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ASPECTS OF THE BREEDING BIOLOGY OF THE REEF EGRET *Egretta sacra*

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Reef Egret *Egretta sacra* nest site characteristics, nest attendance, vocalizations and eggs and chicks are described. Male and female Egrets spend equal time at the nest site at all stages of nesting. Incubation typically involved long sittings (mean about 21.6 hours, standard deviation (s) = 9.46). The timing of feeding and nest attendance is correlated with the tidal cycle, but differences between Reef Egrets and colonial nesters, such as the Cattle Egret *Ardeola ibis*, might also come from the greater security provided by solitary nesting. Prior to egg laying, the Reef Egrets leave their nests unattended for long periods while they feed at low tide. Male Cattle Egrets guard their nests continuously at this stage. The Reef Egret guards advanced chicks whereas the Cattle Egret does not. This guarding is only at high tide when there are fewer feeding opportunities and they perch some distance from the nest, possibly to avoid advertising its location. Compared with other egret species the Reef Egret would appear to have a small clutch and a long nesting season. A second brood is also indicated for some pairs. These may be adaptations to a chronic shortage of food for egrets in the coral reef environment.

INTRODUCTION

Our knowledge of the breeding biology of the Reef Egret *Egretta sacra* is very incomplete (Hancock and Kushlan 1984; Marchant and Higgins 1990). This study was undertaken on Heron Island, a coral cay on the southern Great Barrier Reef (23°27', 151°55'), from 3rd to 15th December 2000. The egrets' foraging behaviour has been studied there in some detail (Recher and Recher 1972; Recher 1972) but only brief notes are available on its breeding (e.g. Kikkawa 1970; Guthrie 1972). On Heron Island the egrets nest solitarily and feed on nearby coral reefs during low tide. Given the fundamental differences between this environment and that of other Australian ardeids one might expect significant adaptive differences in breeding behaviour and ecology. The present study describes Reef Egret nest sites and adult nest attendance and describes aspects of the behaviour and morphology of adults, eggs and chicks. Their biology is contrasted with that of colonial egrets, in particular the well studied, Cattle Egret *Ardeola ibis*.

METHODS

Egret nests were located i) by advice from staff and researchers on the Island, ii) by a comprehensive search of the foreshore vegetation and open layered woodland and, iii) in the more extensive *Pisonia* forest, by walking five transects, four north-south about 80 metres apart and one bisecting these along an east-west axis. Nests were located on a map of the island (see Acknowledgements) and this was used to estimate the relative extent of the above habitats. The area of the Resort (P&O Australian Resorts) was excluded from the study. The characteristics of the nest site and nest were noted, together with nest condition, contents and the distinguishing features of adults at 'active' nests. One pair of adults per nest was assumed.

Nine active nests were checked five times a day (commencing at 0600, 0900, 1200, 1500, 1800 on a round that took 30 to 60 minutes); except for Nest 1, which was checked hourly. Some nests were checked after dark one evening. The remaining nests were checked daily.

Nests were accessed using a combination of 3 metre ladder, climbing and a mirror on the end of a 2.5 metre pole. Nest contents were checked at 0600 and 1800 hours. Eggs were marked and measured using vernier calipers and chicks were measured and weighed, using 0–100 and 0–300 gram Pesola spring balances, photographed and their plumage and skin colour described. Notes were made of chick and adult behaviour during nest visits.

Reef Egrets feed on the reef flats during low tides for periods ranging from 2–7 hours depending on the tidal range (Recher and Recher 1972). During this study these lows were from late morning into the afternoon, during the night, and in the last few days, in the early morning (Table 1).

RESULTS

Nest number, distribution and characteristics of nest sites

A total of 32 nests were discovered but others were undoubtedly overlooked in dense shrubbery and perhaps also in the forest, where the search was less intensive. Twenty-three nests were in the tree *Pisonia grandis*, and nine in the shrubs *Argusia argentia* Octopus Bush (4), *Pipturus argentius* Native Mulberry (4) and *Scaevola sericea* Fan Flower (1). The twig nests had no lining material and were from 0.6 to about 6.5 metres above ground (mean = 3 m, standard deviation (s) = 1.55, n = 32). The closest nests were about 3 metres apart but the closest active nests were about 35 metres apart.

Approximately 25 per cent of the area searched was foreshore vegetation, arbitrarily defined as being a 20 metres wide strip of shrubs/trees adjoining the beach, 25 per cent was open layered woodland and the remaining 50 per cent was *Pisonia grandis* forest.

