FIRST MONITORING SURVEY OF VATUIRA ISLAND, LOMAIVITI, FIJI

-

AUGUST 15-20TH 2006

October 2006

Environment Consultants Fiji

VATUIRA – 1ST MONITORING VISIT, 15-20TH AUGUST 2006

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ABBREVIATIONS AND ACRONYMS

PMS Permanent Monitoring Station
PVP Permanent Vegetation Plot

1 INTRODUCTION

Rats were removed from Vatuira by a BirdLife – Pacific Invasives Initiative team in mid July 2006.

BirdLife International have commissioned Environment Consultants Fiji to undertake the follow up monitoring visits on Vatuira Island. This report relates to the first of the post rat-removal monitoring visits. The monitoring team comprised Elenoa Seniloli, Amit Sukal (BirdLife); Dick Watling (Environment Consultants Fiji); Sione Gonewai (boat captain); Suliasi Waqalala and Manueli Naivalubasaga (landowners). The team arrived on the island at 1500 on Tuesday 15th August and departed at 0800 on Sunday 20th August.

1.1 WEATHER

The weather during the visit was fine but windy for the first two days but on Thursday a front came over and by the evening it was blowing very hard with intermittent rain squalls – this abated by Saturday evening enabling an early departure from the island on Sunday.

1.2 TASKS UNDERTAKEN

Monitoring covered the following activities:

1. Selection and establishment of 18 Permanent Monitoring Stations (PMS):

   - Setting up of 1 Snap Rat Trap; 1 Peanut Butter Bait; and, 1 Tunnel with Ink Pads; PMPs marked with black pink triangular marker (Figure 1);
   - Five morning inspections undertaken;

2. Total Count of all seabirds nesting on the island and documentation of nest stage:

   Species nesting – Red-footed Booby; Brown Booby; Lesser Frigatebird;

3. Selection of four Permanent Vegetation Plots (PVP):

   Four PVPs set up and total inventories made of all plants within the four plots of $100m^2$ each (5m x 20 m; Figure 1);

4. Skink Transects:

   Three transect lines totaling 598m were set up (Figure 1). One transect count made (poor weather prevented further);

5. Plant Species Checklist:

   A checklist of all plants on the island was drawn up;

2 PERMANENT MONITORING STATIONS

2.1 SET UP

Three lines were set up as follows (Figure 1):

- One line with six sites along the western coast, starting just above the 'cliff' site at the southern end, the last just before the northern 'rock'. The line includes a site adjacent to each of the main camp sites;
- One line with eight sites along the centre line on the island with the first site (7) on the northern rocks stack, and the last (14) on the southern point of the island; with three sites on the southern hill.
- One line with four sites along the eastern coast.

Plate 1: Pink Triangle marking location of PMS

Each site is marked with its number on a pink plastic triangle screwed into a tree
The following was set up at each PMS

- a snap trap baited with burnt coconut.
- a tracking tunnel baited with burnt coconut. Bait (burnt coconut) was attached to the inside of the roof of the tunnel with paper clips – one at each end.
- a peanut butter-flavoured wax tag nailed to trees at random heights.

2.2 INSPECTIONS

Sites 2-14 were set up on afternoon-evening 15th August; Sites 1,15-18 were set up on the morning of 16th August. Set up sites were inspected each morning, 15-20th August.

2.3 RESULTS

Rat Traps No rats were caught in the traps, nor was there rat sign on either the ink pads or the peanut butter baits (refer Table 1).

One rat carcass was found on a rocky ledge – it was highly desiccated and is considered to have died from poison at or about the the time of the bait laying.

Plate 2: Desicated Rat Carcase found at head of the Southern Cliffs

There were 84 trap nights. 66 (78%) of traps were – not sprung and bait still present. 16 (19%) were sprung Sprung traps caught two crabs, leg being left – large hermit crab and ghost crab. One trap killed a kingfisher, clearly trying to take the coconut bait. Others were believed to have been sprung by small **uga**[1] which were not caught.

[1] **Uga** – small hermit crabs

Tunnel and Ink Pads There was no sign of rats on the ink pads (Appendix 2). The only recognisable tracks were those of **uga**. Ants were also common and cockroaches were also known to cross the ink pads. Several of the ink pads were being eaten , probably by cockroaches. Baits from the tunnels were lost or dropped quite frequently, this is probably cockroaches with **uga** removing the baits once they have dropped.

Wax Peanut Butter Baits There was no sign of rats on the peanut butter baits. One of them was finished in the first night, but that was a site with a lot of small **uga** to which it was accessible (Table 2). Two others were progressively eaten and finished during the monitoring period, probably by **uga**, possibly by cockroaches. All other baits showed some sign of being eaten. It is believed that these were eaten by **uga**, cockroaches or ants. After the first night, all peanut tabs that were obviously accessible to **uga** were moved to inaccessible sites.

Plate 3: Small Hermit Crabs (uga) feeding on Peanut Butter flavoured bait.

Ants and Other Insects Ants found the coconut baits almost immediately and most of them were covered every night with many persisting during the day as well. Baits need to be changed every two or three days. Observations at night revealed large American cockroaches feeding on the baits at night.

Geckos Observations at night revealed the large Pacific Gecko *Gehyra oceanica* close to a peanut bait. No marks were attributed to geckos but they might be licking them.. This species of gecko feeds on soft fruit (bananas, pawpaws etc.) by licking the pulp.

Uga – *Small Hermit Crabs* These were not overly abundant except at two or three sites. Otherwise they were either absent or their in ones and twos. The peanut butter tabs were moved after night 1 to sites inaccessible to **uga** (sloping trunks or upper branches). **Uga** cannot reach the baits in the tunnels so that is not a problem, but where they are in large numbers they can spread the ink about and it would be best to place tunnels with a lip of 3cm at each end to minimize their movement in the tunnels. Similarly it would be best next time to place rat traps out of **uga** reach.

Plate 4: Small Hermit Crabs (uga) around a finished Peanut Butter flavoured bait.

