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NOTES ON THE DISTRIBUTION AND BREEDING OF THE GREY SWIFTLET, *AERODRAMUS SPODIOPYGIUS*

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INTRODUCTION

The Grey Swiftlet, *Aerodramus spodiopygius* (previously known as *Collocalia spodiopygia*, and misnamed *C. francica* in some publications) belongs to a genus in the Swift family (Apodidae) which lives in caves, and nests in colonies. The Grey Swiftlet is capable of flying in total darkness with the aid of a low-frequency form of echolocation. A useful review of the habits and taxonomy of all swiftlet genera and species is that by Medway and Pye (1977). Echolocation in the Grey Swiftlet is discussed in some detail by Roberts *et al* (1976) and Smyth (1979).

In this paper we describe the known distribution of the Grey Swiftlet in Queensland and examine the roosting and nesting habitats of 16 colonies, with some notes on breeding in the species.

DISTRIBUTION

The distribution records indicate that the species is restricted to Queensland north of the Tropic of Capricorn, including some offshore islands. Macdonald (1973) and Slater (1970) indicate on distribution maps that the Grey Swiftlet is found only in a narrow band of the eastern coast between Cape York and Mackay. The northern limit appears, however, to be the rainforests at Iron Range (Kikkawa, pers comm.) with no recorded sightings in the disjunct forest areas further north. There are also well-established colonies at Chillagoe (Pecotich 1974), 175 km west of Cairns and it seems probable that the species will be found to have a wider inland distribution than is currently known.

Grey Swiftelts occur in a wide range of habitats within the above distribution. Nesting colonies are known from caves and mines in rainforest-covered mountains, from rock shelters just above high tide levels on islands, and from limestone caverns in country variously semi-arid and inundated by monsoonal floods. Nevertheless, the known nesting sites are restricted to five discrete localities which are by no means evenly distributed within the known range of species. Figure 1 shows the distribution of the Grey Swiftlet in Queensland and the locations of the known breeding sites.

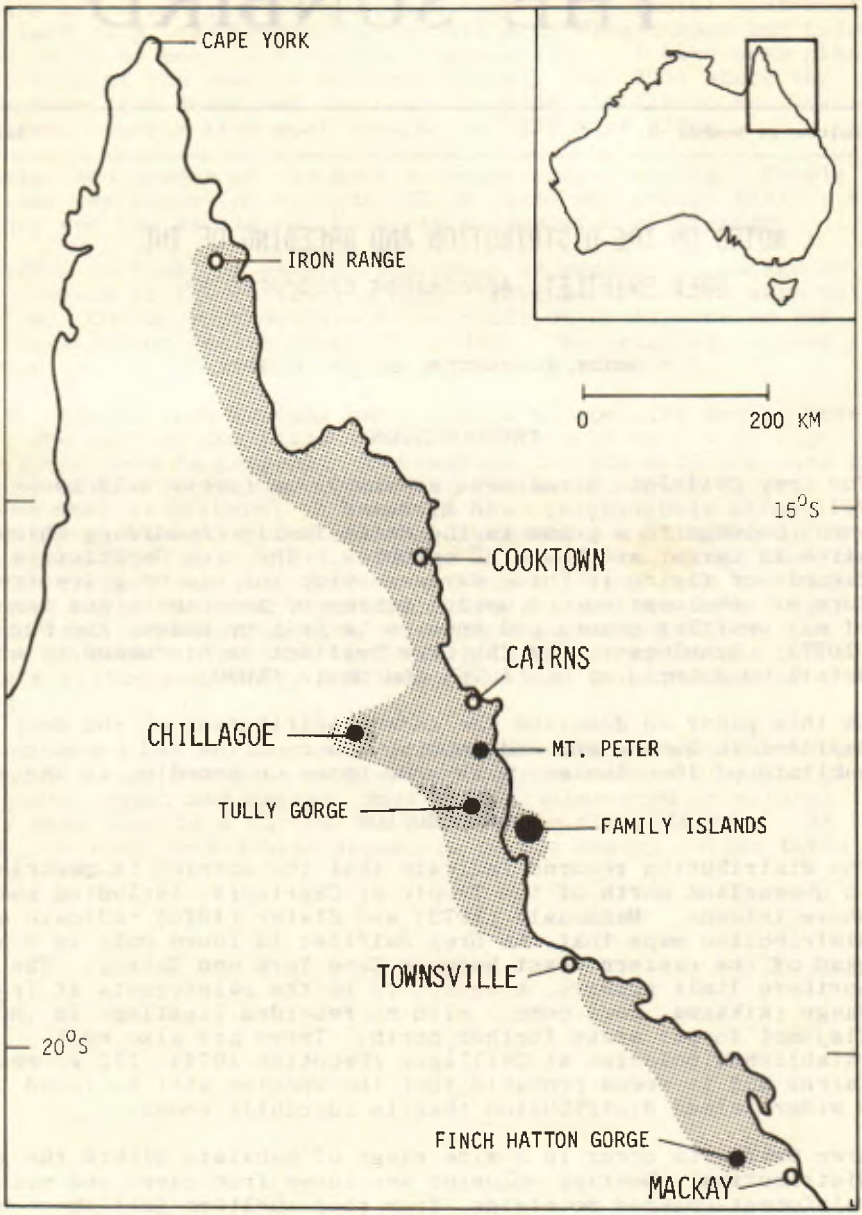

Figure 1. Map of North Queensland showing the estimated distribution of the Grey Swiftlet (stippled area) and the known breeding localities (closed circles). The inset shows the location of the map area in Australia.

THE COLONIES

Chillagoe Caves

Grey Swiftlet colonies at Chillagoe live in caves in large limestone outcrops or bluffs. The bluffs are part of a limestone belt, which lies on a north west south east axis, about 65 km in length and up to 6.5 km wide (de Keyser and Wolf 1964). The exposed limestone constitutes an aligned towerkarst, generally taking the form of spectacular vertical cliffs rising to about 50 m above the surrounding plain and measuring up to 2.5 km long by 800 m wide. Most of the bluffs contain caves, some of which extend below and beyond the limits of the limestone belt.

Records of the Queensland National Parks and Wildlife Service and the Chillagoe Caving Club show that at least twenty caves contain colonies of Grey Swiftlets. All caves visited by the National Parks' personnel have been designated a code number, commencing with the letters 'CH'. This section of the paper deals with eight colonies studied by us. The locations of the caves are shown in Figure 2.

