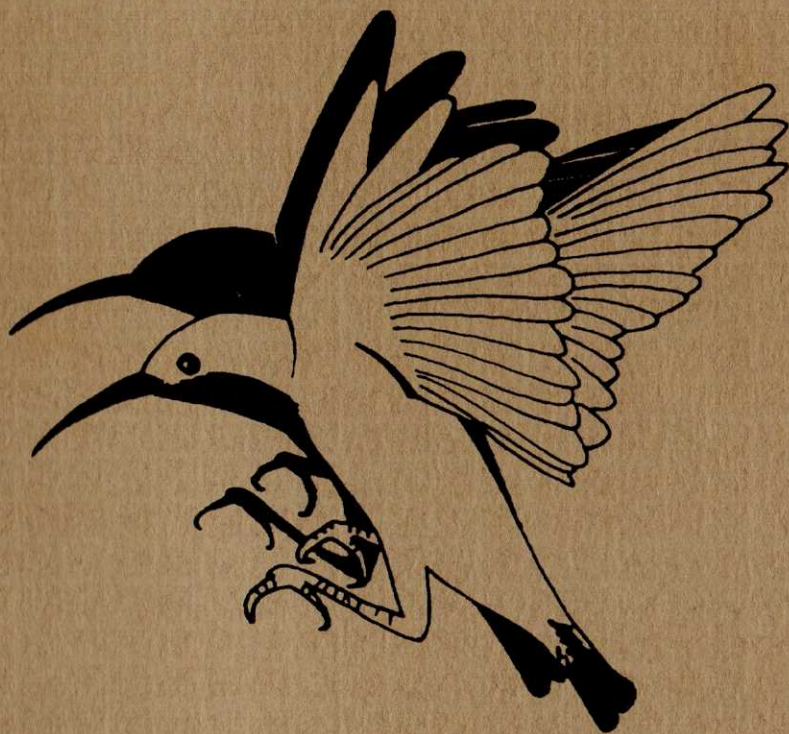


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# THE SUNBIRD

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## UTILISATION OF SEASHORE VEGETATION BY TROPICAL SEABIRDS ON NORTH EAST CAY (HERALD CAYS), CORINGA-HERALD NATIONAL NATURE RESERVE, AUSTRALIA

GEORGE N. BATIANOFF

### ABSTRACT

The vegetation patterns and distribution of tropical seabird nesting sites on the North East Cay (Herald Cays, 16°56'S, 149°11'E) are summarized. This article provides strong evidence of temporal and spatial resource partitioning and the interaction of seabirds with cay vegetation and dry land. Some data on seabird breeding populations on Raine Island is used to understand the significance of North East Cay as a nesting site for the nine species studied. Population estimates suggest that about 141 000 seabirds may nest on the 34 ha cay annually. Seabird nesting sites occur above, on and below the ground. *Pisonia grandis* low closed-forest; *Argusia argentea* open-scrub and *Abutilon*/*Ipomoea* vine-covered shrubland are the preferred nesting sites for the largest cluster colonies of seabirds. *Pisonia grandis* forests provide nesting sites for the greatest variety of seabirds, including the most abundant species. The shrub and tree layers greatly increase island areas available for seabird nesting sites.

The Common Noddy, although small in numbers, occupies the greatest range of nesting site habitats, whereas the large cluster colonies of the Black Noddy and Wedge-tailed Shearwater occupy the least number of habitats. Nests of the Lesser Frigatebird occur on the ground, in low shrubs and in the tree canopy, whereas Great Frigatebird nests only occur in the treetops. The most common plant materials utilized in nest building include stems and leaves of *Abutilon asiaticum* var. *australiense* (shrub), *Lepturus repens* (grass), *Pisonia grandis* (tree) and seaweeds, reflecting their local availability as nesting material.

### INTRODUCTION

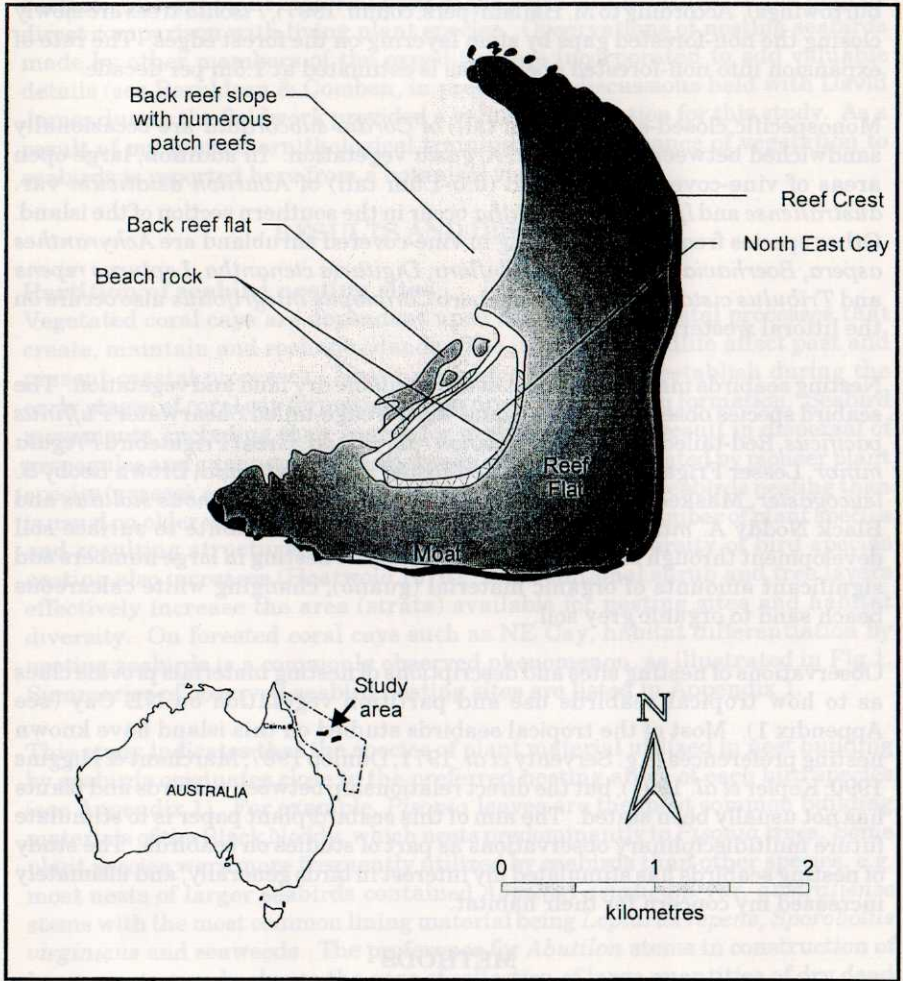
The North East Cay (NE Cay) of Herald Cays (16°56'S, 149°11'E) is located within Coringa-Herald National Nature Reserve in the Western Coral Sea about 400km

east of Cairns. This 34 ha (ANPWS, 1989) or 44 ha (Neil and Jell, in press) sandy cay is half-moon shaped and aligned along a NE-SW axis (Fig. 1). The sheltered straight line of the northern shore consists of broad sandy beaches bordering a discontinuous line of beach-rock at the low water mark. The exposed southern (south-east and south-west) shorelines are windswept, with narrow beaches stabilised by a broad platform of beach-rock up to 30m wide. Along the south-eastern shore some of the beach rocks are piled up to one metre high resembling a low rock wall. This stabilising rock wall is indicative of high seas during cyclonic weather. Mean annual rainfall is estimated at 1100 to 1150 mm with the wet season usually occurring between January and April. According to ANPWS (1989) rainless spells of 50 to 80 days have been recorded during the dry season (August to October). Daily mean temperature range between 21°C and 31°C while the maximum recorded temperature since 1932 is 34°C (and the minimum 17°C). South-easterly winds predominate over the region from March to November and the north-west monsoon prevails from December to February (ANPWS 1989).