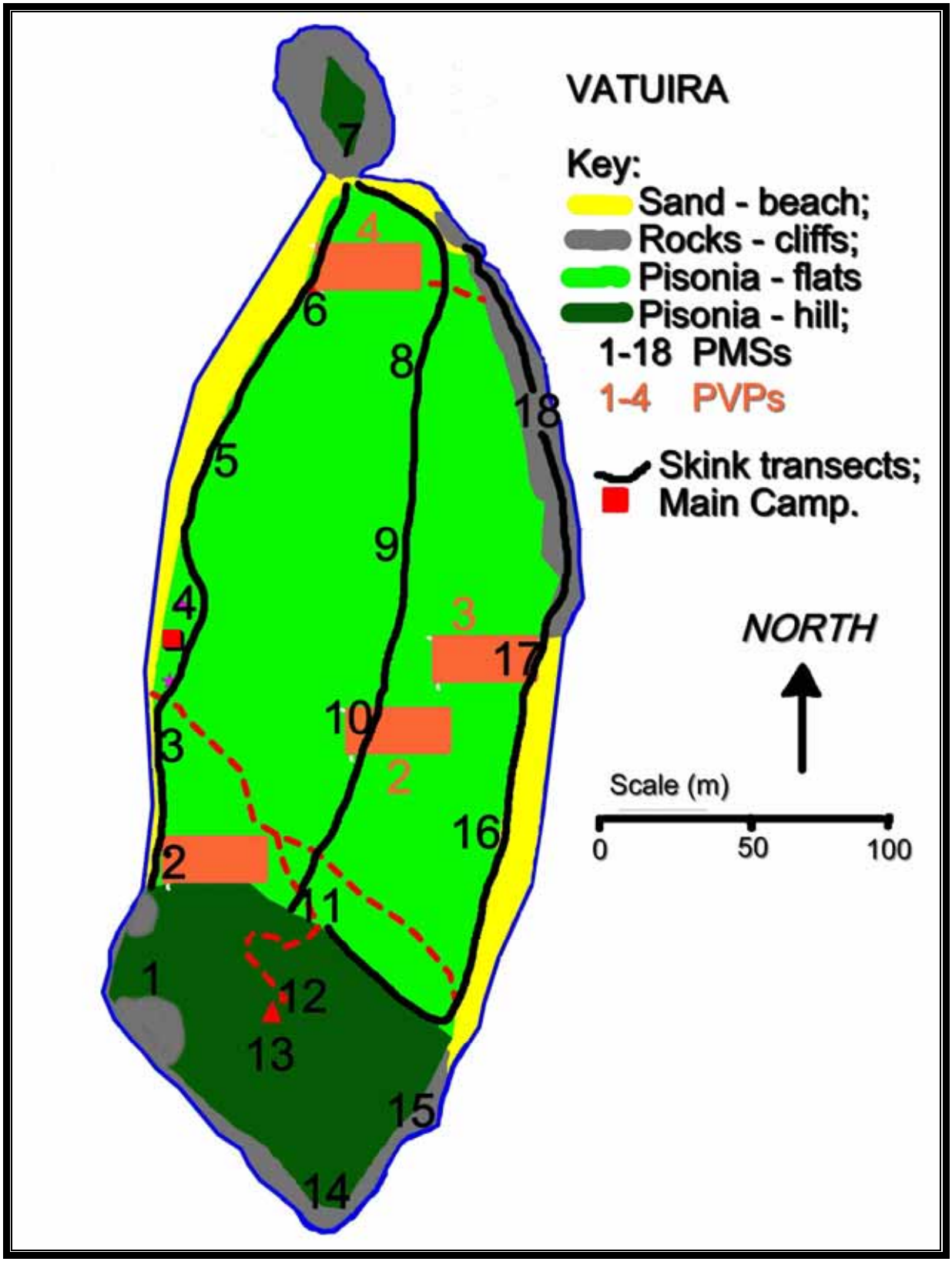


Figure 1: Vatuira Island with Permanent Monitoring Stations, Permanent Vegetation Plots and Skink Transects

Table 1: Rat Trap Monitoring Data

RAT TRAPS

The Monitoring Results for Vatuira Island.
16th-20th August ,2006 **85** **Total Trap Nights**

Date	Site #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total	Combined	%
16-Aug-06	OK/BP		1	1	1			1	1	1	1	1	1		1					10	66	77.6
	OK/BG																			0	0	0.0
	S/BP													1						1	3	3.5
	S/BG					1	1													2	16	18.8
	Comment	Not set	Ants++	Ants++	Ants++	Uga +++; Ants+	Crab leg; Uga +++	Ants++	Ants++	Ants++	Ants++	Ants	Ants+			Not set	Not set	Not set	Not set	0		
17-Aug-06	OK/BP	1	1	1	1			1	1	1	1	1		1	1	1				12		
	OK/BG																			0		
	S/BP																	1		1		
	S/BG					1	1						1				1		1	5		
	Comment	Ants ++	Ants++	Ants++	Ant++, Uga+			Ants++	Ants++	Ants++	Ants++	Ants++		Ants ++	Ants ++	Ants ++	Uga+	Ants-	Crab leg; Ants	0		
18-Aug-06	OK/BP	1	1	1				1	1	1	1		1	1	1	1	1	1	1	14		
	OK/BG																			0		
	S/BP																			0		
	S/BG				1	1	1					1								4		
	Comment	Ants ++	Ants ++	Ants ++	Ants-	Ants -	Ants-	Ants ++	Ants-	Ants +++	Ants ++	Ants-	Ants-	Ants ++	Ants ++	Ants ++	Ants ++	Uga ++	Ants ++			
19-Aug-06	OK/BP	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	16		
	OK/BG																			0		
	S/BP																			0		
	S/BG					1						1								2		
	Comment	Ants ++	Ants++	Ants ++	Ant++	Ants +++	Ants++	Ants-	Ants++	Ants-	Ants++	Ants++& Kingfisher	Ants+++	Ants-	Ants ++	Ants+++	Ants ++	Ants-	Ants+			
20-Aug-06	OK/BP	1	1	1		1	1		1		1		1	1	1	1	1	1	1	14		
	OK/BG																			0		
	S/BP									1										1		
	S/BG				1			1				1								3		
	Comment	Ants +	Ants++	Ants++		Ants++	Ants++									Ants+++	Ants -	Ants+++	Ants-			

Key:

OK/BP	Trap Set; Bait Present
OK/BG	Trap Set, Bait Gone
S/BP	Trap Snapped; Bait Present
S/BG	Trap Snapped, Bait Gone

Table 2: Peanut Baits Monitoring Data

PEANUT BAITS

The Monitoring Results for Vatuira Island.
16th-20th August ,2006

Date	Site #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
16-Aug-06	Peanut		OK	OK	OK	OK	Finshed	OK	OK	OK	OK	OK	OK	OK	OK				
	Comment	Not Set	Ants ++	Ants ++	Ants ++	Ants ++	Uga +++	Ants	Uga +; smoothed	Ants +	Ants +	Ants +; smoothed	No Ants	No Ants	No Ants	Not Set	Not Set	Not Set	Not Set
17-Aug-06	Peanut	OK	OK	OK	OK	OK	Finshed	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Comment	Ants+++	Ants ++	Ants+++	Ants+++	Ants+++		Ants+++	Ants+++	Ants+++	Ants++	Ants+++; prongs emerging	No Ants	No Ants	Ants+++	Uga & Ants++	Uga & Ants++	Ans ++	Ants ++
18-Aug-06	Peanut	Half eaten	OK	OK	OK	OK	Finished	Liittle left	OK	OK	OK	OK	OK	OK	OK	Little left	OK	OK	Little left
	Comment	Uga +	Slight Depression	Ants++	Ants++	Ants++		Uga++	Ants+++	Ants+++; prongs visible	Ants++	Ants+++; prongs exposed	1 ant	Ants+++	Ants+++	Ants+++	Ants++	Ans ++	Ants+++
19-Aug-06	Peanut	Finished	OK	OK	OK	OK	Finished	Finished	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	Little left
	Comment	Ants+++	Half eaten; Ants+++ & Cockroaches+	Ants+++	Ants+	Ants+++		Uga& Ants++	Ants+++	Half-eaten; Ants++	Half-eaten; Ant+++ & Cockroaches	Nearly-finished; Ants+++ & cocockroaches	Hardly touched	Ants+	Well eaten; Ants+	Little left: Ants+++	Ants++	Ants+	Ants++
20-Aug-06	Peanut	Finished					Finished	Finished											
	Comment																		