The colony studied over the longest period is that found in the Royal Arch Cave (CH 9). This colony can be easily and quickly reached by following a well known, specially paved tourist track in the cave, then deviating from it near the "Royal Arch" through a tunnel 22 m long, 1 m high and 80 cm wide, sloping into a large, dark chamber.

The birds' nests are located on a concave wall about 5 m from the floor. This chamber was visited in December 1972, December 1973, August 1975 and January 1980. During this time, the number of occupied nests varied from 122 in 1972, to nil during the winter of 1975 and 37 in 1980. Between 1975 and 1980 there were two minor landslips in the chamber, about 5 m and 12 m, respectively, from the nests, and there is ample evidence to show that people have been regularly visiting this chamber. It is possible that these occurrences have contributed to the decline of the swiftlet population in this cave.

A second swiftlet colony in the Royal Arch bluff inhabits Flow Cave (CH 124). This nesting site was studied in June 1974, July 1975, May 1976, December 1977 and December 1979. Flow Cave is composed of a series of small chambers interconnected by narrow passages and right-angle bends. The entrance is small, and difficult to locate amid the complex topography near the summit of the Royal Arch bluff. The cave terminates in a large vaulted chamber with a horizontal silt floor, roughly rectangular in shape, 7 m long and 4 m wide. The irregular cave walls are from 1.2 m to 10 m high with angles of inclination varying from almost vertical to almost horizontal. There are, however, large areas where the slope is approximately 70^{o}, and it is on these surfaces that most of the swiftlets come to roost and build their nests. More than 200 birds (in 1976) roost in clusters within which the individuals are arranged either singly or in pairs, the latter being most common. No birds or nests were found in this chamber during the winter, daytime visits of 1974 and 1975.

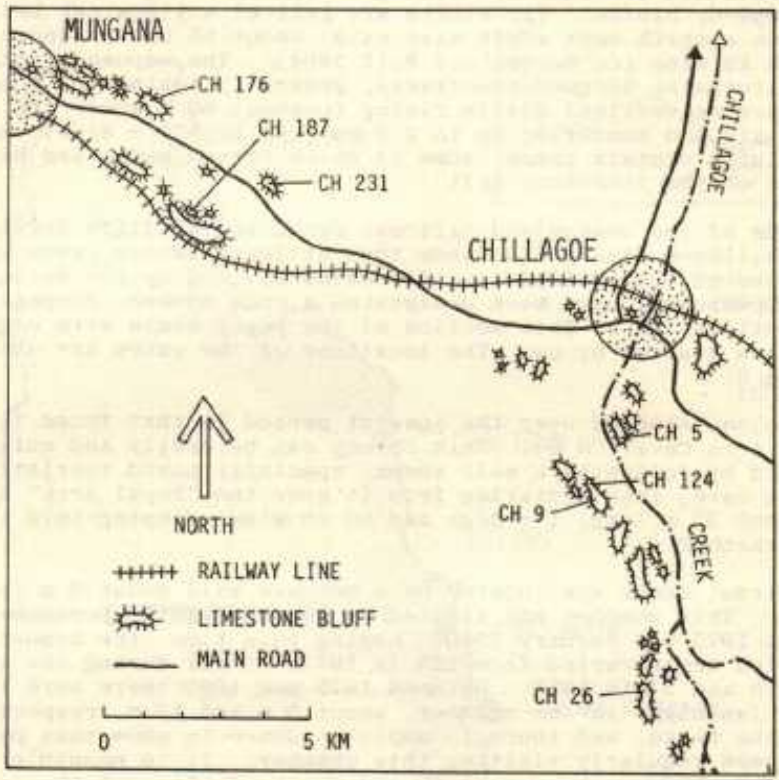

Figure 2. Map showing the location of Grey Swiftlet Colonies in the Chillagoe-Mungana area.

During the visit to the chamber in May 1976, a group of 30 to 40 swiftlets were found roosting in a distant corner away from the main flock of the colony. This sub-group could be distinguished by the lack of organization into pairs and because these birds did not possess the characteristic dark grey plumage of the species. These birds were pale brown with only a suggestion of the off-white rumps found on all adult birds. No records of the juvenile plumage of the Grey Swiftlet are available, but it does seem probable that this sub-group represents the newly fledged young of a recently completed breeding season. This indicates that breeding is probably completed by May, and indeed the uniformity of the juvenile group may point to a degree of synchrony of breeding within this colony.

The presence of footprints and widespread minor damage to formations (noted during a visit to this colony in December 1979) suggests to us that this cave is regularly visited by people. On that occasion only 13 of the nests were occupied. It seems that regular disturbances might have contributed to the decline of the swiftlet population in this colony.

Two colonies were briefly observed in August 1973: one in Tower of London Cave (CH 5) and the other in Morachoo Cave (CH 33). The entrance to the Tower of London Cave is a 10 m deep sinkhole about 3 km southwest of Chillagoe. The colony is very small and relatively inaccessible. The Morachoo Cave is comprised of a narrow, 30 m long passage in a large bluff 30 km west of Chillagoe. The Morachoo colony is small and the cave is difficult to reach during the wet season.

An unnamed swiftlet cave in Suicide Bluff (CH 231) was visited in June 1974. The swiftlet chamber was entered by descending a 20 m vertical shaft and thereafter progressing down a sloping floor through a series of high-ceilinged chambers. Some daylight holes in the roof provide direct visual access to most parts of the cave, but not to the nesting site which remains in total darkness. The birds navigate visually for all but the final stages of their flight from the outside world to their roosting sites; the birds only begin to echolocate as they enter the nesting chamber itself.

The Clam Cavern (CH 26) colony was visited on 29 December 1979. Access to this cave is by way of a large, wedge-shaped entrance downwards over rocks to a narrow S-shaped, 60 cm wide tunnel, then upwards into a totally dark chamber 22 m long and 13 m wide. The entrance is at the base of the cliff-line and at the top of a low scree slope leading into a slight re-entrant on the eastern side of the tower, about 150 m south of the Walkunder Arch (CH 168). The colony in Clam Cavern contains about 50 birds. When visited, there were 23 occupied nests, with chicks in 16 and eggs in 7. The guano pile below the nests was 4.5 m long, 3 m wide and 60 cm thick. Many insects were in evidence in and on this pile. The nests were invariably distributed among short (about 60 cm), cone-shaped, dark grey stalactites on a concave wall 1 to 2.5 m from the floor. This colony is easy to reach and the behaviour of the birds is readily observed.