The north Coral Sea islands are well known as breeding sites for migratory tropical seabirds (Serventy *et al.* 1971). According to ANPWS (1989), forested cays are critical for the survival of many seabirds that come to them from an extensive oceanic 'catchment'. NE Cay is one of the three *Pisonia grandis* forest cays within the Coral Sea Island Territory. The vegetation of this cay is dominated by luxuriant *P. grandis* rainforest. According to Batianoff (1999a), this vegetation is a rare plant community in Australia. However, all of the sixteen plant species present on the island are widespread tropical species of the Indo-Pacific Region. Most of these 'specialised' coral plants display very strong zonation patterns (Batianoff in press).

*Argusia argentea* forms a shrubland and/or open-scrub (2-3m tall) fringing the circumference of the island. Along the northern and western shores the *Argusia* open-scrub (3-4m tall) zone becomes wider, occurring with an understorey dominated by herbs, including *Lepturus repens*, *Sporobolus virginicus*, *Boerhavia albiflora* var. *albiflora*, *Stenotaphrum micranthum*, *Tribulus cistoides*, *Achyranthes aspera*, *Portulaca oleracea* and an occasional *Boerhavia mutabilis* and *Abutilon asiaticum* var. *australiense* shrub. Extensive grasslands of *Sporobolus virginicus* and *Lepturus repens* occur on the seaward margins along the northern and western beaches with smaller patches on the exposed southern and eastern beaches.

Low closed-forests (6-10m tall) of *P. grandis* occupy most of the inner and outer sections of the island. The more developed (larger trunks) and taller (8-11m) *Pisonia* closed-forest occurs in the north-western sector of the cay. This possibly indicates an early arrival/establishment and/or the older island section (Batianoff 1999b, in press). On the exposed windward margins of the island, the *Pisonia*



**Figure 1. Coral Sea Island Territory, location of Coringa-Herald National Nature Reserve and North East Cay and reef.**

forest becomes a wind-shorn closed-scrub 2 to 3m tall, frequently showing the sculpturing or tunnelling effects of strong winds. The ground cover of *Pisonia* forest consists of a deep litter layer alternating with bare raised sections (bird burrowings). According to M. Hallam (pers. comm. 1997), *Pisonia* trees are slowly closing the non-forested gaps by stem layering on the forest edges. The rate of expansion into non-forested open areas is estimated at 1.5m per decade.

Monospecific closed-scrubs (3-8m tall) of *Cordia subcordata* are occasionally sandwiched between *Pisonia* and *Argusia* vegetation. In addition, large open areas of vine-covered shrubland (0.5-1.5m tall) of *Abutilon asiaticum* var. *australiense* and *Ipomoea macrantha* occur in the southern section of the island. Other species frequently occurring in vine-covered shrubland are *Achyranthes aspera*, *Boerhavia albiflora* var. *albiflora*, *Digitaria ctenantha*, *Lepturus repens* and *Tribulus cistoides*. The annual herb *Coronopus integrifolius* also occurs on the littoral western margins.

Nesting seabirds make use of most of the available dry land and vegetation. The seabird species observed on this island were Wedge-tailed Shearwater *Puffinus pacificus*, Red-tailed Tropicbird *Phaethon rubricauda*, Great Frigatebird *Fregata minor*, Lesser Frigatebird *F. ariel*, Red-footed Booby *Sula sula*, Brown Booby *S. leucogaster*, Masked Booby *S. dactylatra*, Common Noddy *Anous stolidus* and Black Noddy *A. minutus*. Many burrowing birds contribute to surface soil development through bioturbation. Also, seabirds nesting in large numbers add significant amounts of organic material (guano), changing white calcareous beach sand to organic grey soil.

Observations of nesting sites and descriptions of nesting materials provide clues as to how tropical seabirds use and partition vegetation on NE Cay (see Appendix 1). Most of the tropical seabirds studied on this island have known nesting preferences (e.g. Serventy *et al.* 1971, Dunlop 1987, Marchant & Higgins 1990, Kepler *et al.* 1994), but the direct relationship between seabirds and plants has not usually been stated. The aim of this seabird/plant paper is to stimulate future multidisciplinary observations as part of studies on seabirds. The study of nesting seabirds has stimulated my interest in birds generally, and ultimately increased my concern for their habitat.

## METHODS

Fieldwork was undertaken from 14 June to 29 June 1997 as part of the Royal Geographic Society survey of this cay. Eleven permanent transects are located east to west across the cay. Nine of these transects were sampled for vegetation and bird observations at 50m intervals (using 5x5 m plots) in both the morning and afternoon. Some free sampling (plotless observations) sites were recorded in the early morning to include vegetation and bird assemblages not present

along the transects. Recordings were made of vegetation data, the presence of birds and estimates of flock sizes, and plant material use in nests and soil diggings (collecting *Pisonia* roots and soil sampling) within 75cm of the soil surface. The dry plant material used in the nests was identified in the field by direct comparison with living plant species. Observations of nesting seabirds made by other members of the expedition are incorporated to add valuable details (see Beruldsen & Comben, in press). The discussions held with David James during the fieldwork provided a valuable foundation for this study. As a result of my limited ornithological training, the importance of vegetation to seabirds is reported here from a botanical viewpoint.

## RESULTS AND DISCUSSION

### Partition of seabird nesting sites

Vegetated coral cays are dependent upon the physical coastal processes that create, maintain and reshape islands. The impacts of wildlife affect past and present coastal processes. Nesting colonies of seabirds establish during the early stages of coral cay formation, often prior to vegetation formation. Seabird movements, including their search for nesting material, result in dispersal of propagules and guano within and between cays. Cays vegetated by pioneer plant species (grasses and low bushes) may have fewer species of seabirds nesting than is usual on older wooded islands (Heatwole 1976). As the number of plant species and resulting structural complexity increases, the diversity of bird species nesting also increases (Heatwole 1976). The additional shrub and tree layers effectively increase the area (strata) available for nesting sites and habitat diversity. On forested coral cays such as NE Cay, habitat differentiation by nesting seabirds is a commonly observed phenomenon, as illustrated in Fig. 1. Summaries of observed seabird nesting sites are listed in Appendix 1.

This study indicates that the species of plant material utilized in nest building by seabirds originates close to the preferred nesting areas of each bird species (see Appendix 1). For example, *Pisonia* leaves are the most common building materials of the Black Noddy, which nests predominantly in *Pisonia* trees. Some plant species were more frequently utilized by seabirds than other species, e.g. most nests of larger seabirds contained *Abutilon asiaticum* var. *australiense* stems with the most common lining material being *Lepturus repens*, *Sporobolus virginicus* and seaweeds. The preference for *Abutilon* stems in construction of larger nests may be due to the ease of collection of large quantities of dry dead material from this short-lived shrub.