No observations made on 20th; baits to the office

Table 3: Tracking Tunnels Monitoring Data

TRACKING TUNNELS

The Monitoring Results for Vatuira Island.
16th-20th August ,2006

Date	Site #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
16-Aug-06	T/Tunnel		OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK				
	Comment		Ants+	Ants+	Ants+	Ants+	Ants	Ants+	Ants+	Ants+	Ants+	Ants+	Ants+	Ants+	Ants+; Uga				
17-Aug-06	T/Tunnel	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Comment	Ants +++	Ants++	Ants++	Uga+, Ants++	Ants++	Ants+++	Ants+++	Ants+++	Ants+, Uga+	Ants	Ants++	Ants++	Ants++	Ants++	Ants++	Ants++	Ants+, Uga++	Ants++
18-Aug-06	T/Tunnel	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	Blown Away	OK	OK	OK	OK
	Comment	Ants +++	Ants++	Ants++	Ants++	Ants++	Uga+, Ants++	Ants++,Uga+	Ants+++	Ants+++	Ants++	Ants+++	Ants++	Ants++	Replaced	Ants++,Cockroaches+	Uga++	Uga +	Ants++
19-Aug-06	T/Tunnel	OK	OK	OK	OK	OK	OK	Missing	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Comment	Ants +++	Ants +++	Ants +++	Ants +++	Ants +++	Ants +++	Not replaced	Ants +++	Uga+, Ants++	Ants++	Ants+	Ants++	Ants++	Ants++	Ants+++, Uga +	Ants++, Uga+	Uga+, Ants+	Ants+++
20-Aug-06	T/Tunnel							Missing											
	Comment																		

No observations made on 20th

3 TOTAL COUNT OF ALL SEABIRDS NESTING ON THE ISLAND

3.1 BIRD SPECIES PRESENT ON THE ISLAND

Reef Heron - Two grey phase present.

Wandering Tattler – Two seen on each day.

Lesser Frigatebird - All birds identified were of this species. Breeding was under way; refer below.

Red-footed Booby - Approximately 600 birds counted from the beach at first light each morning on the northern side of the hill representing number of birds roosting on this part of the island. Nesting beginning in numbers, refer below.

Brown Booby – About 150 Brown Booby roosting and many present during the day, mainly on the southern cliff face, but also some on the northern stack and the eastern hill. A single pair with one egg, one just hatched on the eastern hill.

Brown Noddy – No nesting. 15-20 seen around the island, usually first thing in the morning on the northern stack.

Black Noddy – No nesting. About 1 hour before dusk, black noddys started congregating off the western coast in increasingly large fast wheeling flock. Increasingly individuals come ashore and others leave. Many birds come into roost after dark. Impossible to estimate how many but certainly over 500. All leave `before dawn. Estimating numbers of noddys based on evening or dawn counts would appear to be a waste of time because of:

- the constant movement of birds,
- that they constantly enter the island then leave; and,
- because many birds appear to arrive after dark and leave before dawn.

Black-naped Tern – 115 counted on the northern stack and rocks immediately offshore soon after dawn on two mornings. About 10-15 remain all day.

Bridled Tern – No birds present

Crested Tern – No birds present

White-tailed Tropic Bird – None seen.

White-collared Kingfisher – A single individual observed on day 2 but not seen or heard thereafter. Found dead caught in the rat trap closest to where it was first seen. I believe it was the only one present on the island.

Plate 5: White-collared Kingfisher killed in a rat trap

3.2 BREEDING

The method used follows the "Simplified method to estimate the rate of egg-laying of seabirds" (McCormack 1991, Unpubl. Mss; Attachment 2).

A complete count of all the trees on the island was undertaken. This took less than 1.5 days using all five personnel spread around a particular tree at which point the number of nests and their contents were called out aloud until there was agreement. Wherever possible adjacent slopes or trees were climbed to allow the contents of nests to be better observed. This was important during the visit because most Boobys were on eggs or nestlings or even downy chicks. They were sitting tight because the weather was not good – windy, cold with occasional rain. Thus it is probable that the number of nestlings and downy chicks was underrepresented because unless something could be seen, sitting birds were recorded as sitting on eggs.

Manueli and Suliasi soon learned how to recognize the different nestling stages and to do the recording as well. They undertook the counts on the southern side of the hill by themselves.

Brown Booby

A single pair with one egg, one just hatched, on the eastern hill.

Red-footed Booby

213 occupied nests[2] were counted and there were an additional 17 adults perched next to unoccupied nests – possibly about to lay. Figure 1 shows the rate of egg-laying (number of clutches started per week) of the Red-footed Booby. This presumes that Red-footed Boobys are growing at the same rate as those for which the model was developed – a 23 week period from egg laying to fledging. For 2006, at least, it is quite clear that Red-footed Boobys on Vatuira are seasonal and start laying in numbers in late June and July. Only a very few pairs started breeding before July.

Lesser Frigatebird

Lesser Frigatebirds nest in substantial numbers on Vatuira and there are very few such islands in Fiji. 114 occupied nests were counted and there was one adult perched next to an unoccupied nest. The nesting period for Lesser Frigatebirds, at 31 weeks, is considerably longer than that for Boobys. Figure 2 shows the 2006 rate of egg-laying (number of clutches started per week) for the Lesser Frigatebirds on Vatuira and this would indicate that they are not such a seasonal breeder as the Boobys.

On day 3 in the late afternoon a "Wings or Tail" stage nestling was found blown out of the nest (strong winds all day) and had landed apparently uninjured on the ground below. At dawn next morning Manueli managed to climb up and replace it on its nest and by midday, a female was sitting adjacent to it, the next day a male was seen at the same nest – job well done !!

Plate 6: Nestling Lesser Frigatebird (just out of 'Scapular' and entering 'Wings or Tail' Stage) blown off its nest and subsequently replaced by Manueli

[2] Nests with an adult sitting on the nest or a nestling-juvenile in the nest. Adults sitting next to (presumed empty) nests were not included.

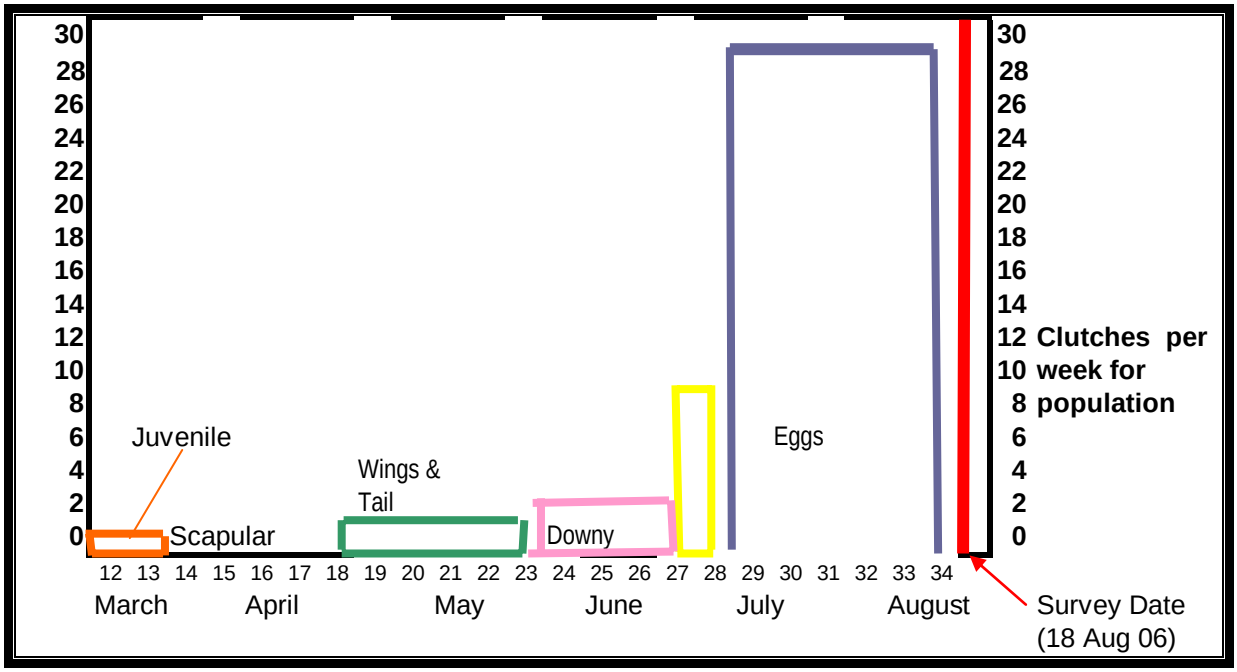


Figure 1: Rate of Egg-laying of the Red-footed Booby on Vatuira– mid 2006 (x axis - week #)