Of the swiftlet colonies studied in Chillagoe, that in the Capricorn Cave (CH 176) in Queensland Tower, visited in December 1979, is

perhaps the most intriguing. Entry to Capricorn Cave involves a free, 4 m steep climb to a floor of a grike that leads on to a large, dark chamber 9 m vertically below. Access to this chamber can be gained with the use of a ladder. The floor of the chamber slopes gently downwards with a drop of 13 m leading to a terminal chamber about 80 m away. The passage to the swiftlet colony is well decorated with fossils, flowstone, shawls, stalagmites and delicate floor formations. To preserve these decorations it is necessary to negotiate this area with utmost care.

A well-preserved, complete skeleton of a goat (hence the name Capricorn) is found about halfway to the swiftlet chamber.

The birds' nests were arranged in clusters from 1.2 to 2.6 m from the floor on two almost vertical walls. One cluster was made up of 34 nests, 11 of which contained eggs, two were empty and the remainder harboured chicks. The second cluster was made up of 13 nests, seven of which were occupied.

The Capricorn Cave contained a rich variety of invertebrates, including two species of spider and at least six ectoparasitic insects living on the swiftlets.

In November 1979, more than 1000 adult swiftlets were counted in a cave named Gordale Scar Pot (CH 187). The entrance to this cave is a series of deep grikes near a rambling fig tree growing at the top, slightly north east of the track leading up to Spring Cave (CH 12) about 120 m north east of the Spring Cave entrance. The simplest entrance to Gordale Scar Pot is a grike 10 m long, 1 m wide and 14 m deep; it can be negotiated with a 30 m ladder. At the end of a 25 m long, large chamber is a wide tunnel leading to two totally dark small chambers in which swiftlets roost and nest. One of these chambers had more than 500 nests scattered over five almost vertical walls. These nests could easily be studied from a ledge about 2 m away. Most of the nests are from 2.3 to 5 m above a deep guano pile on the floor. The adjoining chamber, a former home of thousands of swiftlets, now contains only three occupied nests situated about 3 m above a guano pile about 2 m deep. Access via a 30 m caving ladder represents a barrier to casual inspection of this colony.

Tully Gorge Caves

Several swiftlet colonies are known to inhabit caves in the upper reaches of the Tully River Gorge, about 100 km south of Cairns. A large stream of water used to flow continuously through the gorge via a 300 m fall from the Atherton Tableland towards the coast. About 20 years ago, a dam, a weir and a hydro-electric power station were built in this area. Since then, only a trickle of water runs over the falls and down the old river bed, except in times of flood. For several kilometres below the falls, the river bed passes through a narrow, 300 to 400 m deep gorge. The floor of the gorge consists of stretches of small stones and sand, large boulders up to 20 m in diameter, and pools of water.

At intervals along the gorge, cracks and fissures extend into the walls. These features, combined with those resulting from boulders piled one on top of the other, make up the roosting and nesting habitats of the swiftlets. Earlier descriptions of the Tully Gorge

colonies can be found in Pecotich and Collins (1966), Griffin (1969) and Pecotich (1974). Figure 3 is a map of the Tully Gorge system, showing the locations of the swiftlet caves described below.

Cave 1 was visited during the winters of 1965, 1966, 1967, 1972 and 1973, and during the summers of those years and of 1975 and 1976. This cave opens into the gorge about 15 m above the level of the river bed. It consists of two low chambers divided into several sections each. The nests are distributed on many surfaces throughout the chamber and occur in large crowded clusters of up to 100, in smaller groups and even singly. Estimates of the adult swiftlet population during the summers of 1965 and 1976 were 1000 and 1100, respectively, most of them living in the larger of the two chambers.

Although the length of the chambers is not great, extending no more than 12 m into the wall of the gorge, the entrance is sheltered and shaded by a large overhanging rock. Consequently, the interior of the cave is dark within a few metres of the entrance and the birds within it have to navigate by the aid of echolocation.

When this cave was visited during daytime in June and July of 1965 there were no swiftlets seen inside, nor flying anywhere along the gorge. During the summer visits (October to March) breeding was invariably underway; nests contained eggs and chicks at various stages of development.

Cave 2 is a chamber several metres further up the gorge wall from Cave 1, and it is formed from the junction of a number of large boulders. The floor is approximately 3 by 3 m and is almost horizontal. The walls are formed by the sloping sides of the boulders which come together to create an incomplete ceiling. The nests in this colony, as seen in November 1976, were all situated on one wall and were easily visible by day in the light penetrating gaps in the ceiling. Indeed, even when the birds assembled at dusk, each nest and roosting site could be located visually.

Cave 3 is situated about 100 m from Cave 1 in the direction of the Falls. It also is on the northern wall of the gorge, but its entrance is about 5 m above the river bed. Thirty-five nests were counted during a visit to this cave in October 1965, and swiftlets were seen occupying the cave in October 1967 and November 1976. This is the smallest of the known colonies in Tully Gorge.

Cave 4 is situated in the wall on the eastern side of the gorge near the base of the now, usually dry, Tully Falls. Its entrance, a vertical slit in the gorge wall, is visible from several points at the top of the falls. In dry weather the cave can be reached by walking through the scrub almost to the bottom of the falls, then negotiating the steep section near the bottom by the use of a 10 m ladder or rope. The entrance to the cave is about 30 m from the river bed up a gently sloping rise. In wet weather the rocky bottom of the river bed is extremely slippery and travel along the gorge therefore very hazardous.