Drift seaweeds deposited on the beach provide additional nesting material for many seabirds. Succulent plants such as *Portulaca oleracea*, *Boerhavia* spp., *Tribulus cistoides* and leaves of *Argusia argentea* were minor components in nest construction. These plant species may be avoided by many seabirds due to the

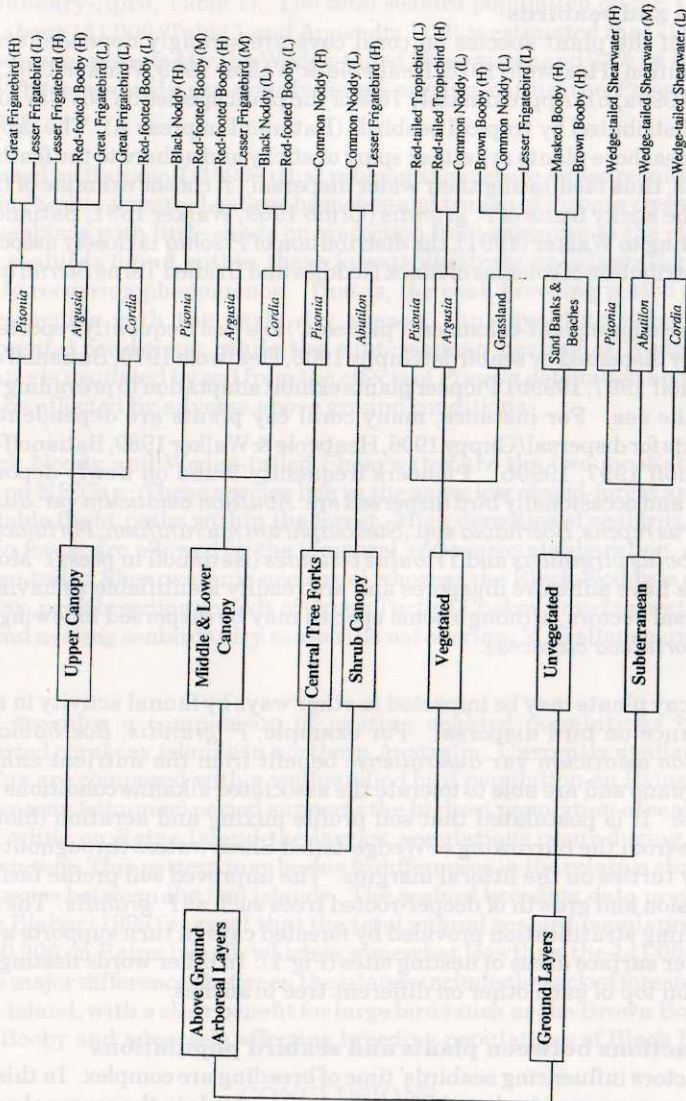


long periods required for drying and/or other factors. The subterranean nesting habit of the Wedge-tailed Shearwater is dependent on soil compaction and plants play an indirect role in providing soil stability by their fine surface root mass. Likewise, *Pisonia* trees benefit from the burrowing activity of Wedge-tailed Shearwaters, which enhances soil development through aeration and organic mixing. On NE Cay, the highest population of Wedge-tailed Shearwater burrows occurs within consolidated (deeper) *Pisonia* forest soils.

The natural partitioning of seabird breeding sites on this cay is summarized in Fig. 2. On NE Cay eight out of the nine seabird species nest in colonies forming a variety of flock clusters within and between woody vegetation, while five species nest off the ground in the upper, middle and lower canopy. Of these above ground arboreal nesters, one species nests in central tree forks and two nest in shrub canopies. Six species nest on the ground in both vegetated and unvegetated areas, and a single species builds a subterranean nest. *Pisonia* vegetation supports the highest number of seabird species, including Great Frigatebird, Lesser Frigatebird, Black Noddy, Common Noddy, Red-footed Booby and Wedge-tailed Shearwater. Incidentally, the only other bird observed nesting on NE Cay, the Buff-banded Rail *Gallirallus philippensis tournelieri*, also nests in *Pisonia* forests. The vegetation least preferred by all seabird species for nesting on this cay is *Cordia* closed-scrub (see Fig. 1).

There are a greater number of seabird nests, species and individuals on the ground than in surrounding vegetation. The highest diversity of nesting sites was found on the littoral margins and at the junction of two vegetation types. Birds such as the Red-tailed Tropicbird, with weak, fully webbed feet, are unable to use inland vegetated sites due to their restricted movements on land. Black Noddies nesting within *Pisonia* forests have the most specialized nesting site, and their nesting colonies distribution appears to depend on the proximity of aerial entry points (ie. relatively large overstorey canopy openings for fly paths) created by cyclone damage (see Appendix 1).

Plants may be used by seabirds for purposes other than in nest construction, and behavioural aspects of seabirds indirectly associated with plants were observed and noted. On many occasions frigatebirds (both species) carrying nesting material were pursued vigorously by other frigatebirds in an attempt to steal this material, and interactions were both inter- and intra-specific in nature. Much of the nesting material is eventually dropped to the ground (ie. incidental seed dispersal). The anonymous reviewer suggested that frigatebirds chasing such congeners might be engaged in a form of aerial skill development for their kleptoparasitic behaviour. Plant material also features in pre-egg laying ceremonial displays (Serventy *et al.* 1971). Brown, Masked and Red-footed Boobies all have nesting displays in which pieces of wood and other plant material are used in their display ceremonies (Marchant & Higgins 1990, M. Preker pers. comm. 1997).



**Figure 2. Relationship between nesting preferences of tropical seabirds and plants on NE Cay (Herald Cays). (H)= high density, (M)=medium density, (L)= low density of nesting sites relative to species populations.**

### Plants and seabirds

Many of the plant species on coral cays are strongly dependent on seabird distribution (Heatwole 1976, Heatwole & Walker 1989, Walker 1991; Batianoff 1997, 1999a, b). Approximately 76% of the plant species on NE Cay are thought to be distributed by tropical seabirds (Batianoff in press A). The propagules of many seashore plants are either spiny or sticky and adhere to the feathers or feet of birds, thus facilitating their wider dispersal. A classic example of this is seen with the sticky fruits of *P. grandis* (Cribb 1969, Walker 1991, Batianoff 1999a). According to Walker (1991), the distribution of *Pisonia* is closely associated with the distribution of colonies of Black Noddies and Bridled Terns *Sterna anaethetus*.

Early seashore plant-colonisers ('pioneers') are less frequently reported as being actively dispersed by seabirds (Guppy 1906, Heatwole 1976, Batianoff *et al.* 1993; Batianoff 1997, 1999b). Pioneer plants exhibit adaptation to prevailing conditions near the sea. For instance, many coral cay plants are dependent on ocean currents for dispersal (Guppy 1906, Heatwole & Walker 1989, Batianoff *et al.* 1993; Batianoff 1997, 1999b). Pioneers frequently found on newly deposited sand banks and occasionally bird dispersed are: *Abutilon asiaticum* var. *australiense*, *Lepturus repens*, *Boerhavia* spp., *Stenotaphrum micranthum*, *Portulaca oleracea*, *Sporobolus virginicus* and *Tribulus cistoides* (Batianoff in press). Most of these species have adhesive diaspores and are readily identifiable as having birds as dispersal vectors, although some species may be dispersed following ingestion (e.g. *Portulaca oleracea*).