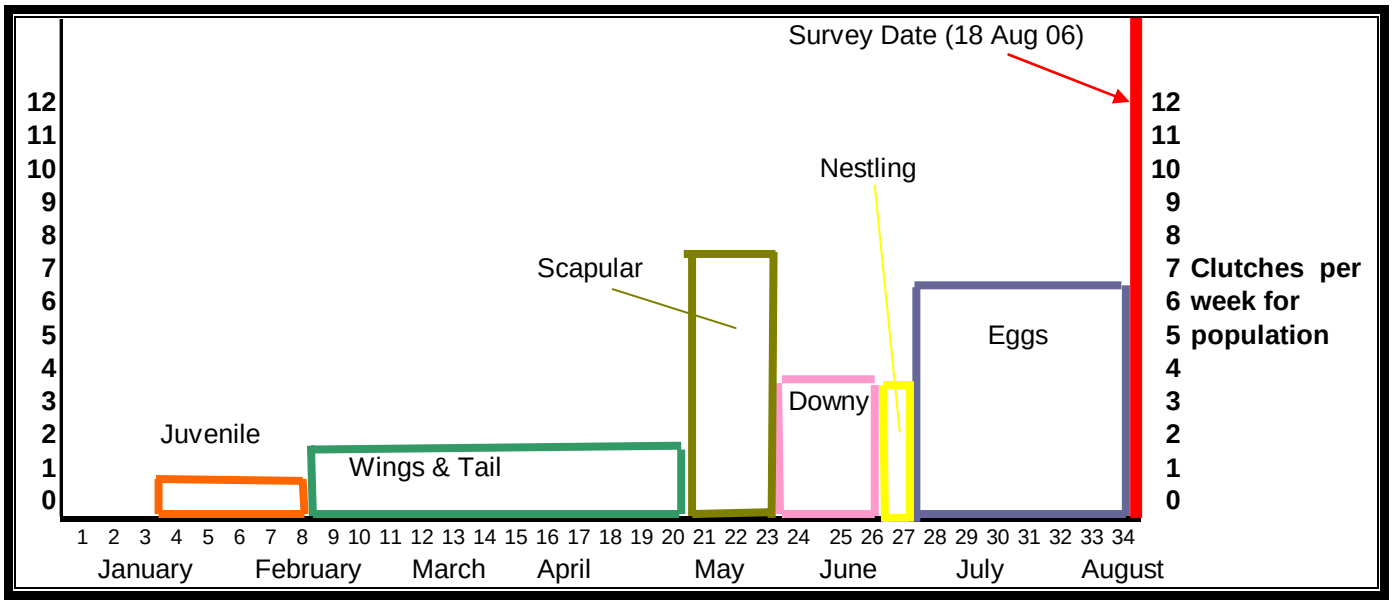


Figure 2: Rate of Egg-laying of the Lesser Frigatebird on Vatuira– early/mid 2006 (x axis -week #)

4 PERMANENT VEGETATION PLOTS

4.1 VEGETATION OF VATUIRA

31 species of plant have been recorded on Vatuira as listed in Table 4. This is a nearly complete list, one or two species will invariably turn up during later visits.

There is only a single distinguishable vegetation association – that being the Pisonia dominated woodland and this extends over the entire Southern hill as well as the flat lowland area. The fig *Ficus ?prolixa* is most common in the Pisonia on the steep southern facing slope of the Southern hill. The strand vegetation at the beach head is not well established and does not occur over a large enough area to be distinguished as a separate association, only at the northern end near PVP 4 is it well developed (see photo in Appendix 4). Similarly the vegetation on the stacks (northern and eastern) do not have a sufficiently similar association to be distinguished. Most of the rarer herbaceous plants on the island occur along the eastern coast and on the eastern ridge.

4.2 PERMANENT VEGETATION PLOTS ESTABLISHMENT

Four Permanent Vegetation Plots (PVP) were established as identified in Figure 1. The four plots are 5m wide by 20 m in length and were selected to be representative of the vegetation of the flat land on Vatuira. Each PVP was established close to a PMS with the plastic tag being used as a corner or close to the corner. It should be able to reconstruct the PVPs without much difficulty given the information provided on the data sheets (Appendix 4). The sides are measured out, by walking them using a hip/thread measurer.

The purpose of setting up PVPs is to monitor the rate of vegetation regeneration on the island and see if there are changes following rat removal.

Species Composition

Only seven species of plant were recorded in the PVPs and these were vastly dominated by Pisonia as shown in Table 5. The occurrence of regeneration as opposed to mature vegetation was correspondingly low and probably representative of the overall occurrence.

English Name	Scientific Name	Common Fijian Name	Abundance
Trees			
	Pisonia grandis		Abundant, the dominant tree
Tree Heliotrope	*Tournefortia argentia*	Roro ni bebe	A few in strand areas
Chinese Lantern Tree	*Hernandia nymphaeifolia*	Evuevu	One tree inland
Beach Almond	*Terminalia catapa*	Tavola	A few in strand areas
	Terminalia littoralis	Tavola	One or two in strand areas
Beach Mulberry	*Morinda citrifolia*	Kura	One or two in strand areas
Cordia	*Cordia subcordata*	Nawanawa	One or two in strand areas
Coconut	*Cocos nucifera*	Niu	About 8 in all
Pandanus	*Pandanus tectorius*	Vadra	Two or three on the island
	Excoecaria agallocha	Sinu gaga	A single tree
	Ficus cf *prolixa*	Baka	Quite common on S. side of hill
Fish Poison Tree	*Barringtonia asiatica*	Vutu wai	One or two in strand areas - small
Beach Laurel	*Calophyllum inophyllum*	Dilo	One or two in strand areas - small
	Thespesia populnea	Mulomulo	One or two in strand areas
Beach Hibiscus	*Hibiscus tiliaceus*	Vau	Two patches on W side
Puzzle nut	*Xylocarpus moluccensis*		One or two in strand areas - small

Shrubs			
Papaya	*Carica papaya*		One or two (near the camping area)
Scaevola	*Scaevola taccada*		Common in strand areas
Beach Privet	*Clerodendron inerme*	Verevere	Five or six patches
Herbs, Vines and Ground Layer			
	Phymatosorus grossus	Vativati	Common on stacks
	Nephrolepis sp.	Digi	On northern stack
	Lepturus repens	Vutika	Not common
Unid. grass			Not common
Beach Sedge	*Cyperus stoloniferus*	Malaga	One large and one small patch
	Mariscus javanicus		Common on stacks
	Boerhavia repens		Uncommon
	Chamaesyce chamissonis		Uncommon
	Portulaca oleracea		One plant
	Achyranthes aspera		Dispersed
	Vernonia cinerea	Kaukamea	Dispersed
	Canavalia sp.		Strand
Morning Glory	*Ipomoea macrantha*		Strand

Table 4: Plant Species Recorded on Vatuira Island, Lomaiviti

Summary	**Number of trees/plants**					
	Plot Number					**Index of Abundance**
Species	**1**	**2**	**3**	**4**		
Pisonia grandis	19	17	20	20	**76**	1900
Terminalia catappa	1				**1**	25
Tournefortia argentea			6		**6**	150
Barringtonia asiatica		1			**1**	25
Cocos nucifera		1	2		**3**	75
Cyperus stoloniferus			1	1	**2**	50
Lepturus repens	1				**1**	25
Plot Total	21	19	29	21	**90**	
Mature					88	2200
Regeneration					2	50

Table 5: Plant Species Recorded in the Permanent Vegetation Plots and their Abundance

Index of Abundance: Relates to the overall number of individual plants of a given species encountered in all the plots combined. Calculated as Number recorded divided by number of plots multiplied by 100.