Fifteen nests (47%) were in foreshore vegetation, seven (22%) in the layered open woodland and ten (31%) in the

TABLE 1A

Reef Egret nest site attendance. Grey shading represents nest attendance. There were few night observations (see text). Black bar = low tide +/- 1.5 hours. ND = No data.

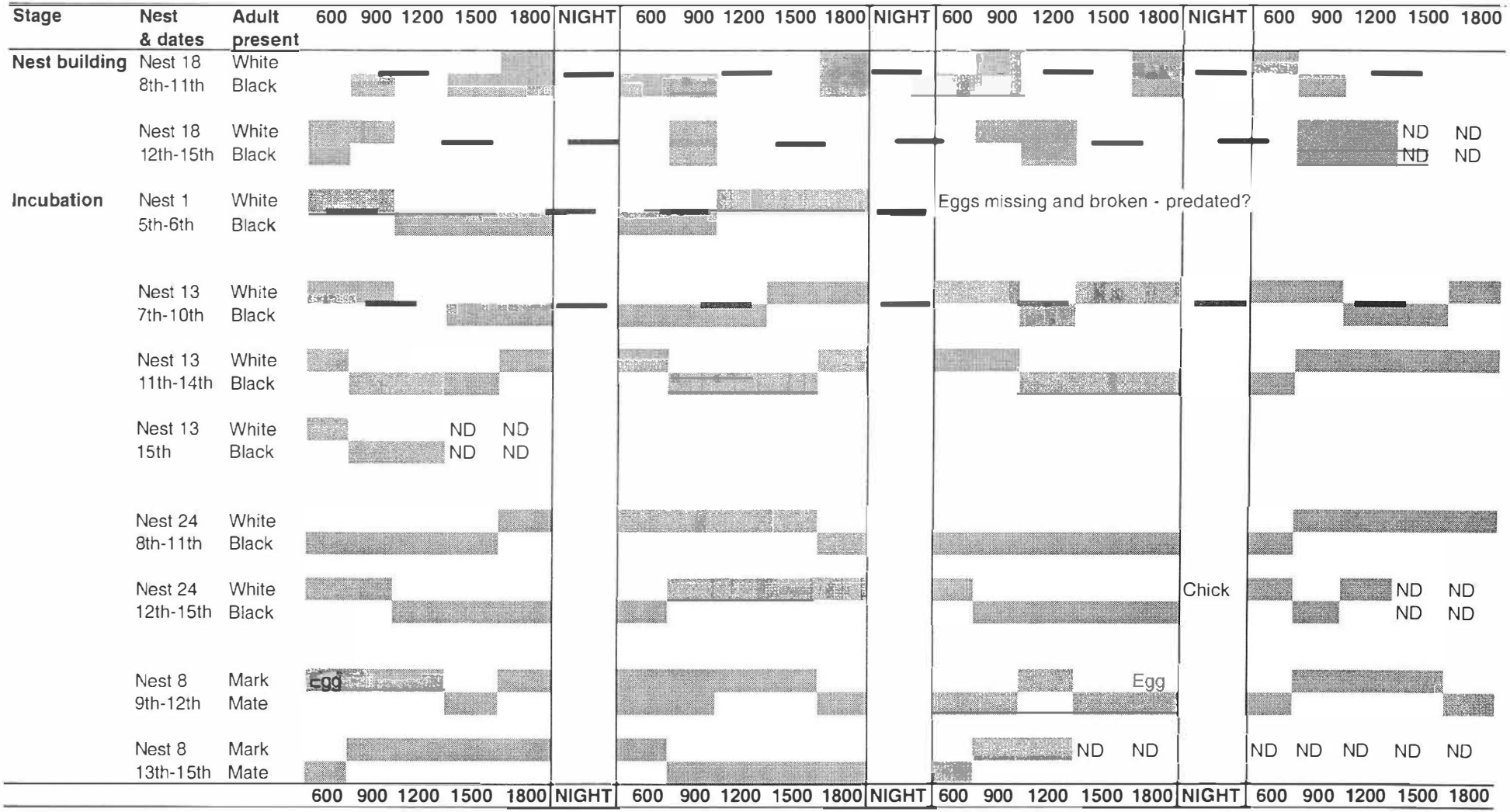
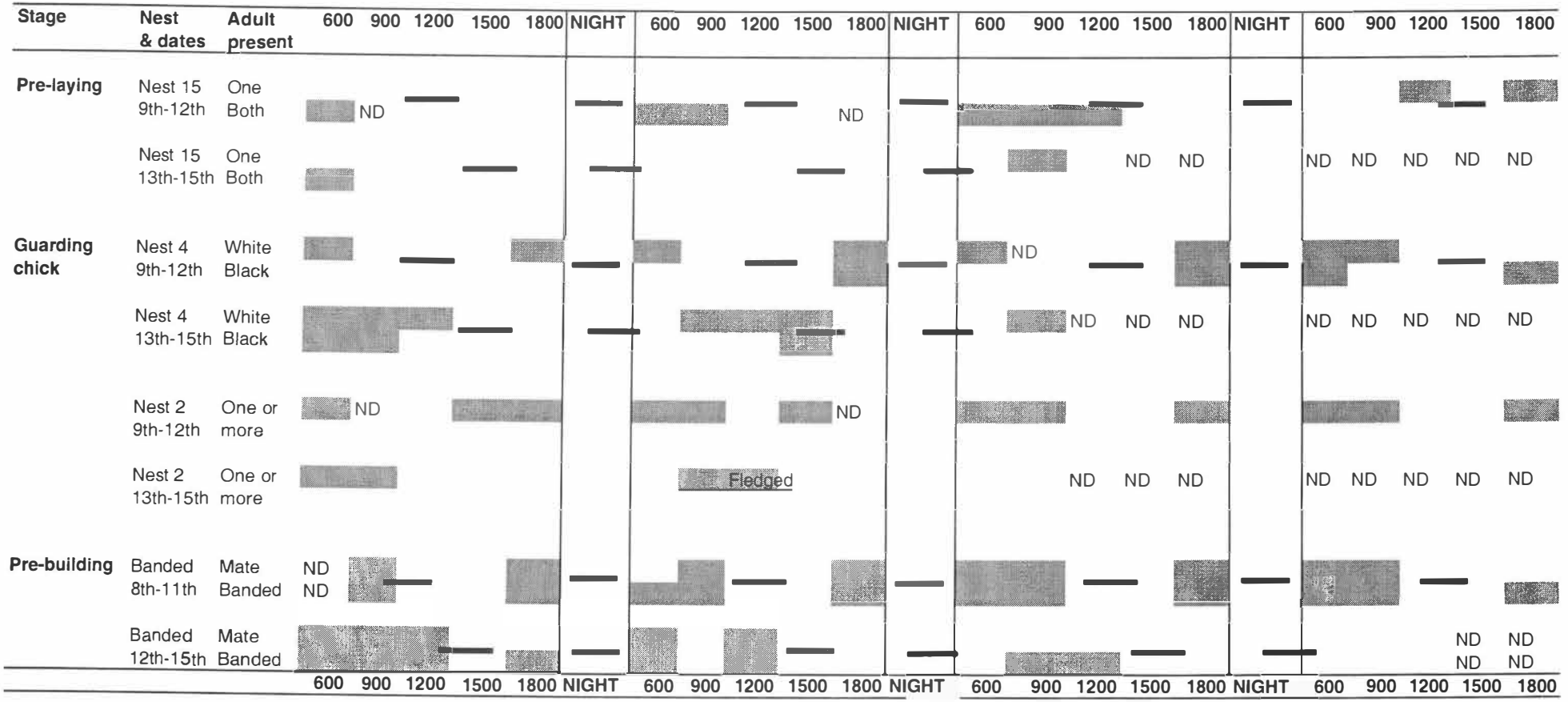