Coral cay plants may be impacted in other ways by faunal activity in addition to a reliance on bird dispersal. For example, *P. grandis*, *Boerhavia* spp. and *Abutilon asiaticum* var. *australiense* benefit from the nutrient enhancement from guano and are able to tolerate the associated alkaline conditions on the soil surface. It is postulated that soil profile mixing and aeration (bioturbation) results from the burrowing of Wedge-tailed Shearwaters throughout the island and by turtles on the littoral margins. The improved soil profile facilitates the expansion and growth of deeper-rooted trees such as *P. grandis*. The additional branching stratification provided by forested cays in turn supports availability of larger surface areas of nesting sites (Fig. 1). In other words nesting sites may occur on top of each other on different tree branches.

### Interactions between plants and seabird populations

The factors influencing seabirds' time of breeding are complex. In this study the weather was recognised as playing an important role in the seasonal partitioning of available resources. The examination of seasons indicates that about 60% of the species on NE Cay have a peak-breeding season during the dry winter (August-October). These are Black Noddy, Common Noddy, Red-tailed Tropicbird, Lesser Frigatebird and Great Frigatebird. Brown, Masked and Red-footed Booby and Wedge-tailed Shearwaters mostly breed during the wet summer

period (January-April, Table 1). The total seabird population on NE Cay over a year is about 141 000 (Table 1 and Appendix 1). It is estimated that 72% of this population is represented by the Wedge-tailed Shearwater and 21% by the Black Noddy. These seabirds are mainly found nesting within the *Pisonia* forest boundaries.

It is reported by Batianoff (1999a) that prolonged moisture stress results in total leaf loss in *Pisonia* forests. Leafless branches and trunks of *Pisonia* trees provide nesting seabirds with little shade or protection from exposure to the elements. The two seabirds found within these forests illustrate an adaptation to this frequently recurring phenomenon. That is, the peak breeding period of Black Noddy coincides with the early dry season, thus avoiding these hostile environmental conditions, while the subterranean nesting of Wedge-tailed Shearwater is insulated by soil from the effects of *Pisonia* defoliation and as such may not be affected by adverse above ground conditions.

The Black Noddy and Wedge-tailed Shearwater are the two most abundant seabirds on NE Cay. These species live in the same low closed-forest and share the available flight paths within the forest. High densities of seabirds nesting in *Pisonia* forest are allowed by the temporal and seasonal separation. That is, the Wedge-tailed Shearwater is nocturnal whereas the Black Noddy is diurnal. On NE Cay, peak breeding periods of Green Turtles *Chelonia mydas* (wet season) and ground nesting seabirds (dry season) do not overlap (M. Hallam pers. comm. 1991).

Table 1 provides a comparison of nesting seabird populations between similar-sized coral cay islands in northern Australia. Currently available data for NE Cay are compared with a well-studied bird population on Raine Island. The wet season (summer) period supports the highest population of seabirds on NE Cay, while on Raine Island the largest populations occur during the dry season (winter). This pattern may be due to differences in the relative abundance of bird species between the two islands. The seabird breeding data provided by Taplin & Blaber (1993) suggest that the total annual seabird population size is about 100 900 on Raine Island, which is somewhat less than the 141 000 on NE Cay. The major differences between the islands include the lack of forested areas on Raine Island, with a clear benefit for large birds such as the Brown Booby and Masked Booby and adversely affecting breeding populations of Black Noddy.

## CONCLUSIONS

Seabirds living in large groups inevitably depend on island vegetation for resting, roosting and nesting materials. Large colonies of seabirds can disperse plant propagules and provide soil nutrients for vegetation growth. The coral cay plants are adapted to the nutrient enhancement from guano and bird dispersal

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**TABLE 1. Comparison of estimated breeding seabird populations between Raine Island and North East Cay. Note: data for NE Cay and Raine Island are modified from Beruldsen & Comben (in press) and Taplin & Blaber (1993), respectively. W = wet season (summer); D = dry season (winter).**

Species	North East Cay Yearly estimates	Raine Island Yearly estimates	Breeding Peak
Wedge-tailed Shearwater	102 000± 38 000	3 000±2 000	W
Red-tailed Tropicbird	770±?	150±50	D
Great Frigatebird	800±200	10±?	D
Lesser Frigatebird	5 000±2 000	3 500±1 500	D
Red-footed Booby	2 000±?	200±?	W?
Brown Booby	20±?	12 000±4 000	W
Masked Booby	50±?	2 000±500	W
Common Noddy	200±?	80 000±20 000	D
Black Noddy	30 000±10 000	2±?	D
Total	140 840	100 862	-

of their propagules. Many burrowing birds of the cay contribute to soil profile formation via bioturbation. Nesting site preferences and nesting material used by seabirds on NE Cay are summarized. It is observed that most resources on this cay appear to be not only partitioned but also heavily utilized. Peak breeding populations occur within the low closed *Pisonia* forest. The highest number of seabirds occurs during the wet season.

Temporal partitioning of nesting ground, plant resources and fly paths by seabirds is significant on NE Cay, particularly within *Pisonia* forest, which is recognised as the critical nesting habitat on this cay, due to its having the highest annual numbers of breeding seabirds. This paper suggests that bird and plant assemblages show strong interrelationship based on breeding site preferences and vegetation zonation. It is reasonable to conclude that NE Cay is comparable to Raine Island and thus a major nesting site in Australia. Finally, it is suggested that future expeditions explore the plant-bird relationship further on other coral islands.

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**APPENDIX 1. Summary of seabird nesting sites on North East Cay (see Fig. 2 for nest partitioning information).**

**1. Wedge-tailed Shearwater**

**Sites:** At the time of this survey there was only a limited number of active breeding burrows, which may be explained by the observed occurrence of the breeding peak in the wet season at Raine Island (Taplin & Blaber 1993). These subterranean breeding sites were found only in older, consolidated vegetated soils. The main concentrations of burrows were under *Pisonia* vegetation. Other areas include *Abutilon / Ipomoea* vine-covered shrubland and grassland between *Pisonia* and *Argusia* arboreal vegetation. A few burrows also occurred within *Cordia* vegetation. Beruldsen & Comben (in press) estimated 62 250 burrows in the forested area in 1997 and reported previous estimates as high as 111 000 burrows for NE Cay. Incidentally, Batianoff (1999a) reported the total number of burrows within *Pisonia* forest ranging from three to nine burrows (about 6) per

10m<sup>2</sup>. Assuming 50% burrow occupancy, the annual number of breeding birds at NE Cay was estimated at 62 000-140 000 individuals.

Soil excavations show that *Pisonia* trees have their main root mass located between depths of 30-60cm: nesting chambers occur immediately below this zone. Some burrows were about 70cm deep. The burrows within *Abutilon* / *Ipomoea* shrubs appeared to be shallower. Two excavations indicated main chambers from 25cm to 35cm deep. Observations of burrows on Raine Island indicated that most of the birds were nesting in the upland areas of *Abutilon* shrubland and *Achyranthes* / *Lepturus* herbland (Batianoff unpublished data, 1992).