Regeneration

The amount of regeneration (trees under 1m and newly germinated herb/shrubs) was very small. Two regenerating trees were recorded inside the four plots and another two just outside PVP 1 (excluded from the analysis). *Pisonia* appears to regenerate mainly from broken branches taking root in the mulchy soil. This was not recorded as regeneration.

5 SKINK TRANSECTS

One species of skink is found on Vatuira, the pygmy snake-eyed skink *Cryptoblepharus eximus*. It is possible that its numbers could rise significantly in the absence of rats. To monitor its numbers, three transects have been identified (Figure 1). These are set out by laying a hip-measurer thread along the ground and this is used as the centre of a transect. The perpendicular distance to the thread for each skink seen is measured as an observer walks slowly along the transect. The data are then computed using Distance software to provide a density (Watling 2001).

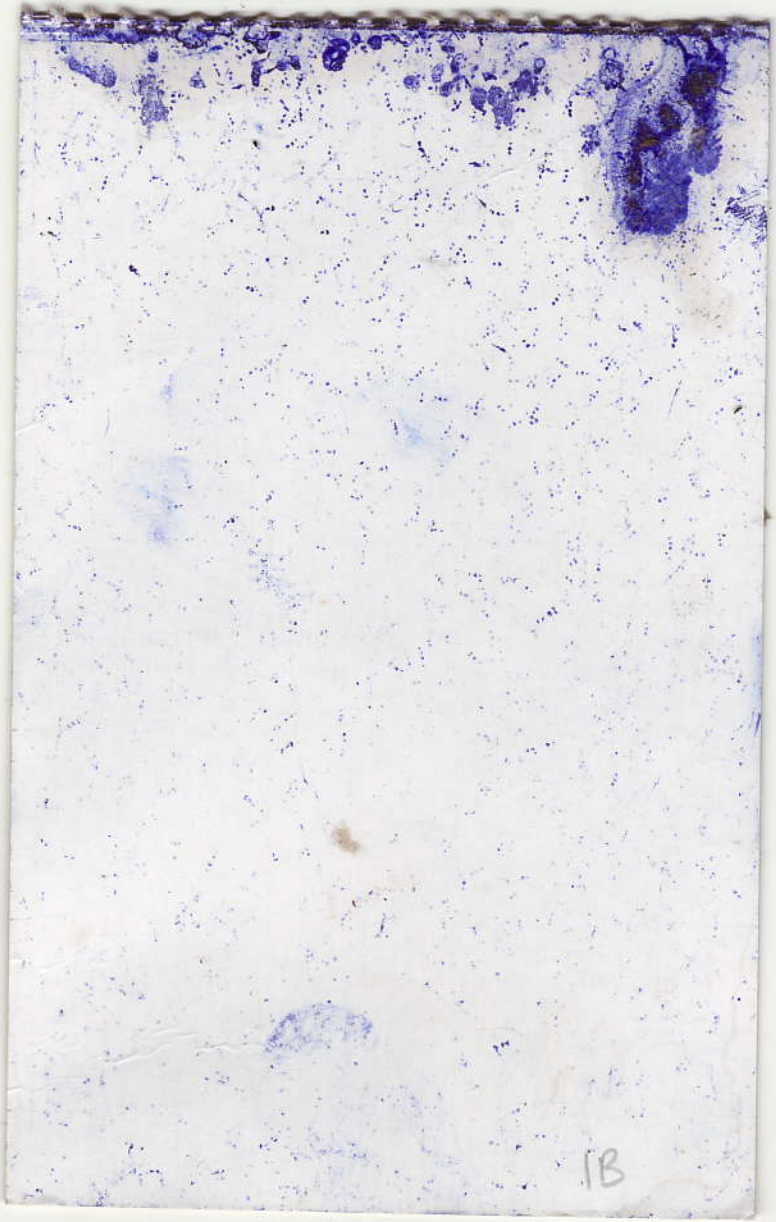
Cryptoblepharus is strongly heliophile and counts should only be made on bright sunny days.

The transects were set out on Day 3, however, bad weather prevented more than one set being counted. These provided insufficient observations to compute a density. At the moment the skinks are highly localized in areas where there are rocks – especially the northern and eastern stacks and along the east coast.

Tansect	Route	Length (m)	Counts 1
1	PMS 1 to PMS 7 just inside the shoreline	213	4
2	PMS 7 to PMS 11 through centre of island	194	0
3	PMS 11 to east coast and along HWM to eastern stack	191	84
	Total	598	88