TABLE 1B

Reef Egret nest site attendance.



Pisonia forest. The foreshore shrubs are bushy, concealing and effectively supporting the egret's nest. Woodland shrubs are less dense making the nests more visible and the *Pisonia* are large trees with widely spaced branches typically providing few nest sites. Nests in *Pisonia* sat on a stable platform provided by the intersection of horizontal branches, broken branches, a low stump and a sapling. All but two of the 10 nests in this forest were on its edge or adjacent to a clearing.

Stages in nesting and nest attendance

Of the 32 nests five were part-built ('see through') and empty; eighteen were 'built', comprising a solid platform with several layers of sticks but also empty, four nests had one or more eggs and five had one or two chicks. Five of the eighteen built nests were compacted and dirty and at least two of them had fledged chicks earlier this season (Ted Upton, pers. comm.). The clean appearance of the other 13 suggested they had not had chicks and these are termed 'pre-laying' below.

Table 1a and Table 1b show daytime nest site attendance for nine pairs at the stages: pre-building (1 pair), nest building (1), pre-laying (1), incubation (4) and chick guarding (2). If present, the birds were observed for only a few minutes near the start of each three-hour interval, but Table 1 assumes their attendance for the whole three hours. It was possible when visiting a site to overlook an attendant adult perched up to 20 metres from the nest.

Pre-building is the term applied to a pair of birds repeatedly seen at a location which was clearly not just a high tide roost, and had no nest nearby. They were assumed to be claiming a nesting territory. There were three pairs behaving like this and one bird was distinguished by having a metal leg band. The presence of this pair, termed 'Banded', was recorded. This banded bird was probably 10 years old (Australian Bird and Bat Banding Scheme, pers. comm.). The banded bird was seen on the same Octopus Bush on 19 of the 37 (51%) recording occasions and its (presumed) mate was with it on 14 (74%) of these sightings. They were there at all times of the day except 1500 h and their periods of absence coincided with low tides (Table 1b).

Nest building was seen only at Nest 18, where the white adult was seen taking a stick to the nest on one occasion, but adults attended three of the other part-built nests. At Nest 18 one or both egrets were present on 18 of the 38 (47%) observations; the white bird 12 times and the black 15 times. Neither was seen during daytime low tides (Table 1a).

Pre-laying nests received eggs during the course of the study in two instances, one the day after its discovery and the other six days after (Nest 8). By contrast, Nest 15 still had no egg 12 days after its discovery. Nest 15 was attended by white Egrets that could not be distinguished. One or both birds were seen on 10 of 31 (32%) observations and on 7 (70%) of these both birds were present. Periods of daytime absence coincided with low tides and to a lesser extent with high tides (Table 1b).

Incubation was recorded for four nests (Table 1a). The mates were black and white except for Nest 8 where one of the two white birds had persistent marks on its head feathers. Nest 1's stage was unknown and its eggs disappeared, presumably predated, after two days of study. Clutches at Nests 13 and 8 were at an early stage in incubation each having received an egg during the study. Nest 24 hatched a chick on the last day of the study.

Incubation was shared evenly. At Nest 1, out of 26 observations including one at 2100 hours, the mates were each on the nest 13 times. At Nest 13, white was there 22 times and black 20. At Nest 24, white was present 18 and black 20 times. At Nest 8, 'mark' 17 and 'mate' 14 times, plus two occasions on 10 December 2000 when both were present and either might have been sitting before I disturbed them.

Long continuous stints of incubation are indicated from the hourly observations at Nest 1. The presence at all nests of the same bird at 1800 hours and then at 0600 hours the following morning suggests that it had sat all night. There was, however, some irregularity, and where a bird was recorded only on one occasion flanked by observations of its partner it could have incubated for almost six hours or for a much shorter period. The longest possible stint was 42 to 45 hours, encompassing two nights and a day (black at Nest 24). Counting each observation as representing three hours incubation and 12 hours overnight, the average duration of a sitting for these four pairs was 21.6 hours, ($s = 9.46$, $n = 26$ complete stints).

Chick guarding by the adult was monitored for Nests 4 and 2 (Table 1b). The single dark chick of Nest 4 was monitored from about 14 to 19 days of age. It remained in the nest where it was hard to see. Its black and white parents sat about 20 metres from the nest, several metres apart in a particular Octopus Bush. White was once seen at the nest. One or both was present in 16 of the 31 (52%) observation occasions, 15 with the white and 7 with the black. Their absence coincided with low tide for the most part.

The white chick of Nest 2 was monitored from four to six weeks of age. It perched within a few metres of its nest until it fledged. On my arrival it responded to a single warning 'Kro' from the adult by hiding in the foliage. One or both white adults were perched at various vantage points within about 15 metres of the nest on 16 of the 30 (53%) occasions. Again, the adults tended to be absent at low tide.

Dense shrubbery prevented systematic observations of the other three nests with advanced chicks. At Nest 25, which had two chicks, a black and a white adult bird were seen perched nearby at night.

Adults, eggs and chicks

Of the thirty-three adults associated with nests 13 (39%) were the black morph. At 12 nests where both adults were seen, three pairs were white, one pair was black and eight pairs comprised a black and a white adult. This represents a significant bias towards black with white matings (Chi-square = 6.82, $P < 0.01$, 1 d.f.).