Cave 4 was visited during the winters and summers of 1965, 1966, 1967, 1972 and 1973, in August 1975 and in January 1980. In November 1965, the swiftlet colony in this cave contained about

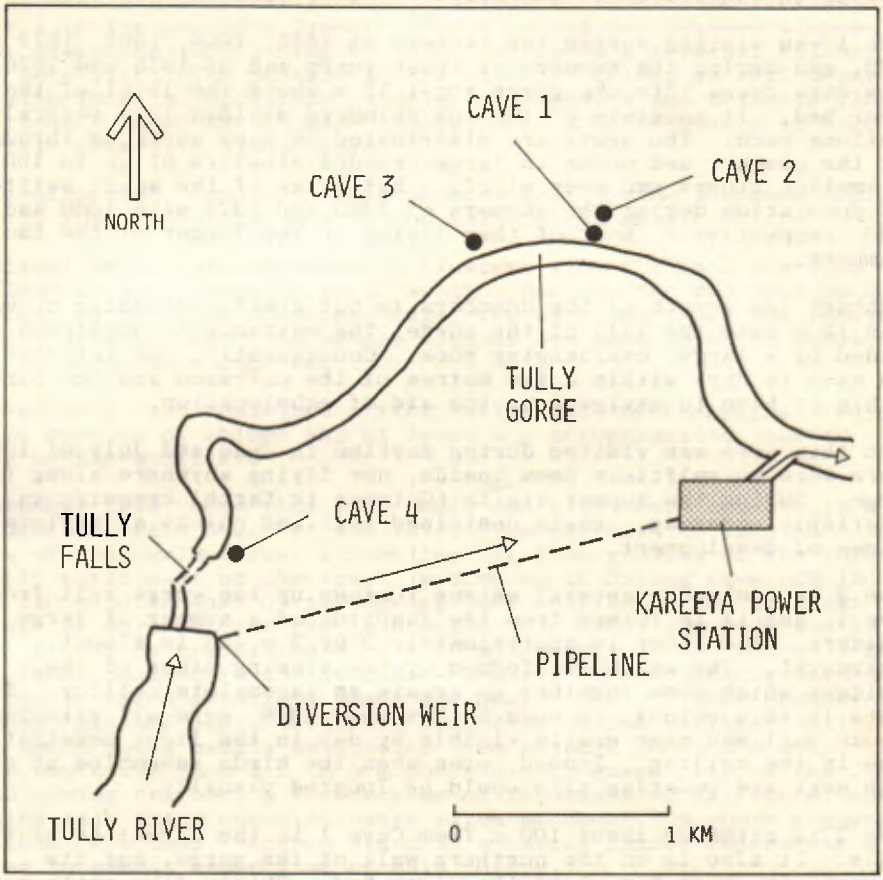

Figure 3. Map of the Tully Gorge area showing the locations of the caves which contain Grey Swiftlet colonies.

1000 adults. The nests were constructed singly and in clusters more than 2 m from the cave floor on a large flat wall sloping at an angle of about 50°. When this colony was visited in August 1975 more than half of the nests contained an egg each. On this occasion the birds remained inside the cave during the inspection, and some individuals approached close to the visitor in an apparently aggressive manner, accompanied by vocalizations. On other occasions, the birds vacated the cave and remained in flight outside until the human intruder had left. In January 1980, there were about 200 more birds and 100 new nests compared to the numbers present in 1965.

Mount Peter Mines

Mount Peter is a steep discrete peak on the Bellenden Ker Range located about 10 km south west of the town of Edmonton. It was the site of intensive goldmining in the first half of this century. Near its summit the two horizontal shafts of *The Twins Mine* and the *Golden Crown Mine* remain open, though in disuse. During March 1960, Cassels (1961) found a nest containing an adult and an immature Grey Swiftlet attached to the ceiling about 100 m from the entrance of the *Golden Crown* shaft. No information is available on this "colony" between that time and an inspection made in December 1977 during our study. In 1977 the shaft was found to have caved in some 50 m from the entrance almost completely blocking the passage. Sufficient gaps remained in the rubble to allow birds access, but it is not known whether this shaft is currently occupied by swiftlets. However, *The Twins Mine* was found to contain three nests on the ceiling of the shaft about 40 m from the entrance. Several bends in the shaft meant that the nest site was in total darkness. The three adult birds encountered were echolocating as they flew towards the entrance. This small colony shared the mine with large numbers of bats of several species which roosted further along the shaft. Many swiftlets were seen feeding over the cane fields on the lower slopes of Mount Peter, suggesting that other colonies were located in the area.

Data on breeding in the two known "colonies" on Mount Peter consist only of the sighting of a fully fledged young in the *Golden Crown Mine* in March 1960 (Cassels 1961), and the sighting of a pin-feathered young and an egg in *The Twins Mine* on 31 December 1977; the third nest in this colony was empty.

The Family Islands

The Family Islands are a cluster of small islands lying between 10 and 15 km off the Queensland coast opposite the Tully region (see Figure 4). All are rainforest clad with large granite boulders forming prominent features on their seaward shorelines. It is these boulders that form the shelters and caves used as nesting chambers by Grey Swiftlets. Three colonies are known to occur in this island group, one on each of Dunk, Bedarra and Wheeler Islands.

Dunk Island is the site of the first recorded nesting colony of *A. spodiopygius* in Australia. In 1908, Banfield (1912) discovered a nest fragment, subsequently ascribed to this species, in a cave near the highest point of the island (elevation 500 m above mean sea level). Banfield's deliberate search for an extant colony was rewarded by the discovery of 53 nests in a rock shelter near the

