

Birds of Nusa Dua Sewage Treatment Ponds, Bali, and an unusual foraging behaviour of egrets

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Ringkasan. Laguna di tengah kawasan tujuan wisata berbintang lima dan dekat dengan bandar udara internasional Denpasar dulu diidentifikasi sebagai tempat penting bagi burung air selama awal 1990-an (Mason 1994, 2000) namun avifauna dari kawasan seluas 30 ha ini tidak pernah dihitung secara pasti. Dari Januari sampai April 1999 kami melaksanakan 12 kali sensus (masing-masing berlangsung 2 jam) untuk menentukan kekayaan jenis dan kelimpahan burung yang menghuni kawasan seluas 30 ha ini. Kami melaporkan 56 jenis asli termasuk satu jenis baru untuk pulau Bali, yaitu burung Trutu Hijau *Nettapus coromandelianus*. Kami juga mengamati sampai 223 Kuntul Kecil dan 155 Kowakmalam Abu dalam sensus yang dilakukan, namun jenis dengan rata-rata kelimpahan paling tinggi adalah Punai Gading *Treron vermans*. Jenis introduksi meliputi Kakatua Tanimbar *Cacatua goffini* dan Kakatua Jambul-kuning *C. sulphurea*. Kami juga mengamati Kuntul Kecil *Egretta garzetta* terbang mencari pakan dengan menyambar ikan dari permukaan kolam sambil terbang, perilaku yang nampaknya hanya sekali dilaporkan sebelumnya di lokasi kolam buangan di Papua-New Guinea.

Introduction

Since the early 1970s Bali has become increasingly popular as a cultural tourism destination (Picard 1997). However, due to the constant expansion of the industry, increasingly large expanses of the island are being consumed by infrastructure (e.g., hotels/resorts, shopping centres) to support the tourism industry. Human pressures have therefore greatly modified much of the area around Bali's capital, Denpasar. Despite this intense development, many bird species can still be seen in this part of Bali. Indeed, the Nusa Dua Laguna (Lagoon) sewage treatment complex, in the midst of a five-star tourist destination, attracts such large numbers of waterfowl that it was recommended for gazetted as a Wetland Reserve (Mason 1994, 2000). Despite this recognition, however, little published information is available on the avifauna of the sewage treatment ponds.

The aim of the present study was to document the species and abundance of birds using the ponds, while encouraging local ecologists to undertake quantitative research.

Study site and methods

The Nusa Dua Laguna sewage treatment complex (Denpasar, Indonesia; 115°13'41E; 8°48'7S) was developed to receive sewage from adjacent five star hotel and resort complexes administered by the Bali Tourism Development Corporation. The 30 ha sewage treatment complex incorporates a series of large concrete rectangular lagoons, divided by 2-3 m wide grassy bunds, and numerous small islands supporting trees, shrubs, and vines (Plate 1). The water depth in the ponds is mostly maintained at approximately 1.4 m (Suryadipura 1998).



Plate 1. Views of Nusa Dua sewage treatment ponds showing vegetated islets and bunds (left) and edge of complex bordering mangroves (right).

The complex is bounded on two sides by mangrove forest and gardens, and on the other sides, by high walls that separate the complex from the roads which service nearby settlements and tourist resorts. Entry to the complex is via a gate, which is locked at night, and guarded by maintenance staff. Typical average minimum and maximum temperatures during the months sampled were 23°C to 30°C with an average daily temperature of 26.5°C. The relative humidity typically averages 87% (Anon. 1995).

The study was conducted from January through April 1999. Censuses of 2 h duration were conducted over three days each month, comprising two mornings (between 06:15 and 08:15 hrs) and one afternoon (between 16:15 and 18:15 hrs), giving a total of 12 censuses (9 morning censuses and 3 in the afternoon). The days when sampling occurred were chosen at random, but censuses were not conducted during inclement weather. The two observers (AD and SS) alternated between observing from a stationary point and moving intermittently around the perimeter of the effluent ponds, being cautious not to disturb the birds. All birds were identified by appearance and/or calls, with the aid of 8 x 40 mm binoculars, and reference to available literature (Mason & Jarvis 1989; Iskandar 1989; MacKinnon & Phillipps 1993; Strange 1998). Numbers of birds were recorded using a Hand Tally® counter (model LH 102, Japan), when necessary.

Data were analysed with a chi-square goodness of fit test to compare abundance and diversity between morning and afternoon observations. Since visits occurred on only one afternoon but two mornings, one of two morning data sets collected for each month were randomly excluded from this analysis to ensure equal sampling effort between morning and afternoon.

Results

In total 59 species were observed, but two species were presumably feral (Sulphur-crested Cockatoo *Cacatua galerita* and Tanimbar Corella *C. goffini*) and another, a tern, was unidentified (Appendix 1). The Cotton Pygmy-Goose *Nettapus coromandelianus*, an individual of which was observed on four occasions, has not previously been recorded on Bali (Mason & Jarvis 1989; Mason, this issue).