**Nesting material:** Nil. Possibly some plants are taken as linings and/or entrance blockages (Dyer 1990).

## 2. Red-tailed Tropicbird

**Sites:** According to Taplin & Blaber (1993) the breeding peak of this species at Raine Island coincides with the dry season. A few nests occur among beach-rock rubble along the exposed north-eastern side of the cay. Several nests were found sheltering in the exposed roots of *Argusia* and *Pisonia* trees along the eroding sections of the seashore, while the majority were hidden under *Argusia* trees growing close to the high tide margins. In 1997, Beruldsen & Comben (in press) counted 386 occupied nests, and they concluded that, as a breeding location, NE Cay is second only to Christmas Island. The numbers of birds counted may reflect high population size during the peak-breeding season. The large distances between nests gave the impression that the Red-tailed Tropicbird is a solitary nester at NE Cay. However, M. Preker (pers. comm. 1997) observed four nests under a single *Argusia* bush, suggesting that group nesting also occurs. On Raine Island, most nests were observed on ledges in unvegetated areas along the cliff line (Batianoff unpublished data, 1992).

**Nesting materials:** Nil. The nests are shallow scrapes and depressions in the sand.

## 3. Masked Booby

**Sites:** This species has a peak breeding period during the dry season at Raine Island (Taplin & Blaber, 1993). No breeding Masked Boobies were observed by the author. However, other members of the expedition reported one pair unsuccessfully attempting to incubate eggs (Beruldsen & Comben in press). Past observations of birds on Raine Island and literature reviews (e.g. Serventy *et al.* 1971, Marchant & Higgins 1990), suggest that they would most likely nest (avoiding woody vegetation) on the north-west sand bank, the southern beach sand bar or the eastern beach patches of low grassland on NE Cay. Beruldsen & Comben (in press) reported fifty-three birds on the island on 26 July 1997.



**Nesting materials:** According to Serventy *et al.* (1971) and Batianoff (unpublished data, 1992), Masked Booby nests on Raine Island are scrapes or depressions in sand or on rock with little if any material used.

#### 4. Red-footed Booby

**Sites:** According to Beruldsen & Comben (in press) this species commonly breeds between June and January (ie. end of the dry season to the beginning of the wet season). Solitary nests were scattered along the outer edges of *Pisonia* low closed-forest and on *Argusia* trees on the western beach. Up to one dozen birds were observed. Beruldsen & Comben (in press) reported past estimates of Red-footed Booby in excess of 1 000 pairs in September. The timing of this estimate may correspond to the peak breeding period. Dense cover of *Abutilon asiaticum* var. *australiense* (up to 1.5m) was the main nesting area for this species on Raine Island, indicating a preference for woody vegetation (Batianoff unpublished data, 1992); the observed nests were substantial and mainly composed of *Achyranthes aspera* and *Lepturus repens*.

**Nesting materials:** Most of the nests examined in the *Argusia* trees were either abandoned or were early attempts at new nests. The nests observed consisted mainly of *Abutilon* sticks and *Argusia* leaves loosely woven into moderate-sized stacks lodged in the forks of outer middle and upper branches. The inside lining included small leaf fragments and grassy matting, possibly of *Sporobolus virginicus*, *Lepturus repens*, *Boerhavia* spp., *Portulaca oleracea* and seaweeds.

#### 5. Brown Booby

**Sites:** According to Taplin & Blaber (1993) the peak breeding period is during the wet season at Raine Island. At the time of the survey no nesting was recorded for the Brown Booby. My past observations of these birds on Raine Island (1991), and thorough literature reviews (e.g. Serventy *et al.* 1971, Marchant & Higgins 1990), suggest that large seabirds such as Brown Booby nest on grassy open spaces away from dense arboreal vegetation. However, according to M. Preker (pers. comm. 1998), Brown Booby nests in *Pisonia* forest on Hoskyn Island in the Capricornia Section of the Great Barrier Reef. Beruldsen & Comben (in press) reported ten adult birds on 26 July 1997.

**Nesting materials:** Observations on Raine Island (Batianoff unpublished data, 1992) indicated that stems of *Abutilon*, *Achyranthes* and *Lepturus* are used to make substantial nests on unvegetated surfaces. According to M. Preker (pers. comm. 1997) a range of vegetative materials are used on other islands. Vegetated ground nests tend to be formed from simple matting of grass or scrapes on bare sand between tussocks of plants.

## 6. Great Frigatebird

**Sites:** According to Taplin & Blaber (1993) the peak breeding period of this species occurs from the end of the wet season to the end of the dry season at Raine Island. At the time of the expedition this species was breeding in close proximity to the Lesser Frigatebird. The nesting sites of the Great Frigatebird occurred within the central areas of *Pisonia* closed-forest with the exception of two nests located within *Argusia* open scrub next to or within the Lesser Frigatebird nesting site. Several nests occurred on *Cordia* closed-scrub along the eastern side of the island. All nesting occurred on the tops of tree and tall shrub canopies. Kepler *et al.* (1994) observed that Great Frigatebird preference for *Pisonia* forest on Caroline Atoll is probably due to its choice of more sheltered sites at higher elevation rather than the tree species (ie. it prefers sheltered high trees for its nesting). On Raine Island (Batianoff unpublished data, 1992) nesting occurred on mounds of phosphate rock with or close to Lesser Frigatebirds. Beruldsen & Comben (in press) estimate a ratio of one Great Frigatebird nest to five Lesser Frigatebirds, taking this species' population size into the low hundreds. David James (pers. comm. 1991) has suggested that the Great Frigatebird seen on this cay is an undescribed taxon, with a blue orbital ring (ie. different to the normal red or pink orbital ring); he estimated the NE Cay population be in the high 100s.

**Nesting materials:** The nests were substantial stacks of woody branches, stems of *Ipomoea* and twigs of *Argusia* and *Abutilon*, with a herbaceous lining of *Boerhavia albiflora*, *Lepturus* and *Sporobolus*. From observations made on the ground, nests appeared to be loose structures. However, the one nest examined in the canopy was tidy and well cemented by guano.

## 7. Lesser Frigatebird

**Sites:** According to Taplin & Blaber (1993) the peak breeding period of this species occurs from the end of the wet season through the dry season at Raine Island. Throughout our stay in June 1997 the Lesser Frigatebird was the most conspicuous species in both sky and breeding colony, and Beruldsen & Comben (in press) reported numbers to be a few thousand. Major breeding populations occurred inside *Abutilon*/*Ipomoea* vine-covered shrubland. Nesting was mainly on *Abutilon* shrubs with only a few nests constructed on grass tussocks and two or three ground nests. Three or four colonies were also scattered on the western side of the cay, all nesting on *Argusia* branches. One colony occurred within the upper canopy of the *Pisonia* forest next to or within the Great Frigatebird nesting site. On Raine Island, Lesser Frigatebird nests occurred on restricted elevated areas of phosphate rock in the central island section, some of these nests formed raised 'cushions' up to 30cm high, built up over years of successive use (Batianoff unpublished data, 1992). It appears that NE Cay has a greater variety of potential nesting sites for these seabirds than is available at Raine Island.

**Nesting materials:** The ground nests were large platforms or stacks of stems and sticks, loosely woven and cemented together with guano. These structures were about 30cm in diameter, from 15 to 20cm high and possibly built-up over successive seasons. Those on the *Abutilon* shrubs were less substantial, involving a pan shaped nest made of *Abutilon* sticks and lined with fine grass-straw of *Lepturus repens* and *Digitaria ctenantha*.