The sizes of completed clutches were one, two, two, two and three eggs. Another clutch had a single cold egg and no adult sitting. Two eggs were laid between the dusk and dawn the following morning and a third laid between 0600 and 1800 hours. A second egg was added to a clutch

between 47 and 71 hours of the first being laid. Two eggs in the same clutch each weighed 30 grams when measured within 24 hours of being laid. Mean egg dimensions were: length = 46.13 millimetres, s = 1.122; width = 34.03 millimetres, s = 0.668; n = 10.

The chick at Nest 24 had hatched overnight since its down feathers were dry on its discovery at 0630 hours. It then weighed 20 grams, had a culmen length of 12 millimetres and a tarsus length of 18.2 millimetres. It seemed destined to become the dark morph. Its crown, breast, thighs and wing feathers were off-white but those of the rest of its head, neck and back were predominantly grey-brown. The entire skin was orange-yellow except for the dorsal lower neck that was yellow. The gape skin was pink, and the eyelids, lores and iris grey. The mandibles were flesh coloured with a dark tip and a white egg tooth.

The chick of Nest 4 was judged (by reference to the Intermediate Egret *Egretta intermedia* chick (McKilligan 1991)) to be about 12 days post hatching when it was captured. It weighed 172 grams and the tarsus was 46.2 millimetres. It still had off-white down feathers on its crown and upper neck, but the pin feathers sprouting on its head, wings and back were grey-brown. The skin was green on the legs and body, except for the head and upper neck, which were blue. The gape was pink, the lores grey and the iris yellow. The entire beak was grey-brown. Its powder down tracts were not yet visible. It had no visible ectoparasites. It was able to climb out of the nest to attempt to avoid capture, but was unable to perch when placed on a narrow stick.

A dark morph chick aged about three weeks and whose nest was unknown, was captured running on the forest floor. It was able to perch. Its plumage and skin colours were as for the 12-day-old chick. It had powder down tracts developing on its breast and thighs and ectoparasitic arthropods, probably louse flies (Hippoboscidae: Diptera), which quickly hid under the feathers when disturbed. A white morph chick aged about 4 weeks, too fleet footed to capture, was covered in sticky *Pisonia* seeds. It had a predominantly yellow beak, but with a dark tip and dark smudges proximally, yellow lores and iris and grey-green leg.

Three chicks were flying and exploring the ground 15–20 metres from their nests by the end of the study period and were therefore 5–6 weeks old by then. Prior to fledging, the two in high nests (Nests 2 and 4) remained near their nest. By contrast, from it first discovery at about four weeks old, the chick at the third nest, built low in an isolated bush, always ran to nearby cover on my arrival. The tendency by the advanced chick to stay near the nest may vary depending on how secure it feels there. These advanced chicks had all-white plumage, pale grey-green legs, a predominantly dark beak, grey lores and yellow iris. They still had a fuzz of down feathers on their crown.

Behaviour and vocalization

Food begging. The newly hatched chick raised its head and gave a soft, rapidly repeated 'chi' call similar to the begging call of the Cattle Egret downy chick, when I first approached it. A fledged young was seen soliciting food from an adult high in the treetops and two approximately five-week-old chicks were fed 5–8 metres from their nests. These chicks begged with mandibles slightly agape and both wings raised and flapped through a small arc. They attempted to grab the adult's beak proximally in a scissors grip to obtain regurgitated food.

Agonistic behaviour. The newly hatched chick's begging call became a louder and more rasping 'chee' when I handled it, probably expressing its alarm. The adult egrets gave 'Alert' and 'Forward' displays as described by Recher (1972). In 'Alert' the feathers are sleeked and the neck more or less extended. This was sometimes accompanied by a low, rapidly repeated 'kro' or 'ku' call with small movements of the gular membrane, signaling apprehension. 'Forward' is given as a threat to another egret, tern or seagull, warning them off or displacing them. In the 'Forward Display' the head and back feathers are raised and sometimes the breast plumes and the wings also. The beak is directed to the other bird, the body usually close to the horizontal and the neck flexed, but one bird assumed an erect posture. The feathers were also raised slightly when an egret approached its mate at the nest site. In this context feather erection is likely to be part of the Greeting Display, as it is in other egrets (Blaker 1969 and pers. obs.). When disturbed the Reef Egret often departed with a 'kreow' call. This alarm call was given as a short utterance (less than 1 s) once or twice, or in disputes with another egret, as a louder and more prolonged 'kreoow' (1.5 s) with longer intervals between calls.