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Plate 2. View of large fig tree that attracted large numbers of Pink-necked Green Pigeons, Nusa Dua sewage treatment ponds.

The number of species per census varied from 23 to 36, with a mean of 31 species (SD, 3.6; n, 12), and the number of individuals from 299 to 673, with a mean of 465 individuals (SD, 116.7; n, 12). Almost 80% of species averaged less than 10 individuals per census (71.4%, ≤ 5). The species with the highest mean abundance were Pink-necked Green Pigeon *Treron vernans* and Little Egret *Egretta garzetta*, although numbers of the latter varied dramatically throughout the period (Appendix 1). Up to 99 Green Pigeons were often attracted to fruits in several

large figs and other trees planted within the complex (Plate 2). The Black-crowned Night Heron *Nycticorax nycticorax* and Javan Pond Heron *Ardeola speciosa* were the next most abundant species, but variance was very high for the former species. Maximum numbers for the Little Egret was 223, and for the Black-crowned Night Heron, 155. The migratory Barn Swallow was also found in large numbers (up to 97 individuals). The number of birds observed during morning visits was significantly higher than that in afternoon visits ($\chi^2_3 = 58.93$, $P < 0.05$), although species richness did not differ significantly between these times of day ($\chi^2_3 = 0.43$, $P > 0.05$).

While watching egrets we observed an unusual foraging behaviour for the Little Egret. Each day just before sunrise, hundreds were observed to fly over the ponds, swooping down and skimming the surface of the water to catch their prey

(typically fish). If successful, they would fly to a nearby perch or land on the banks of the ponds to consume their catch.

Discussion

The Nusa Dua sewage treatment complex is undeniably an important local site for herons, several of which breed there (Mason 2000) and on occasions large numbers are present, including resident and migrant species. A total of 59 bird species were recorded to use the complex during the wet season of 1999, although the total species richness of the site is likely to be much higher given the short period of this survey (four months) and the lack of dry season records.

The Cotton Pygmy Goose has not previously been recorded in Bali, and although the species has a wide distribution stretching from India and southern China to Australia, it is very rare in Indonesia, with few recent records from Java (MacKinnon & Phillips 1993), and only four specimens from Wallacea, all from North Sulawesi (Coates & Bishop 1997). As our observations concerned a single bird over a short period, the species can only be considered as a vagrant on Bali.

The high demand for caged birds (Prayogo & Suranto 1995) has provided incentive for people to capture and trade them (Imansyah *et al.* 1999). Such birds may escape and form the basis of feral populations. Our survey yielded two species that probably represent such escapees, the Sulphur-crested Cockatoo and Tanimbar Corella, neither of which occur naturally west of South Maluku (Coates & Bishop 1997). Based on the numbers observed of the latter species (up to 10 birds per survey), there may now be an established feral population on Bali.

The Little Egret was the most abundant heron during the survey, with over 200 individuals counted on a single census, the largest recorded number of any species encountered (Appendix 1). Our observation of the aerial foraging behaviour of these egrets is significant as most egret species typically secure food by wading, or standing motionless on emergent branches or in shallow water, waiting for their prey (e.g. Recher *et al.* 1983; Hancock & Kushland 1984; Wiggins 1991; McKilligan 2005). However, very similar behaviour was reported by Mackay (1967) at the sewage treatment ponds near Moitaka, Papua-New Guinea, where the fish were so abundant that they caused the surface of the water to 'boil' continually. At Moitaka Little Egrets, together with Great Egrets and Pied Herons *Ardea picata*, were observed to fly over the ponds, starting downwind to get the slowest speed, then rapidly snap at the fish that came to the surface immediately in front of them on the line of flight (Mackay 1967). Such foraging behaviour may be confined to situations, such as sewage treatment ponds, where fish are trapped in a relatively confined space, but where the water is too deep to allow birds to wade.

Conclusion

The impressively large numbers of birds found in the Nusa Dua sewage treatment ponds is likely primarily due to the rich and reliable supply of fish and other

aquatic life provided by the ponds (as seen in sewage ponds worldwide) and adjacent tidal creeks, as well as the fruit on several fleshy-fruited trees, including figs. The birds also enjoy a greater than normal degree of protection from hunting by the security patrol of the resort and the sewage ponds themselves (Plate 3). Despite being little more than a series of artificial (concrete) ponds that receive waste from the local tourist hotel complex, the Nusa Dua sewage complex has apparently developed into an important habitat refuge for a wide range of birds, including some rare species (e.g. Mason 2000), within the tourist area of Denpasar.

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Plate 3. Signage at Nusa Dua Lagoon sewage treatment ponds.