## 8. Common Noddy

**Sites:** According to Taplin & Blaber (1993) the peak breeding period of this species occurs from the end of the wet season to the end of the dry season at Raine Island. Nesting sites at NE Cay were scattered in different habitats, ranging from arboreal to ground surface locations. A colony of birds was located inside a taller *Pisonia* forest (mainly in central tree forks) in the middle of the island, and a few nests were seen on *Abutilon asiaticum* var. *australiense* shrubs on the south-western corner. Four or five nests were seen within *Lepturus repens* and *Stenotaphrum micranthum* grasslands on the southern beaches and several were observed on the ground under *Argusia* canopy on the western side of the island. Beruldsen & Comben (in press) reported low numbers of nests and young during the July 1997 visit. Batianoff (unpublished data 1992) observed large breeding flocks scattered in herblands and grasslands (e.g. *Achyranthes aspera*, *Cleome viscosa*, *Lepturus repens*, *Sesbania cannabina*) in sandy areas of Raine Island. This may indicate that Common Noddy has a preference for vegetated areas and/or a sandy surface.

**Nesting materials:** Common Noddy nests were found in the basal forks of *Pisonia* trees whilst the middle branches were occupied by Black Noddies. Nests of Common Noddy were substantial platform structures about 18cm in diameter consisting of sticks, herbaceous stems and leaves. The sticks were from *Abutilon* shrubs and *Achyranthes aspera* herbs, with leaves mainly from *Pisonia* (and possibly *Cordia*) trees. A solitary nest (about 20cm in diameter) on the inside branch forks of *Argusia* was made with a few sticks of *Achyranthes aspera*, bits of straw material (possibly *Sporobolus virginicus* leaves) and fragments of seaweed meshed together (with large leaves from *Argusia* plants).

The few nests located in the open areas were on the southern beach on low *Abutilon* shrubs and were made of soft stems (*Lepturus repens* and *Boerhavia albiflora*) with a few stems of *Tribulus cistoides* and *Achyranthes aspera*. The nests examined in the *Lepturus repens* grassland were shallow saucer-shaped structures of matted grass. The nests found on the ground were either poorly made or were scrapes in the sand under *Argusia* trees along the western beach.

## 9. Black Noddy

**Sites:** According to Taplin & Blaber (1993) the peak breeding period of this species occurs during the dry season. Nest building, eggs and chicks (most without feathers) were observed in many Black Noddy colonies in June 1997. Almost all nesting sites were within *Pisonia grandis* forest, although a few sites were in *Cordia subcordata* closed-scrub community. Nesting patterns distribution appears to depend on the height of trees and nearby cyclone damaged canopy openings. The very dense low canopy (1-4m tall) of *Pisonia* trees growing on the exposed edge of forest margins appeared to be avoided by nesting birds. It was obvious that taller trees (8-10m high) towards the middle and north-western section of the cay supported larger colonies of nesting birds. Nearby large canopy openings were apparently used as entry points. Beruldsen & Comben (in press) report huge numbers of birds (10 000s) and there are past counts of as many as 37 000 birds. According to Cribb (1969) it is not uncommon to find over 100 nests in a single *Pisonia* tree.

**Nesting materials:** Nests were located mostly in the outer middle layers of the *Pisonia* canopy and were cemented with guano to forks of secondary and tertiary branches. The ten nests examined closely were made of dry *Pisonia* leaves with a few stem segments of grasses and occasional seaweed. The soft leaves were flattened, cemented and/or compacted with excreta into small raised structures of about 12 to 16cm in diameter. Incidentally, on Lady Elliot Island in Capricornia Section of the Great Barrier Reef, many nests occur on *Casuarina equisetifolia* var. *incana* with dry *Pisonia* leaves still the preferred nesting material (Batianoff unpublished data, 1997).

A NORTHWARD EXTENSION OF RANGE OF THE GLOSSY  
BLACK-COCKATOO **CALYPTORHYNCHUS LATHAMI**

STEPHEN GARNETT, PETER BRITTON and GABRIEL CROWLEY

Glossy Black-Cockatoos *Calyptorhynchus lathami* are currently thought to occur as far north as Eungella, west of Mackay (Schodde *et al.* 1993). This paper describes an extension of range to the wet tropics of north Queensland.

On 31 March 1999 at about 4.25 pm, Peter Britton and Hazel Britton saw two black-cockatoos flying silently over tall open forest from the Hidden Valley road, west of Paluma, North Queensland (ca. 19°02'S, 146°08'E, 850 m asl.). The habitat was dominated by Rose Gum *Eucalyptus grandis* with an extensive understorey of Forest Oak *Allocasuarina torulosa*. The cockatoos seemed to be rather smaller and shorter-tailed with less laboured wing beats than Red-tailed Black-Cockatoos *C. banksii*, which were also present in the area. The two birds landed in the vicinity of a large vertical hollow about 25 m above the ground in a partially burnt dead tree.

The male was watched for about 3 minutes before the female was seen to emerge from a hollow below him. The female was then watched for about 6 minutes at a distance of about 30 m. It had a distinct but irregular collar of dull yellow feathers that was interrupted below the bill, but very marked at each side. Both birds had the rather square head, broad bill and rudimentary crest of the Glossy Black-Cockatoo. Though not apparently disturbed by the observers or a passing vehicle, they flew away silently at 4.35 pm. The site was visited again at about 7.15 am on 1 April but neither of the Glossy Black-Cockatoos could be found.

The birds were seen again by Stephen Garnett and Gabriel Crowley at about 7.00 am in the same tree on 11 April. On this occasion the male was observed for about 15 minutes calling in the same tree before the female emerged from the same hollow. The female remained at the hollow entrance for about ten minutes before both flew. They returned the same evening at about 1730, the female entering the hollow and the male flying up to roost in a nearby tree. Neither the tree nor the cockatoos were observed during the intervening period. It was noted that the male had no bars in the tail and that the black bars in the tail of the female were thin and broken indicating that she is likely to be an older bird (P. Chapman pers. comm.). Subsequently this pair of cockatoos has been seen by numerous birdwatchers. A large nestling was present at the hollow entrance on about 26 July and was fed by the female on 10 August. On the evening of 12 August, however, no adults visited the hollow. Since fledging by Glossy Black-Cockatoos usually takes place when the adults return in the evening, but before the nestling is fed (Garnett *et al.* 1999), it is likely the nestling at Paluma fledged on the evening of 11 August (R. McKay pers. comm.). On 23 January 2000 one male

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and two Glossy Black-Cockatoos with barred tails were present near the nest site. One of the latter looked like an immature (I. Clayton pers. comm.).

The timing of the nest attempt was well within the normal breeding period, February to October, for Glossy Black-Cockatoos in southern Australia (Garnett *et al.* 1999). It was at first assumed that the behaviour exhibited in late March and early April was of a pair with a dependent nestling (Britton & Britton 1999). In southern Australia, Glossy Black-Cockatoos incubate their single egg for one month and feed the nestling for three months. Once incubating, the female remains on the egg for all but one hour of each day, coming off at dusk to be fed by the male. Only when the nestling is about ten days old does the female start leaving the nest in the morning to feed, as observed at Paluma in April. She then returns with the male in the evening to feed the nestling, which remains inside the hollow until about 10 days before fledging, when it sits at the hollow entrance (Garnett *et al.* 1999). If the birds had had a dependent young in March/April, the nestling should have fledged, at the latest, in late June. From the presence of a young bird at the entrance in mid-August, the birds must have been prospecting the hollow when first seen, laying the egg in mid-April.