Courtship. A pair of dark birds were habitually together in the same *Pisonia* tree and on several occasions gave repeated 'gurgle' sounds, rendered as 'gri-gro' becoming 'growa'. This was unlike anything I have heard in other egret species. One flew out and back with a slow wing beat as in 'Flap Flight' (Hancock and Kushlan 1984). Mates at the pre-building stages perched 1–3 metres apart and loafed and preened in silence, except for one instance when the banded bird's mate moved towards it with its feathers raised and gave a low gurgle.

Roosting and feeding. At high tide many of the egrets roosted within sight of the sea in tall *Casuarina* and *Pisonia* on the foreshore and in the layered woodland. Others roamed the ground under nesting White-headed Noddies *Anous minutus* where they were seen attempting to swallow a Noddy chick and a juvenile Lewin's Rail *Rallus pectoralis* and vigorously pecked an adult Noddy on the ground, obviously intent on killing it.

DISCUSSION

The overall lower density of nests in *Pisonia* forest compared with nest densities in the two other vegetation types might be partly explained by the Reef Egrets preferring a foreshore or forest edge location and/or a clear flight path, but may also be due to the structural unsuitability of *Pisonia* for nesting. Most nests in *Pisonia* were on the edge of the forest where the storm damage that provides stable nest sites is most likely to occur.

Tidal rhythms obviously have a major influence on how the Reef Egrets time their feeding and nest attendance. During their absences from the nest site at low tide they were presumably feeding. Their long uninterrupted stints

of incubation would have caused them to miss some low tide feeding sessions. In the Cattle Egret older chicks are left alone all day, except when their parents return with food (pers. obs), whereas one or both of the Reef Egret pair roosted in the vicinity of their advanced chick at high tide throughout the pre-fledging stages. This was probably not a food sacrifice for the parent as its feeding opportunities are limited then anyway. The Reef Egret's guarding at a distance may have the advantage of not revealing the chick's location to a predator.

Some differences in nest attendance between these solitary nesting egrets and colonially nesting species may be due to the greater nest security of the former. Nesting was less synchronized among these Reef Egrets than, for example, the Cattle Egret in south-east Queensland (McKilligan 1985), although Kikkawa (1970) says that peak laying for Heron Island Reef Egrets is in September most years. Empty built and half-built nests were left unguarded by the Reef Egrets for long periods, and the adults are presumed to have been feeding then. Even a short absence would spell destruction of the nest in a Cattle Egret colony (pers. obs.) but there is probably no advantage to the widely dispersed Reef Egrets in stealing nest sticks. No Reef Egret nest was followed from the placing of the first sticks to egg laying but shorter observation of a number of nests suggests this takes place over weeks rather than days and includes a lengthy prelaying period. The Cattle Egret takes 6–7 days on average from the start of nesting to laying and some other heron species take less (Telfair 1983). Egg laying in these occurs as soon as the nest is sufficiently well constructed. Unlike the Reef Egret, the male Cattle Egret does not leave his nest to feed until incubation, when his mate takes her turn to sit on the eggs (McKilligan 1990). He would obviously benefit from this being at the earliest possible date.

The simultaneous occurrence of flying young and nest building in early December 2000 suggests the Reef Egrets nesting season lasted at least seven months and Kikkawa (1970) reports fresh eggs in Reef Egret nests on Heron Island from August to February indicating a breeding season of at least eight months. More typical of egrets is the Cattle Egret, which usually nests over five months from mid-October to early March in southeast Queensland (McKilligan 1985) and raises a single brood.

The production of a second brood appears rare among egrets, but two pairs of Reef Egrets familiar to staff at the Heron Island Research Station were said to be re-nesting, having already fledged young (Ted Upton, pers. comm.). These birds were not, however, uniquely marked raising the slight possibility of misidentification. The lengthy nest building and prelaying period observed among these Egrets may be more typical of the second nesting than the first, in which case it might be a necessary refractory period for the female.

This study and that of Guthrie (1972) on Heron Island, although based on small samples, revealed small clutches and typically one chick fledged per successful Reef Egret nest. Successful Cattle Egret nests by contrast mostly fledge two or three chicks (McKilligan 2001). These coral reefs provide less food for egrets than the habitats used by other egret species according to Recher and Recher (1972) and there is probably no large seasonal increase in the Reef Egret's food supply of the sort enjoyed by, for example, the Cattle Egret most years. In these straitened circumstances the Reef Egret may seek to increase its breeding success by rearing a second brood over an extended breeding season. This study has raised a number of questions that deserve further study spanning at least one complete breeding season and individual identification of birds to confirm repeat nesting.

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