion of small seeds that resist digestion is likely to result in viable seeds being dispersed (Traveset 1998). We observed Comb-

crested Jacanas and Purple Swamphens foraging in water hyacinth, after flowering, when seeds were present. Sainty and Jacobs (1994) reported Purple Swamphens eating water hyacinth, but it is not known if the ingested seeds remain viable. Water lettuce was present at only one site and there were no bird interactions with this weed recorded. Weed seeds in mud could become attached to a bird and thus dispersed by the bird as demonstrated by studies on domestic ducks and geese (Vivian-Smith & Stiles 1994). However, studies on external seed adhesion times and seed germination rates in the field are scarce for most commonly occurring waterfowl species. Some species (Magpie Geese, Black Swan and Comb-crested Jacana) were observed scratching or swimming through floating rafts, actions which could potentially liberate daughter plants and propagation nodes, and facilitate dispersal in the direction of wind or water currents.

Some waterbirds make floating nests using aquatic vegetation, or build nests in trees overhanging water (Beruldsen 2003) and could disperse aquatic weeds both within and between water bodies in the nesting season. *Cabomba* has been observed in Purple Swamphen and Australasian Grebe nests (John Noyce pers. comm., Tom Anderson pers.comm.) but little has been published about the local composition of waterbird nests and whether the inclusion of aquatic weeds is voluntary or inadvertent.

Birds are highly visible and attract the attention of landowners and managers but there are many other potential vectors of aquatic weeds that operate together at different scales. They include humans, mammals, wind, rain, floods, machinery, boats and fishing nets. All landholders should continue implementing strategies to provide unsuitable environments for aquatic weed growth on their properties. Strategies such as providing shade and revegetating the banks with endemic riparian species; reducing nutrient run-off to water bodies; as well as identifying and reporting outbreaks at an early stage before they spread out of control, are considered the most effective.

We recommend local and regional studies of resident and migratory bird movements in different seasons (Haig et. al. 1998) and monitoring birds on the Sunshine Coast's major rivers (Mary River, Mooloolah River, South and North Maroochy River, Noosa River and tributaries), major dams and lakes (Lake Cootharaba, Lake Cooroibah, Lake Weyba, Lake MacDonald, Cooloolabin Dam, Ewan Maddock Dam, Baroon Pocket Dam, Wappa Dam and Poona Dam) which include known aquatic weed infestations. Such

information, supplemented by greater knowledge of the probabilities of transportation by birds and the viability of the plant propagules, should they reach suitable habitat, could then be used to predict future outbreaks.

Spatially explicit GIS models of the population dynamics of focal species could be developed and linked to genetic analyses of aquatic weed populations to determine source locations and dispersal patterns of WONS and Queensland Declared Plants (Madder et. al. 1998, Haig et al. 1998).

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