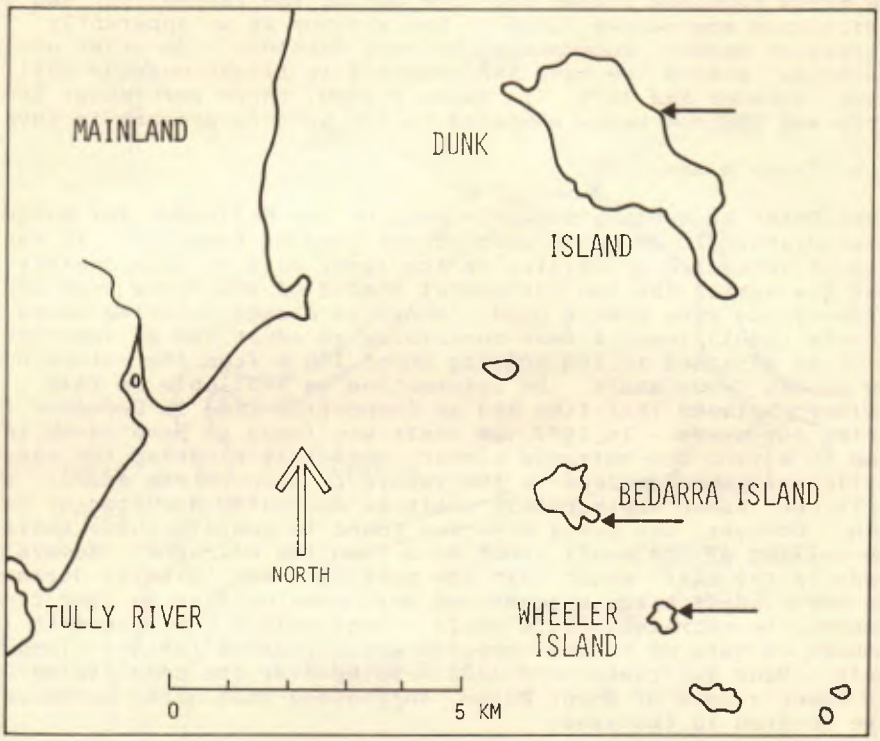

Figure 4. Map of Family Islands showing the locations of *Aerodramus spodiopygius* colonies (arrowed) on Dunk, Bedarra and Wheeler Islands.

shore on the exposed northern side of the island. Campbell (1916) reported between 50 and 60 nests present in the same shelter in 1915, and Chisholm (1929, 1933) found 220 nests there in 1921. The colony was rediscovered in 1977 during our study when 48 nests were counted.

The swiftlet shelter on Dunk Island lies under a thick mantle of rainforest some 10 m from the high tide level among the giant boulders that form numerous shelters and caverns of various complexities along that part of the coastline. There would appear to be a number of suitable sites for establishing swiftlet colonies, but the one found by Banfield is the only one so far discovered. Indeed its rediscovery during our study was the result of many hours scrambling in and out of many crevices in the general area that Banfield described. Campbell (1916) and Chisholm (1929, 1933) were both personally guided to the cave by Banfield. There is no doubt, however, that the present colony occupies the site described by Banfield in 1908.

To enter the Dunk Island shelter the birds fly through the forest canopy and then through one of several gaps between the boulders that form the walls. The nests are located on a rock face (sloping at about 45°) which forms both the roof and one wall of the shelter. The almost total darkness beneath the canopy at dusk means that the birds begin to echolocate before entering the shelter after completing their daily feeding excursions. During the day, adult birds returning to feed their young enter the shelter using their sight, and sufficient light penetrates the chamber for the birds to fly around the interior with occasional click emissions being produced.

Information on breeding in the Dunk Island colony is restricted to the published accounts of Banfield (1912), Campbell (1916), Chisholm (1929) and data collected during the two visits made in 1977 by us. This information is summarized in Table 1.

Table 1. Breeding data from the Dunk Island colony of *Aerodramus spodiopygius*

Date	Nests	Eggs	Young	Source of data
17 Nov. 1908	53	20	0	Banfield, 1912
1915	50-60	12	0	Campbell, 1916
Nov. 1921	220	110	55	Chisholm, 1929
17 May.1977	48	0	0	Present study
28 Dec. 1977	48	17	17	Present study

Most significant among these data is the indication that massive fluctuations in the population size have occurred within the Dunk Island colony between 1908 and 1977. The nature of the fluctuations in population size in the years between visits is not known, but there appears to have been a stable, low population in the years between 1908 to 1915 followed by a fourfold rise within the shorter period between 1915 and 1921. The present population level is slightly below that of 1908.

The colony of Grey Swiftlets on Bedarra Island is located in a cave near the water's edge on the eastern side of the island. It was found in 1958 at which time it contained 224 nests (Busst 1965). It was subsequently visited in 1964 and 1966 when 200 and 150 nests, respectively, were counted (Orrell 1967). The cave is little more than a large rock shelter formed by the leaning together of a number of large, flat-faced boulders. The boulders oppose one another to form a chamber with an inverted V-shape cross section. One wall is almost vertical and the other has an inclination, though variable, of approximately 70^{o} from the horizontal. All the nests of the colony are attached to this sloping wall.

The vertical wall is made up of several boulders. In a gap between two of them there is a gently sloping rock ledge that runs for about half the length of the wall. The ledge is midway between the floor level and the apex of the chamber. The ledge lies directly opposite the nests on the sloping wall and was consequently an excellent vantage point from which to observe the behaviour of swiftlets at roost and in flight.

The Bedarra Island cave is very close to the water's edge and at high tide, sea water can enter the floor of the cave. Because the cave is on the seaward (eastern) side of the island, waves tend to break at the mouth of the cave sending salt spray into the colony. The Coral Sea in this region is afforded considerable protection by the Great Barrier Reef lying some 50 km to the east. The waves that do develop, however, are large enough to create an almost constant fine mist inside the cave at high tide, particularly during strong easterly winds. Rainwater too enters the cave, although the nests are distributed on the sloping wall in such a manner as to avoid the miniature streams that become established on the under-surface of the boulders during wet weather.

Not only is the Bedarra Cave convenient in having a rock platform from which it is possible to view the colony unobtrusively, but it also provides a very useful vantage point from which to witness the gathering of the birds at dusk and their departure early in the morning. It is possible to climb on top of the boulders, which provide the walls of the cave, and from there to gain an unobstructed view of land and sea in all directions. At this spot tape recordings were made of the vocalizations produced as the birds circled above the cave in the late afternoon. For analysis of these and other vocalizations (see Roberts *et al* 1976).

Fourteen visits to the Bedarra Cave were made between April 1974 and December 1978.

The cave has three main entrances: from the end nearest the sea, from the end opposite the sea and through the gap above the ledge on the vertical wall. These entrances provide access to a great deal of sunlight. Even at dusk, when the swiftlets are returning to roost, the visibility within the cave is considerable. Indeed, during the late afternoon the sun shines directly on to a group of three nests low down on the sloping wall. It has been observed that the first birds to return to the cave enter and locate their nests or roosting sites without echolocating; birds arriving somewhat later begin to echolocate as soon as they enter the cave.

The data about breeding for this colony, shown in Table 2, indicates that the peak number of eggs may be laid in October, the month that had previously been thought to be the start of the season. The information, however, does not give any conclusive final date for breeding, except that no eggs or chicks were found on Bedarra Island in April 1975.