These observations extend the species' range by 330 km north-west from Eungella. There are three possible explanations for this record. The first is that Glossy Black-Cockatoos have been present for a long time but overlooked. The extensive tracts of Rose Gum/Forest Oak tall open forest to the north and south of the nest site are seldom visited by ornithologists, and it is conceivable that Glossy Black-Cockatoos have been mistaken for Red-tailed Black-Cockatoos. The latter species is relatively common in this woodland, being present on both visits and appearing regularly over the rainforest at Paluma, mostly in January-March (Griffin 1995). A female Glossy Black-Cockatoo of advanced years, such as the one observed, is likely to have bred several times before. Judging from the presence of three birds in January near the site it is very likely the same hollow has been used repeatedly by the same individual, as has been shown to happen elsewhere (Garnett *et al.* 1999).

The second possible explanation, and the one we think most likely, is that the area has been occupied only recently. In support of this, the area where the birds are nesting was the *site* of regular bird banding expeditions in the early 1980s, has been a study site for much biological research since the 1970s, is currently visited almost weekly by birdwatchers, and its fauna has been well documented by local residents (Griffin 1995). Although, as argued above, Glossy Black-Cockatoos may have been present at the site for several years, they have such a distinctive call that it is unlikely they have been overlooked over such an extended period.

There is every indication that the habitat at Paluma is adequate to support a

breeding pair and its dependent young. Moreover tall open forest, habitat similar to the woodland west of Paluma, is found in a long strip as far north as the Big Tableland near Cooktown (Harrington & Sanderson 1994). All other bird species characteristic of this habitat are found throughout its extent whereas the Glossy Black-Cockatoos sighted were at the southern end of the distribution of this habitat, closest to their previous northern limit, the Eungella Plateau. The species' presence at Eungella itself was only documented for the first time in the 1980s (Pierce 1984), although the cockatoos were in fact present there in the early 1970s (K. R. McDonald pers. comm.). They were not observed, however, during extensive surveys undertaken in the 1960s in the parts of the Eungella Plateau that they now frequent (P. Stanton pers. comm.). Therefore, even if present either at Eungella or Paluma, their numbers must have increased in recent years.

A third possible explanation is that the birds have been released from captive stock or even translocated as adult birds. As for any bird outside its usual range, this cannot be wholly discounted. However survival in the wild is probably more difficult for a captive-reared Glossy Black-Cockatoo than for other species on the basis that juvenile cockatoos take six months to a year to learn feeding techniques, the location of feeding trees of suitable quality and the behaviour of local predators (Crowley *et al.* 1999, Garnett *et al.* 1999). Translocated birds are more likely to survive, though the capture of a wild pair would be extremely difficult and the probability of that pair then managing to stay together and breed must be extremely low. Unlike with other cockatoos, there is no suggestion that any black-cockatoos have established wild populations outside their ranges as a result of aviary releases or escapes.

The likely expansion in range of the Glossy Black-Cockatoo raises two issues. Dispersal across the 330 km between Eungella and Paluma, much of it across unsuitable habitat, indicates the species has potentially greater dispersal abilities than has been assumed. It thus suggests that gaps in the range of Glossy Black-Cockatoos in central New South Wales, western Victoria and south of the Dawson Valley in south-east Queensland are unlikely to create effective genetic barriers. It is partly on the basis of the existence of these gaps that the population north of the Dawson Valley has been erected as a separate subspecies *C. l. erebus* (Schodde *et al.* 1993), although there is some genetic corroboration of this division (Christidis & Norman 1997). Glossy Black-Cockatoos are certainly capable of making such a flight. On Kangaroo Island they can average over 45 km/h in sustained flight (S. Garnett pers. obs.), so the distance represents less than eight hours' flight in a straight line. Furthermore, newly fledged young have been recorded 60 km from their nest tree within three weeks of fledging (Garnett *et al.* 1999). It is also possible for individual Glossy Black-Cockatoos to survive without feeding for at least a day (S. Garnett pers. obs.) and survive the great fluctuations in weight that this would entail (Baume & Garnett 1999). Such

flights, therefore, may not be as unusual as suspected.

The second issue is why Glossy Black-Cockatoos should only now reach an area in which their main foods have been a dominant feature of the landscape for thousands of years (Kershaw 1973). There are two possible reasons for this. The first is that much of the casuarina in north Queensland may not contain food of sufficient quality to sustain Glossy Black-Cockatoos. Elsewhere in their range Glossy Black-Cockatoos require at least 50% of seeds to contain kernels (Crowley *et al.* 1999). In north Queensland, collections of seed at many sites had a germination rate of much less than 50% (Crowley 1986, Crowley & Jackes 1990), suggesting seed fill rate, and thus suitability as cockatoo food, is similarly low.

The second possible reason is a change in burning frequency. For at least the last 40 000 years, the tall open forest has been burnt regularly as part of Aboriginal land management. After burning, Forest Oak may take some years to recover full seed production. Partly as a result of a change from Aboriginal management to pastoralism, much tall open forest has been taken over by rainforest (Harrington & Sanderson 1994). Another consequence of this change in management has been the apparent spread of casuarina (P. Stanton pers. comm.). While some bird species are likely to have declined and may be threatened by the change in fire regime (Chapman & Harrington 1997), the Glossy Black-Cockatoo may have been advantaged.

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## A SIGHT RECORD OF THE WHITE-CHINNED PETREL IN QUEENSLAND

DAVID STEWART

On 1 July 1995, during an organised pelagic trip from the Gold Coast, south-eastern Queensland, a White-chinned Petrel *Procellaria aequinoctialis* was observed flying low over the water towards the boat at 10:05h E. S.T. approximately 48 km due east of the Southport Seaway (27° 58' 48"S, 153° 56' 04"E). The petrel approached the boat to within 15 metres, before flying along the starboard side to a point off the stern and then and away from the boat. During this period, all observers present obtained excellent views of this bird and support the identification. Weather conditions during the observation were fine with south-west winds gusting to 25 knots and moderate seas, producing excellent viewing conditions. The QOSI Records Appraisal Committee has unanimously accepted this sight record (case no. 13).

The only other species present was the Providence Petrel *Pterodronua solandri*, with one bird being seen simultaneously with the White-chinned Petrel behind the boat.

### Description

The bird was noticeably larger than the Providence Petrel and smaller than either of the giant-petrels *Macronectes* app., with a thickset body that tapered towards the tail, and a short thick neck. The wings were broad at the base and long, were held straight or slightly forward and were flapped very infrequently. The feet projected beyond a short wedge-shaped tail.

The plumage was predominantly sooty black except for a small white triangular patch on the chin, and a slightly paler under surface to the primaries, secondaries and the greater underwing coverts. The bill was robust with a deep base, prominent nostrils and bulbous maxillary unguis. At close range the bill was straw coloured with a black strip along the top of the culminicorn between the nostrils and maxillary unguis, black naricorn and sulcus. The legs and feet were black.