Appendix 1. Abundance of birds recorded at Nusa Dua Lagoon sewage treatment ponds, January-April 1999. *, feral; #, unidentified

Common Name	Scientific Name	Mean	SD	Max. no.
Little Pied Cormorant	<i>Phalacrocorax melanoleucos</i>	< 0.5	0.29	1
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>	1	1.06	3
Darter	<i>Anhinga melanogaster</i>	< 0.5	0.58	2
Purple Heron	<i>Ardea purpurea</i>	15	6.4	28
Great Egret	<i>Ardea alba</i>	4	2.92	10
Intermediate Egret	<i>Egretta intermedia</i>	< 0.5	0.67	2
Little Egret	<i>Egretta garzetta</i>	70	65.82	223
Javan Pond Heron	<i>Ardeola speciosa</i>	50	20.16	96
Striated Heron	<i>Butorides striata</i>	3	3.37	10
Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	54	42.27	155
Rufous Night Heron	<i>Nycticorax caledonicus</i>	< 0.5	0.29	1
Yellow Bittern	<i>Ixobrychus sinensis</i>	1	1.53	5
Glossy Ibis	<i>Plegadis falcinellus</i>	1	1.65	4
Brahminy Kite	<i>Haliastur indus</i>	< 0.5	0.62	2
Cotton Pygmy Goose	<i>Nettapus coromandelianus</i>	< 0.5	0.29	1
Sunda Teal	<i>Anas gibberifrons</i>	17	7.04	29
White-breasted Waterhen	<i>Amauornis phoenicurus</i>	4	2.91	12
Common Moorhen	<i>Gallinula chloropus</i>	< 0.5	0.67	2
Wood Sandpiper	<i>Tringa glareola</i>	2	1.98	5
Common Sandpiper	<i>Actitis hypoleucos</i>	11	4.04	20
Tern sp. #	<i>Sterna/ Chlidonias</i>	1	1.22	3
Spotted Dove	<i>Streptopelia chinensis</i>	14	10.3	31
Island Collared Dove	<i>Streptopelia bitorquata</i>	< 0.5	0.29	1
Pink-necked Green Pigeon	<i>Treron vernans</i>	71	22.94	99

Sulphur-crested Cockatoo*	<i>Cacatua galerita</i>	< 0.5	0.58	2
Tanimbar Cockatoo*	<i>Cacatua goffini</i>	2	3.06	10
Plaintive Cockoo	<i>Cacomantis merulinus</i>	< 0.5	0.39	1
Asian Koel	<i>Eudynamys scolopacea</i>	< 0.5	0.29	1
Cave Swiftlet	<i>Collocalia linchi</i>	7	4.09	14
Asian Palm Swift	<i>Cypsiurus balasiensis</i>	< 0.5	0.45	1
Cerulean Kingfisher	<i>Alcedo coerulescens</i>	5	2.9	9
Javan Kingfisher	<i>Halcyon cyanoventris</i>	< 0.5	0.58	2
Collared Kingfisher	<i>Halcyon chloris</i>	2	1.62	5
Blue-tailed Bee-eater	<i>Merops philippinus</i>	20	10.85	43
Fulvous-breasted Woodpecker	<i>Dendrocopos macei</i>	< 0.5	0.29	1
Barn Swallow	<i>Hirundo rustica</i>	26	31.09	97
Pacific Swallow	<i>Hirundo tahitica</i>	4	5.07	15
Yellow Wagtail	<i>Motacilla flava</i>	1	0.9	3
Richard's Pipit	<i>Anthus novaeseelandiae</i>	< 0.5	1.15	4
White-shouldered Triller	<i>Lalage sueurii</i>	< 0.5	0.29	1
Common lora	<i>Aegithina tiphia</i>	1	1.24	3
Sooty-headed Bulbul	<i>Pycnonotus aurigaster</i>	3	4.48	14
Yellow-vented Bulbul	<i>Pycnonotus goiavier</i>	26	18.4	73
Oriental Magpie Robin	<i>Copsychus saularis</i>	< 0.5	0.29	1
Bar-winged Prinia	<i>Prinia familiaris</i>	< 0.5	0.62	2
Olive-backed Tailorbird	<i>Orthotomus sepium</i>	1	1.03	3
Golden-bellied Gerygone	<i>Gerygone sulphurea</i>	5	3.26	10
Pied Fantail	<i>Rhipidura javanica</i>	1	1.83	6
Scarlet-headed Flowerpecker	<i>Dicaeum trochileum</i>	7	4.12	15
Olive-backed Sunbird	<i>Cinnyris jugularis</i>	7	4.66	15
Javan Munia	<i>Lonchura leucogastroides</i>	1	2.02	7

Scaly-breasted Munia	<i>Lonchura punctulata</i>	9	10.46	31
White-headed Munia	<i>Lonchura maja</i>	2	3.14	8
White-vented Myna	<i>Acridotheres javanicus</i>	13	12.03	41
Black-naped Oriole	<i>Oriolus chinensis</i>	< 0.5	0.29	1
Black Drongo	<i>Dicrurus macrocercus</i>	1	0.97	3
Greater Racket-tailed Drongo	<i>Dicrurus paradiseus</i>	< 0.5	0.29	1
White-breasted Woodswallow	<i>Artamus leucorhynchus</i>	1	2.97	10
Large-billed Crow	<i>Corvus macrorhynchus</i>	1	1.73	6

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