Table 2. Breeding data from the *Aerodramus spodiopygius* colony on Bedarra Island

Date	Nests	Eggs	Young
7 April 1974	400	1	0
28 July 1974	400	4	0
8 Sept. 1974	400	100	2
1 Dec. 1974	400	185	68
10 April 1975	400	0	0
3 Oct. 1975	375	0	0
4 Sept. 1976	350	1	0
5 Oct. 1976	350	215	2
9 Oct. 1976	370	130	11
12 Nov. 1976	353	126	51
5 Dec. 1976	365	122	21
28 Dec. 1977	380	93	79

In this colony, ants were seen attacking newly hatched chicks on many occasions, frequently causing them to fall out of their nests, and fall prey to skinks waiting on the cave floor.

The only other known colony on the Family Islands is within a rock shelter just above high tide level on the seaward side of Wheeler Island, about 2 km south of Bedarra Island.

The colony was first discovered by Orrell in 1966 when between 400 and 425 nests were counted (Orrell 1967); there are no records of subsequent visits prior to our present study.

Once again, the nesting chamber is formed by large boulders leaning against each other. But the floor is formed by a rock face sloping at a similar angle to that of the face constituting the ceiling; about one metre separates these two surfaces.

Access to the chamber is restricted to a narrow opening at one end. This in turn leads to a large antechamber formed by another sloping rock face. This chamber, though itself well lit by a large entrance, shades the nesting chamber from direct sunlight. It is just possible, after some minutes of accommodation, to see the outline of the nests without the aid of artificial light. Swiftlets were observed to begin echolocating as they flew from the outer to the inner chamber.

Data about breeding from Wheeler Island are presented in Table 3. The population size and duration of breeding season are similar to those of the Bedarra Island colony.

Table 3. Breeding data from the *Aerodramus spodiopygius* colony on Wheeler Island

Date	Nests	Eggs	Young
28 July 1974	400	7	0
11 Nov. 1976	289	161	70
14 Nov. 1977	500	96	368
27 Dec. 1977	500	112	44

Finch Hatton Gorge

This appears to be the southern-most swiftlet colony known in Australia. It is located in a small cave high up in the Finch Hatton Gorge on the rainforest covered slopes of the Mount Dalrymple Range, about 65 km west of Mackay. Finch Hatton Gorge is a steep, narrow, rocky water course progressing through a series of pools and water falls.

The swiftlet cave is situated at the top of the Dooloomai Falls, approximately a two hour walk from the bottom of the gorge.

The roof of the cave is formed by the base of a large boulder on one side of the gorge. The cave itself is simply the gap produced by the washing away of soil from beneath the boulder. As a result, the cave is low, varying between 0.5 and 2 m high. It extends about 7 m under the boulder and is no more than 7 m at its greatest width. Access is gained through a slightly canted horizontal slit, one metre high, about 10 m from the centre of the water course.

The colony was first discovered in 1951 (Wheeler 1959) and subsequently visited on a number of occasions (Robertson 1962, Seton 1965, Chisholm 1966, Smyth 1976). Two visits were made during 1976 in the course of this study. Table 4 summarizes the published data.

Of great interest from these data is the fluctuation in numbers of nests since the first records were made in 1951. Between 1959 and 1963 the number of nests increased tenfold, and the population appears to have been maintained at that high level for at least two breeding seasons. Then, over a period of 11 years, the colony was reduced to two nests, and it is doubtful that even they were in use during the 1975-76 breeding season. By November 1976 breeding was once again established, this time in six nests each containing an egg or chick. The chicks were large and well feathered, suggesting that they had emerged from eggs laid some considerable time before the four eggs still present in their nests.

The rock forming the ceiling of this cave was covered in water droplets and moisture caused swelling of the saliva holding

the nests to the rock. It is suggested that excessive moisture, perhaps in the form of continuous streams, on the rock surface may prevent the successful construction of nests in this cave. The proximity of the cave to the waters of Dooloomai Falls may, during summers of high rainfall, mean that it is unsuitable for colonization by the swiftlets. The summer of 1975-76 was indeed one of very high rainfall, and it is possible that this single factor accounts for what may have been a total lack of breeding during that season. It is therefore also possible that fluctuating rainfall in years past accounts for the earlier fluctuations in population size as indicated in Table 4.

Table 4. Reproductive data on the *Aerodramus spodiopygius* colony at Dooloomai Falls, Finch Hatton Gorge.

Date	Nests	Reproductive Data
1951	40	No data (Wheeler 1959)
24 Aug. 1953	20	No eggs or young (Wheeler 1959)
7 Oct. 1959	25	Eggs and roosting adults in nearly all nests (Robertson 1962).
8 Dec. 1963	250	Nests either being built or containing eggs or chicks of various ages (Seton 1965)
3 Nov. 1964	200	Most nests contained an egg or chick (Chisholm 1966)
21 Nov. 1964	300	Nests either being built or containing eggs or chicks of various ages (Seton 1965)
29 Feb. 1976	2 (in disrepair)	No eggs or young (Smyth 1976)
27 Nov. 1976	6	4 eggs; 2 young (present study)

In addition to the colony described above, two other colonies have been reported from the Finch Hatton area. One, further up the gorge wall from the cave described above, was described by Wheeler (1959) as containing about 12 nests. That cave is now deserted and shows no signs of recent occupation by swiftlets. The other colony was reported by Robertson (1962) to be in a cave downstream from the Dooloomai Falls. This colony has not subsequently been investigated owing to extreme difficulty of access.

The entrance to the Dooloomai Falls cave is shaded by a large overhanging rock and surrounded by thick vegetation. By late afternoon the interior of the cave is dark and the returning swiftlets begin echolocating as soon as they reach the entrance.

Although the size of the known colony is small, it seems likely, from the large numbers of swiftlets seen feeding in the plains

below, that other colonies must exist in unexplored mountain cliffs and gorges of the area.

Swiftlets in the Finch Hatton area have taken on greater siginficance since the sighting of a flight of (non-echolocating) Glossy Swiftlets, *Collocalia esculenta*, at the base of the gorge by Boles and Barry in 1975. This species had hitherto been regarded as an infrequent and non-breeding visitor to the northern part of Cape York Peninsula (McKean 1967). That Glossy Swiftlets have been found nesting on the fringes of other swiftlet colonies in Malaysia (Medway 1962 a & b) makes it at least a possibility that they will be found annexed to Grey Swiftlet colonies near Finch Hatton Gorge.