This petrel was easily distinguished from Flesh-footed Shearwaters *Puffinus carneipes* by the combination of the large size, general shape of the body, robust bill with a bulbous maxillary unguis, and black legs and feet which projected beyond the tail tip. Confusion with a further two species in the genus *Procellaria* is possible; however, both the bill pattern and white chin on the bird in question clearly eliminated these species. Both the Westland Petrel *P. westlandica* and Black Petrel *P. parkinsoni* have entirely sooty black plumage, which becomes blackish brown due to feather wear (Marchant & Higgins 1990), and large pale

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bills and nostrils with naricorns, culminicorn, maxillary unguis, mandibular unguis and sulcus mostly black.

### General status

The White-chinned Petrel is a widespread species in the Southern Ocean (Powlesland 1989), and is occasionally observed along the southern Australian coast (Marchant & Higgins 1990) and in the Tasman Sea (Robertson 1985). The occurrence of this species further north is less frequent, with only one previous record in Queensland. This was a bird found alive at Coolangatta (28° 10'S, 153° 32'E) on 28 January 1974 after strong winds associated with a cyclonic depression (Vernon & Fleay 1974). This petrel subsequently died and the specimen is now retained in the Queensland Museum (QMO.15178). There have been several possible observations of White-chinned Petrels or one of the other two dark *Procellaria* species in south-eastern Queensland, particularly from Point Lookout and Caloundra Head (unpublished observations). There has also been one beach-cast specimen at Byron Bay (28° 39'S, 153° 37'E; northern New South Wales) during November 1978 (Marchant & Higgins 1990).

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## LACK OF 'PLATELETS' IN PAINTED BUTTON-QUAIL *TURNIX VARIA* IN NORTH- EASTERN QUEENSLAND

LLOYD NIELSEN

Since late 1992, opportunistic searches have been made for quail and button-quail within a 30 km radius of Mt Molloy. Searches over a few days per month to the present in various habitats, but mostly in tropical woodland on the lower slopes and bases of ridges have revealed Buff-breasted Button-quail *Turnix olivii* and Painted Button-quail *T. varia*. Painted Button-quail mostly inhabit denser grassy habitat, but usually occur in the same general flat/slightly sloping localities as the Buff-breasted Button-quail. The Painted Button-quail is much more common, however.

In the time spent observing Buff-breasted Button-quail and Painted Button-quail from 1992 until the present I have never seen scratched platelets (for either species), which are so common in Painted Button-quail habitat in south-eastern Queensland (Olsen *et al.* 1993, McConnell & Hobson 1995). When discussing this at a meeting of the Cairns branch of the Bird Observers Club of Australia, it was suggested that the very hard surfaced soils in much of the habitat may be a reason for this lack of platelets. However, platelets are never seen in leaf litter and other soft materials on the forest floor where one would expect to see platelets.

At one locality where a pair of Buff-breasted Button-quail were seen regularly over a few weeks, I threw seed out to encourage them to stay, with the object of eventually photographing them. Within a few days, a pair of Painted Button-quail moved in and took over the site and the Buff-breasted disappeared immediately. Had it been in south-eastern Queensland, the area would have been scratched over well once the Painted Button-quail moved in, but after a week only a few scratchings had appeared in leaf litter in an erratic manner. No well-formed platelets could be clearly discerned.

No local ornithologists consulted can recall having seen platelets in Painted Button-quail habitat in the Wet Tropics. Perhaps a lack of platelets may suggest that Painted Button-quail in the north-eastern extremity of its range has a distinctive diet which does not necessitate the need for scratching and forming platelets as southern Painted Button-quail populations do. In the process, has it lost the art of forming platelets?

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**BOOK REVIEW**

THE DIRECTORY OF AUSTRALIAN BIRDS: PASSERINES. R. Schodde & I.J. Mason. CSIRO Publishing, Melbourne, 1999. x + 851 pp, \$189.00.

This comprehensive treatment of Australia's passerines is a taxonomic revision, a checklist of species and subspecies, an atlas, and much more. The enormous amount of technical information may be formidable to many readers, but it will be indispensable to dedicated birders and scientists.

This is the first of three planned volumes in a series intended to "inventory the biodiversity of Australia's bird fauna". Volumes on non-passerines and on biogeography are planned. Scientific and technical in style, the series is based on decades of research in laboratory, field and library, and represents a pinnacle in the contributions of two of the country's most influential and prolific systematic ornithologists.

The first section contains four introductory chapters. The first, a fairly brief general introduction, discusses the rationale for the underlying taxonomic philosophy and explains the format and conventions. The taxonomy is based on the familiar biological species concept (BSC), but is compatible with the emerging phylogenetic species concept (PSC). The BSC, used in most checklists and field guides, recognises species as forms that are reproductively isolated from related forms, while the PSC recognises species as the finest level of evolutionary divergence. Subspecies by the BSC are species by the PSC. Schodde & Mason attempt to circumvent the international debate about which species concept is best by introducing the concept of ultrataxa for the finest units of taxonomic divergence (species by the PSC, both subspecies and monotypic species by the BSC). Essentially, they give full credence to subspecies as units of biodiversity.

Chapters two to four review taxonomy at higher levels, list the species and subspecies (a checklist) and summarise taxonomic changes compared to the Birds Australia checklist of species (Christidis & Boles 1994). There is a significant number of newly described taxa (two subfamilies, four subgenera and 46 ultrataxa [i.e. trinomials]) but relatively few changes at the species level (seven recombined species and eighteen split species). Some splits include Paperbark Flycatcher (formerly the northern form of Restless Flycatcher), Kalkadoon Grasswren (formerly the Queensland form of Dusky Grasswren), Arafura Fantail (formerly the northern form of Rufous Fantail) and the division of Shrike-tits into three species. Recombined species include the catbirds and, most controversially, Black-eared and Yellow-throated Miners.

The larger second section contains treatments of "The Taxa" in systematic order

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from the levels of family to ultrataxon. A technical discussion of each family is followed by its species accounts. Within each species account, the ultrataxa are individually described, which is dry reading but provides thorough taxonomic diagnoses of all species and subspecies. Measurement data are sometimes given, but inconsistently and incompletely. Biogeographical ranges, habitat preferences and conservation status (based on IUCN criteria) are documented with a complex system of abbreviations. It is disappointing that the system of habitat classification is unique and a little dated, as there are several recent systems devised by botanists that might have been more universal. The accounts end with explanations of the taxonomic limits recognised at the levels of genus to ultrataxon.

The outstanding feature is the maps, one per species, showing the distribution of all ultrataxa in up to two colours (blue and grey) and four shades per colour. Amazingly, hundreds of hybrid zones of abutting ultrataxa are confidently mapped. Reproduced at the same large scale as maps in the RAOU *Atlas* (Blakers *et al.* 1984), these are definitely the finest maps ever of Australian birds. They are based largely on *Atlas* data and extensive new research, but some supposition has been used as well. For instance, the south-eastern limits of Yellow-spotted and Graceful Honeyeaters are mapped as identical (unlike in the *Atlas*), yet the former occurs 70 km south of the latter. A most serious concern is that the data supporting the mapped limits of subspecies and hybrid zones are largely unverifiable. An ancillary CD or web site of text files listing the specimens examined, with collection data and the authors' taxonomic identification, would improve the scientific value of this work immensely.

I am not aware of a work of this nature and scope for any group of fauna anywhere in the world. It clearly puts the spotlight on a level of biodiversity that most of us have been overlooking. Despite the hefty price, this book is well worth procuring for the maps alone. For those prepared to digest the technical data, a whole new world of insight into the rich, fine-scale biodiversity and distribution of the continent's perching birds awaits.

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