Table 6: Skink Transects and Count

APPENDIX 1:
TRACKING TUNNELS

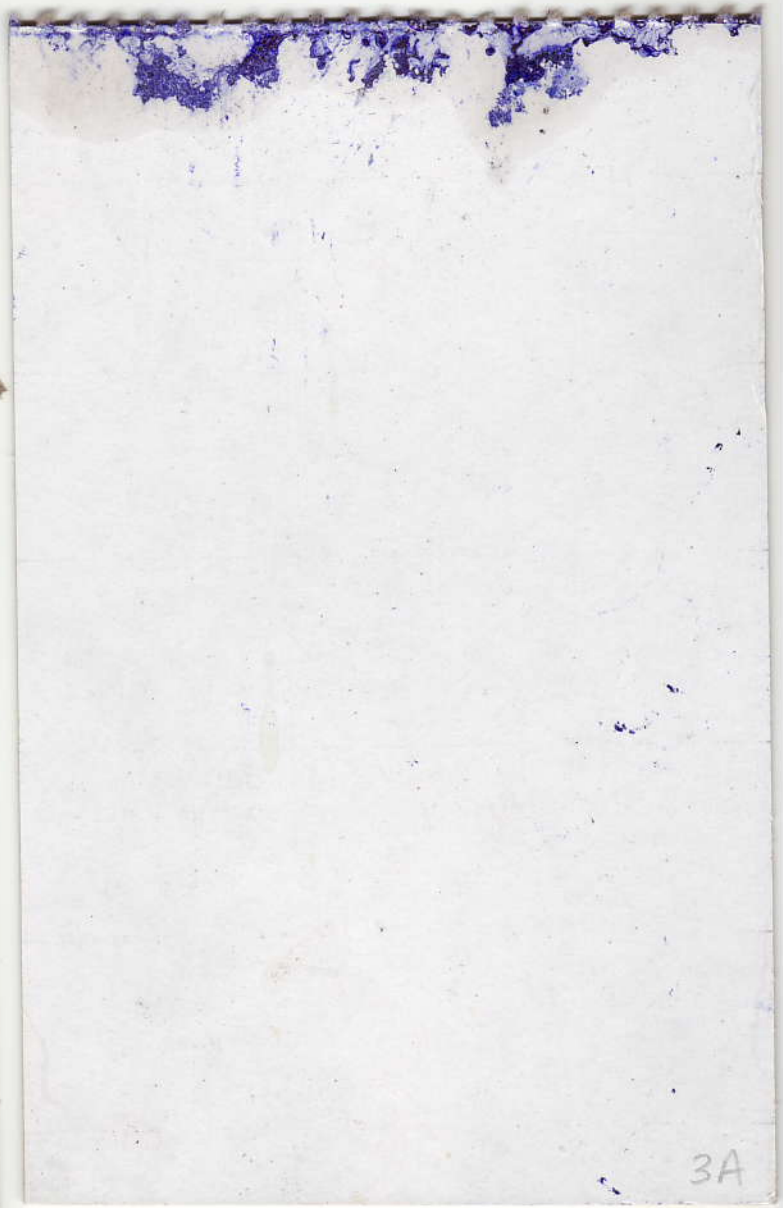

1B

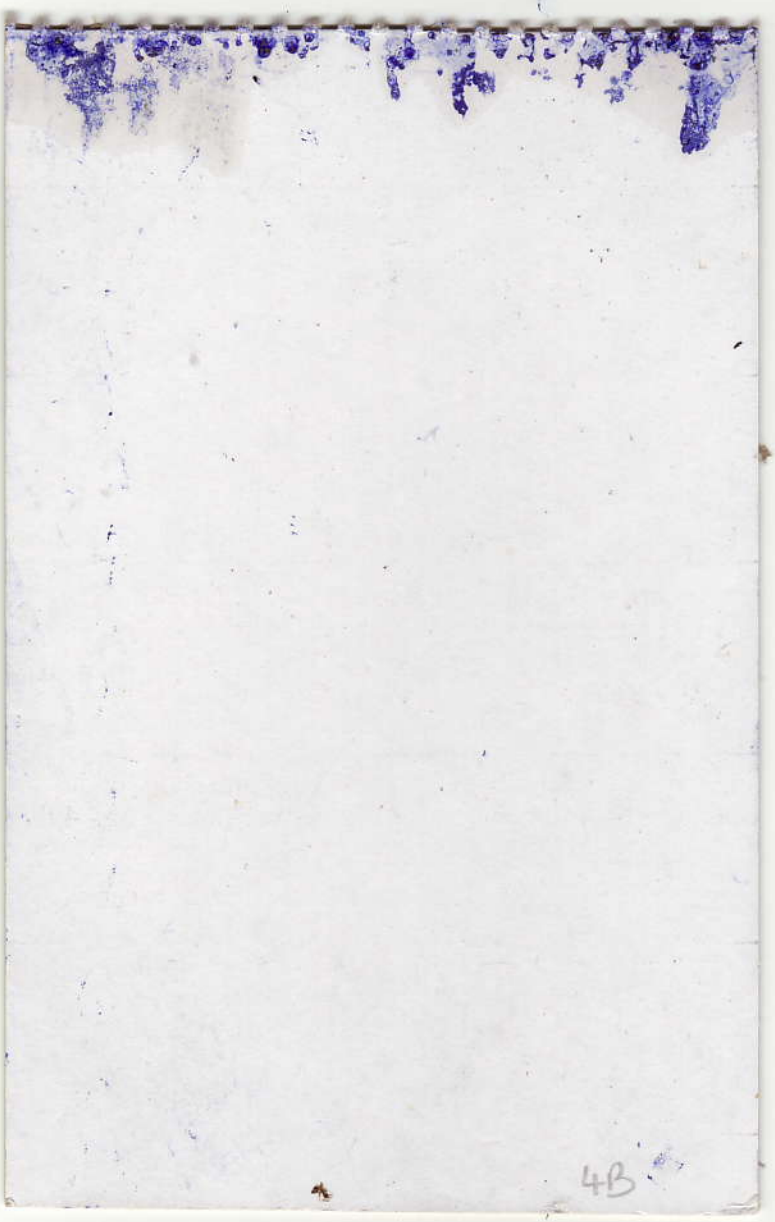

1A


2B

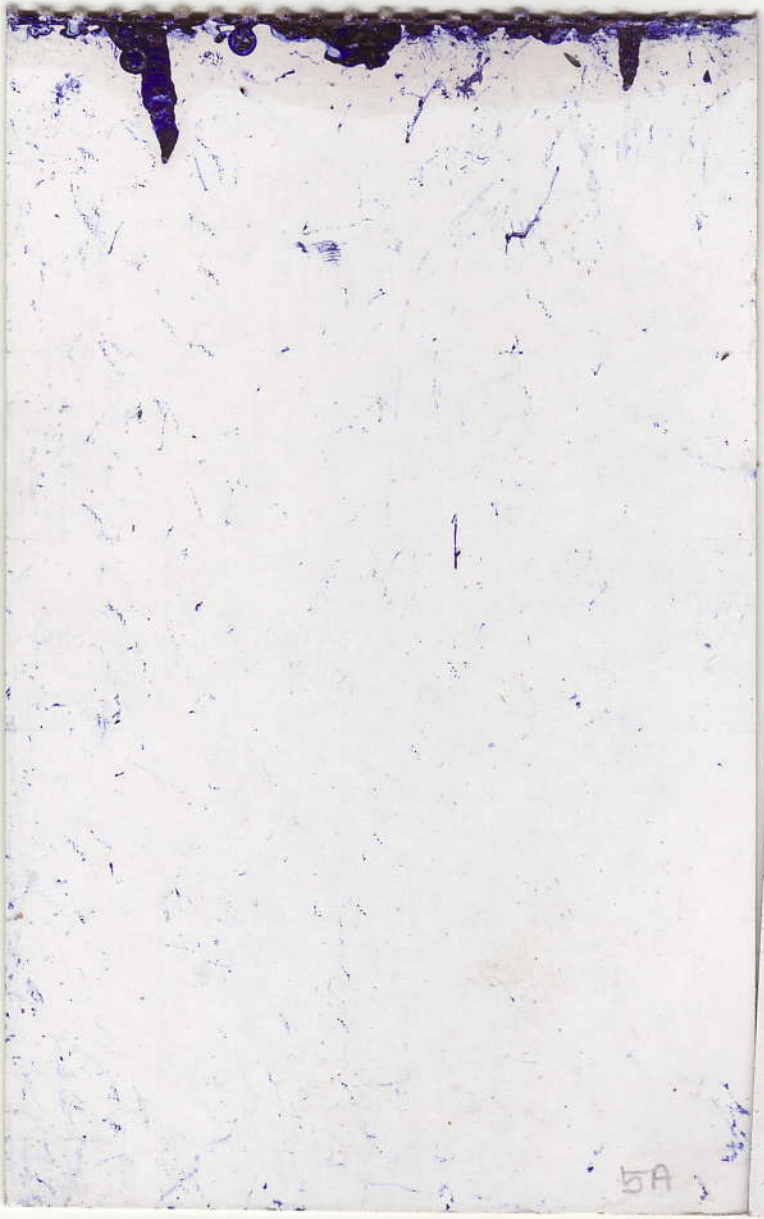