Nests

Grey Swiftlet nests are cup- or bracket-shaped, the largely vegetable constituents being held together with secretions of the swiftlets' salivary glands (Medway 1962c). The nests can be either self-supporting or attached to neighbouring nests to form small or large groups of closely packed nests. The dimensions vary considerably from colony to colony, but fall within the ranges 40 to 60 mm left to right, 30 to 70 mm front to back and 3 to 30 mm deep.

Table 5 shows considerable variation in composition of nests both between and within swiftlet colonies. The choice of vegetable materials used appears to be opportunistic and probably dictates the final dimensions of the nest and the amount of cement that is required to produce a sufficiently rigid structure. There was also variation in whether nests were self-supporting or joined to one another within and between colonies.

Table 5. Summary of nest data from Grey Swiftlet colonies in Queensland

Colony	Association with other nests	Building Materials	Cement Content
Chillagoe	separate	grass and feathers	low
Mt Peter	separate	grass, twigs and feathers	low
Tully Gorge	joined	moss & feathers or grass & feathers	low or high
Dunk Island	separate or joined	grass, vines, egg-shell, feathers and *Eucalyptus* leaves	high
Bedarra Island	separate or joined	*Casuarina* leaves and feathers	high
Wheeler Island	separate or joined	*Casuarina* leaves and feathers	high
Finch Hatton Gorge	joined	grass, moss and water weed	high

For example, the fine *Casurina* needles which are readily available on Bedarra and Wheeler Islands were cemented firmly together along their entire length which produced a very rigid structure indeed. In the nests at Finch Hatton Gorge, on the other hand, it was the intrinsic strength of the constituent grass blades which maintained the basic shape of the nest and application of the cement was confined to the attachment of the nest to the cave ceiling.

That the nests are built joined together in some colonies of *A. spodiopygius* and separately in others was explained by Pecotich (1974) in terms of availability of suitable nesting sites; when nesting sites were at a premium the nests were cemented together, but with a surfeit of suitable rock face, as in the Chillagoe caves, the nests were built separately. However, since individual colonies exploit their individual mixture of materials with which to build their nests, it seems possible that particular styles of construction might have been developed and perpetuated within colonies. The clustering of nests and the fact that some may be separated from the rock face by other nests to which they are attached may, in the Bedarra and Wheeler Island colonies, represent a Family Island "culture" which, while it may have developed in response to a shortage of nesting sites, is now maintained despite the availability of adjacent "vacant" sites on the rock face.

It is also possible that grouping of nests may reflect some social order as yet not understood, such as young birds building nests nearby or attached to parental nests. Such a theory would make sense in facilitating location of the nest in the dark; the acoustic image of the immediate surroundings of the parental nest could subsequently complement other cues (e.g. olfactory) to assist birds to locate their own nests if built nearby.

Medway and Pye (1977) have summarized the known information on the shape and composition of nests of 14 species of swiftlets. The nests are classified as either self-supporting or externally-supported and further described in terms of the relative proportions of vegetable material, feathers and nest cement (salivary secretions) of which they are composed. Only one species, *Aerodramus fuciphagus*, builds a nest entirely of salivary secretion (a nest which provides the ingredient for the soup so favoured by Chinese epicures).

The nests of *A. spodiopygius* fall into both Medway's categories of self-supporting and externally-supported (joined) and show a greater degree of variation in material composition than has apparently been recorded for other swiftlet species.

The data reported above have extended the known breeding season of the species by several months beyond that previously accepted. Macdonald (1973) gives the breeding season as the period between October and March. During this study, eggs were seen in the nests of the Family Island colonies as early as July and the first chicks were observed in September.

When large numbers of young were present, in October, November and December, they represented, as in Tully Gorge, chicks of a wide variety of ages: from the naked and newly hatched to the fully feathered individuals equal in weight to the adults. This can be

interpreted as a lack of short term breeding synchrony within the colony. Some more light is thrown on this subject by Banfield (1912) who for many years was the sole resident of Dunk Island. His observations of the Dunk Island colony suggests that each pair of breeding swiftlets may rear four young from four separate cluthces during the season. Certainly replacement eggs were observed during our study after newly hatched young had fallen from their nests. Replacement clutches are also laid by *A. maximus* in Malaysia (Medway 1962a) when nests are harvested for the bird's nest soup industry. Some credence must therefore be given to Banfield's theory, though he did not provide any specific data to support it.

The choice of roosting habitats clearly provides good protection for adult swiftlets. Medway (1962a) reported that raptorial birds "were not outstandingly successful" at catching swiftlets at Niah Cave. Observations at Bedarra Island suggest that swiftlets are most vulnerable while still in the nest. Medway's observation (1962a) of an egg-eating orthopteran and a predatory snake at Niah supports this finding.

The data on predation in the Bedarra Island colony, and the apparent hazards of persistent water on the surface to which nests are attached at the Finch Hatton cave, make it clear that the ability to exploit dark or dimly lit refuges, by means of echolocation, does not confer impunity to disaster, either to individuals or whole colonies. It is factors such as these which may account for the lack of colonization of apparently suitable cave sites throughout the range of the species in northern Queensland.

Contrary to some earlier reports, the caves used for nesting are not abandoned during the non-breeding season, and there is no evidence of seasonal migration by the Grey Swiftlet. However, to see the Grey Swiftlet at roost between breeding seasons it is necessary to visit their caves after dark. The birds are in flight away from the cave continuously from dawn to dusk in search of their insect prey, always caught on the wing.

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NOTES ON THE DIET OF THE GREY SWIFTLET, *AERODRAMUS SPODIOPYGIUS*

D.M. SMYTH

Grey Swiftlets feed on the wing during daylight hours and it has been established that echolocation by this species, as for other members of the genus, is insufficiently sensitive to assist in the capture of prey (Smyth, 1979). Their food therefore consists of flying or drifting animals which are large enough to be seen, small enough to be eaten and slow enough to be caught. These limitations restrict the diet of swiftlets to flying insects and drifting spiders.

The known colonies of Grey Swiftlets in Queensland have been described above (Smyth *et al*, 1980) and at one of these, the colony on Bedarra Island in the Family Island group, the opportunity arose to sample the food intake of individual swiftlets as they returned to the colony. For the purpose of collecting swiftlets to be used briefly in echolocation experiments, mistnets were strung over the seaward entrance to the Bedarra Island cave at various times of the year. During the breeding season, captured swiftlets commonly regurgitated pellets of food as they were being removed from the net.