2A


3B

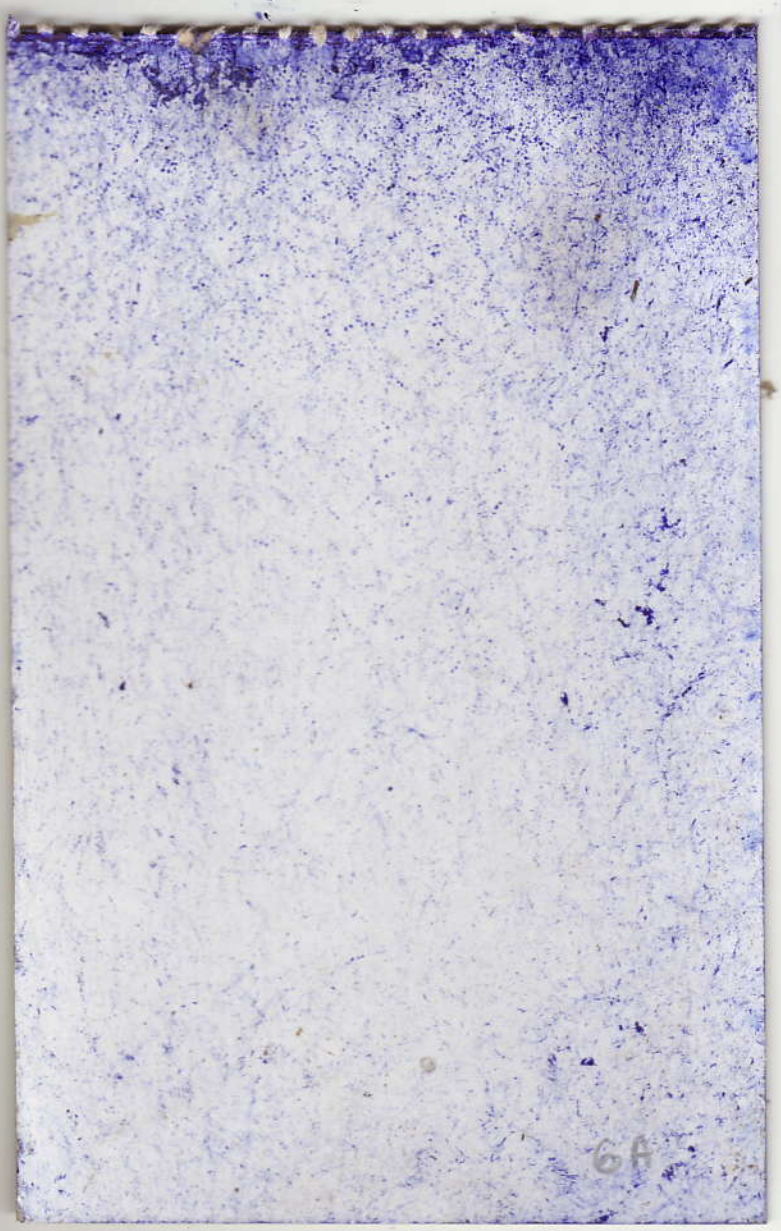

3A


4B


4A

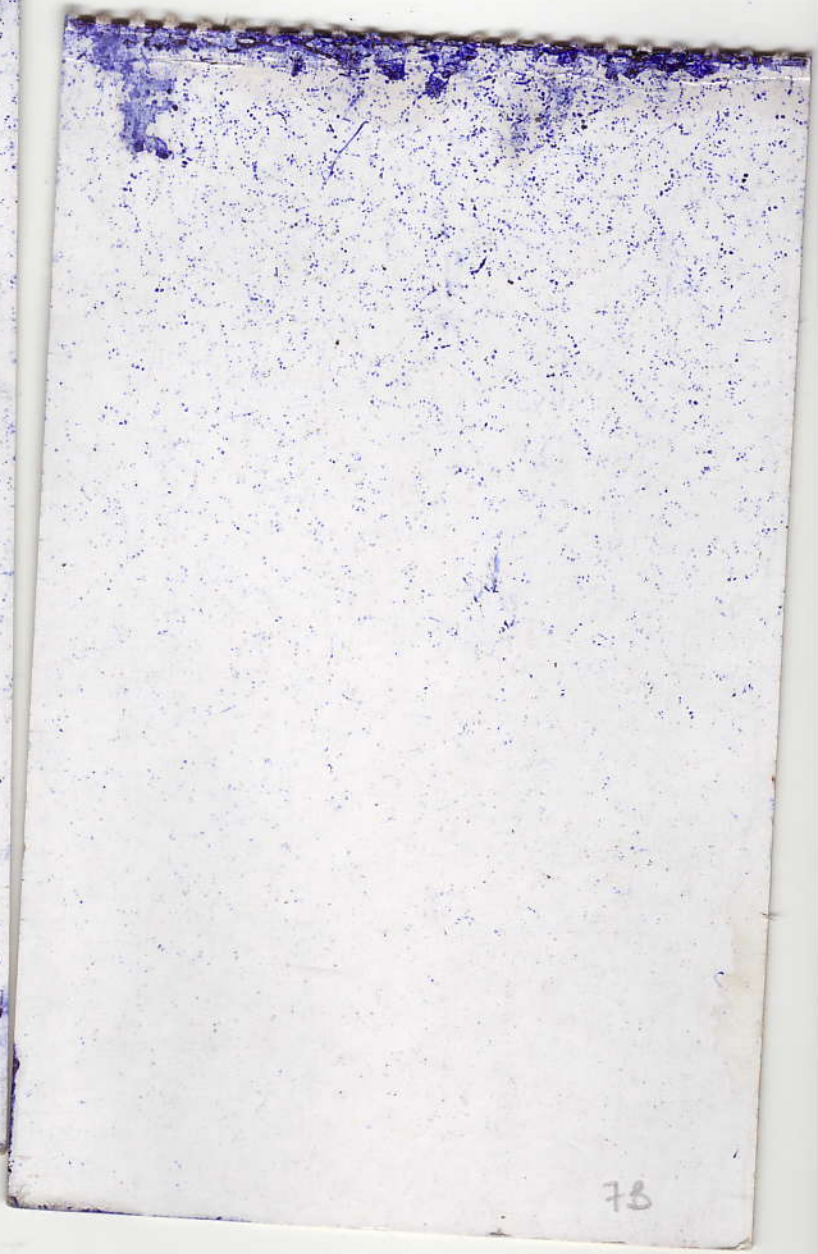

5A


5B


6A


6B


7A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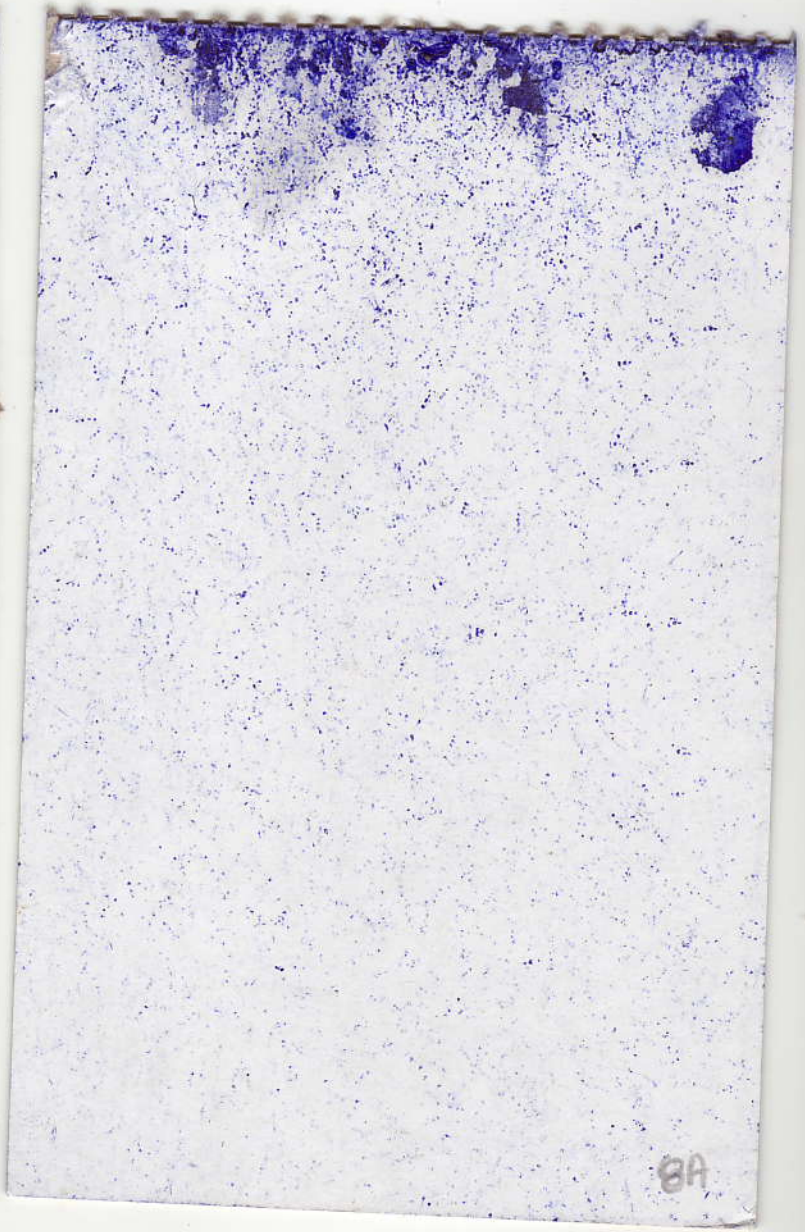