The pellets consisted of a loosely packed collection of intact and sometimes still living insects and spiders covered in a thin coating of saliva. Ten such pellets were obtained from swiftlets caught entering the Bedarra Island cave at dusk during November 1976 and 1977. In a total of 940 food items, the following relative numerical proportions of animal groups were found: Odonata 0.5%, Coleoptera 12.4%, Hemiptera 26.9%, Diptera 50.5%, Hymenoptera 7.0% and Araneida 2.7%. Thus, at least for the samples examined, the Diptera were the most numerically significant group in the diet, although the Hemiptera provided an approximately equivalent biomass. The insects and spiders caught by *A. spodiopygius* varied in length between 1 and 8 mm, with the majority falling within the range 2-6 mm.

Harrisson (1974), on the basis of exhaustive studies of stomach and pellet contents, and from experience gained from first hand helicopter-born observations of feeding swiftlets in the vicinity of the large colonies at Niah Cave, Sarawak, concluded that there was little prey selectivity within or between swiftlet species. Flying ants were found to form a dominant, though seasonally variable, component of the diet for *A. salangana* and *A. maximus*. A similar observation has been made, in more general terms, by Medway (1962) and Chasen (1931). Of the Hymenoptera found in the *A. spodiopygius* pellets, 50% were flying ants, representing only 3.5% of the whole diet.

Further studies on swiftlet feeding behaviour and diet will not only provide a better understanding of the ecology of the species, but will make an important contribution to our knowledge of the aerial invertebrate fauna above the rainforests and coastlines of northern Queensland.

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NOTES ON MONARCH FLYCATCHERS AT WIDGEE

B. HUGHES and P. HUGHES

Three Monarch Flycatchers are seen at Widgee (26°13'S,152°28'E), and over a ten year period definite feeding patterns and times of occurrence have been noted.

Black-faced Monarch *Monarcha melanopsis*

This bird is the most uncommon of the three although it has been recorded in all months. Immature birds have been seen during the June-August period. The height at which this bird feeds seems to be between 1.5 and 6 m. It has not been observed feeding on the ground, on the trunks of trees or on the outer leaves. Feeding method is to move along a branch for a short distance poking into crevices etc. then to move to a higher branch. Once the bird has reached about the 7.5 m level a rather rapid descent is made, perhaps with one or two stops, to a lower level from where the process is restarted. The species is restricted to those areas of scrub where the feeding requirements are met, *i.e.* a relatively open scrub without understorey tangles. In this environment the species has not been observed to take insects on the wing. It does not appear to have favoured food trees.

Spectacled Monarch *Monarcha trivirgatus*

This species is seen all year round with young birds in April. The feeding range appears to be from just above ground level to about 4.5 m. It behaves a little like the Eastern Yellow Robin *Eopsaltria australis* in its habit of perching sideways on a tree trunk. The Monarch forages under loose pieces of bark and then flies to a horizontal vine where it sits before flying to another trunk. Foraging occurs on both the trunk and the vine with the majority being done on the tree trunk. The species has not been observed to feed amongst the outer leaves or above the 4.5 m level. The feeding territory is seemingly restricted to scrub areas in which vines are present. The Spectacled Monarch has been observed once feeding outside the scrub. On this occasion it was in company with the Grey Fantail *Rhipidura fuliginosa* and the Rufous Fantail *R. rufifrons* which were feeding on a swarm of insects about 1 m above the surface of a small dam. The Spectacled Monarch was not as agile in catching the insects as the fantail species although it did catch quite a few.

White-eared Monarch *Monarcha leucotis*

This species is a migrant appearing in late August and leaves at the end of December. Young birds are seen in November. This bird has been observed to feed almost exclusively on the outer leaves of rain-forest trees at a height of 6 to 9 m. There are four favoured trees *Eugenia smithii* and the closely related *Syzygium* sp., Deep Yellow Wood *Rhodosphaera rhodanthema* and Tulipwood *Harpullia pendula*. Birds feed within about a 4.5 m range not approaching the top of the tree and not descending into the understorey growth. The method for feeding is to almost hover outside the leaves and to dart in to catch

insects from the leaves. The bird will then move through and perch on the small branches just inside the canopy. They have not been observed to fly out to catch insects in the manner of the Grey Fantail. Feeding method is easily recognisable and aids in identification.

The White-eared Monarch has been seen away from the scrub on three occasions; once feeding on a young (about 6 m high) Brush Box *Tristania conferta* and twice in small wattles in an area connecting two patches of scrub. They did not feed in the wattles but stayed in the tree for an hour or so. The birds flew out to about 15 cms away from the leaves and hovered but made no move closer towards the leaves.

The four favoured feeding trees have similar appearance with dark glossy green leaves forming a dense canopy away from the trunk. The *Tristania* has a similar appearance and it is surprising more White-eared Monarchs have not been observed feeding on them. Main feeding seems to be undertaken during the mid-morning to mid-afternoon period.

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PIEBALD BLACK NODDIES

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During the summer of 1977-78 three Black Noddies *Anous minutus* with white feathers in their plumage were seen at Heron Island (23°27'S, 151°55'E). In November 1977 a noddy with white feathers on its wings was caught at the research station (Figure 1). The noddy was tangled in a cluster of sticky *Pisonia* seeds and so could not fly. The noddy was photographed, the seeds removed and the bird released. It was not seen again. In December 1977 a noddy with a completely white feather in its tail was seen at the research station. Also during the summer of 1977-78 a fully fledged completely white Black Noddy was seen flying at Heron Island.

Figure 1. White feathers on the wings of a Black Noddy

The white cap of noddies has a function in some of the noddies' displays (see Fisk 1977). The effect of these unusual white markings on behaviour of other noddies with which an unusually coloured noddy interacts is not known.

In the photograph (Figure 1) one can also see a cluster of *Pisonia* seeds stuck on the tail and left wing. Some noddies become so entangled in clusters of sticky seeds that they cannot fly and so eventually die of exhaustion or starvation (Jahnke 1977, Ogden 1979). Although the feathers of noddies get badly battered most are able to fly after the clusters are removed from their plumage.

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