8B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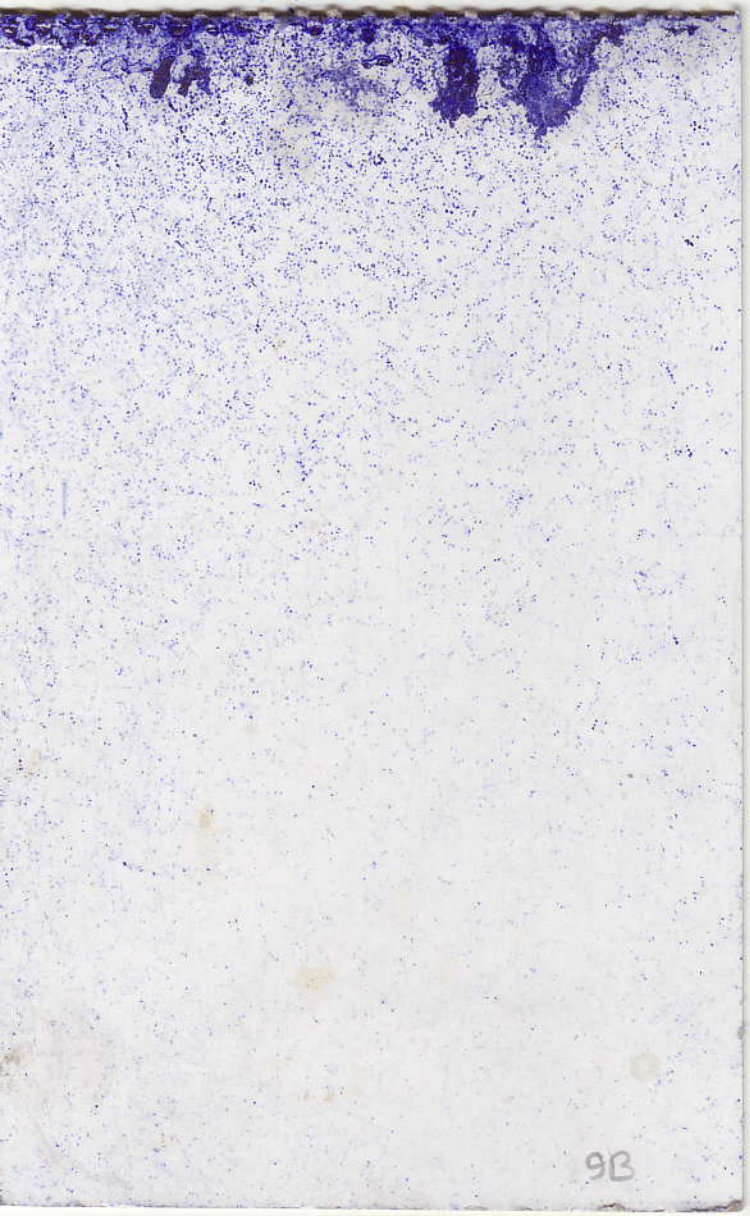
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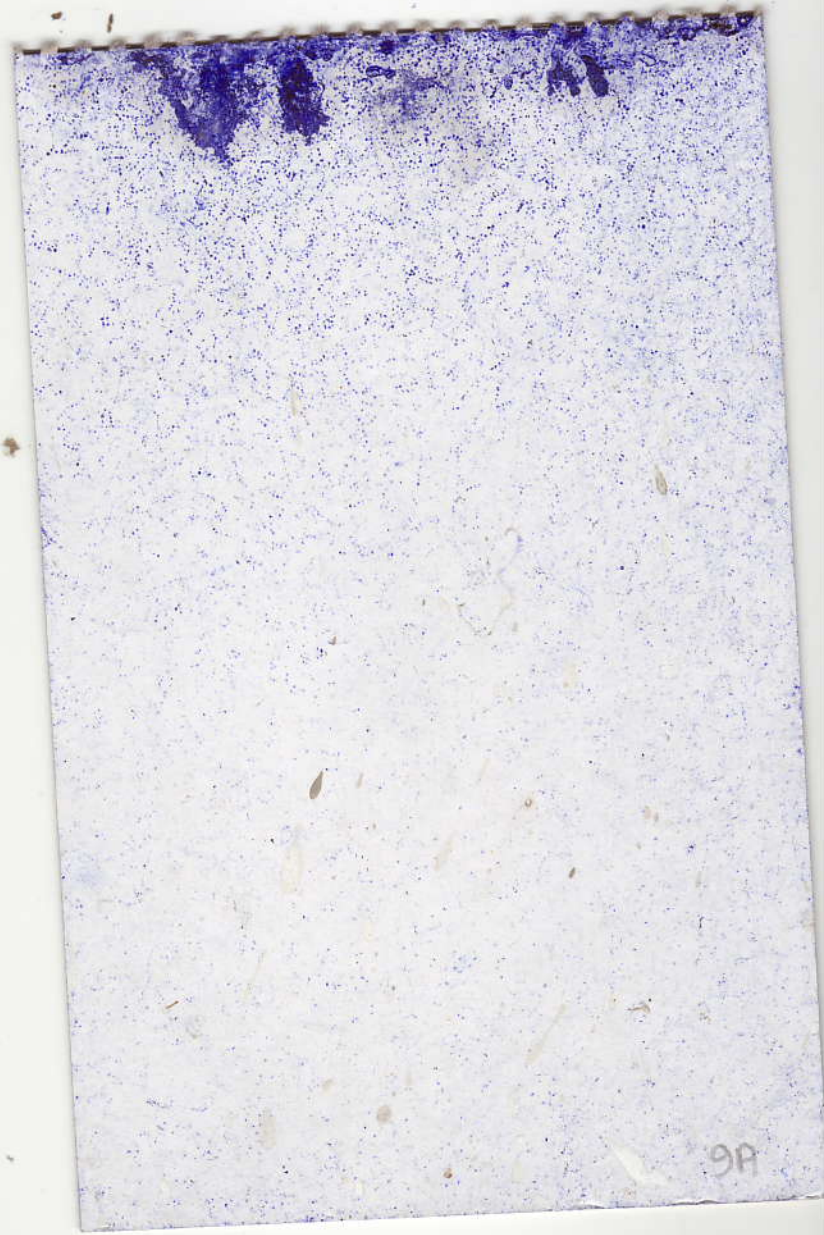
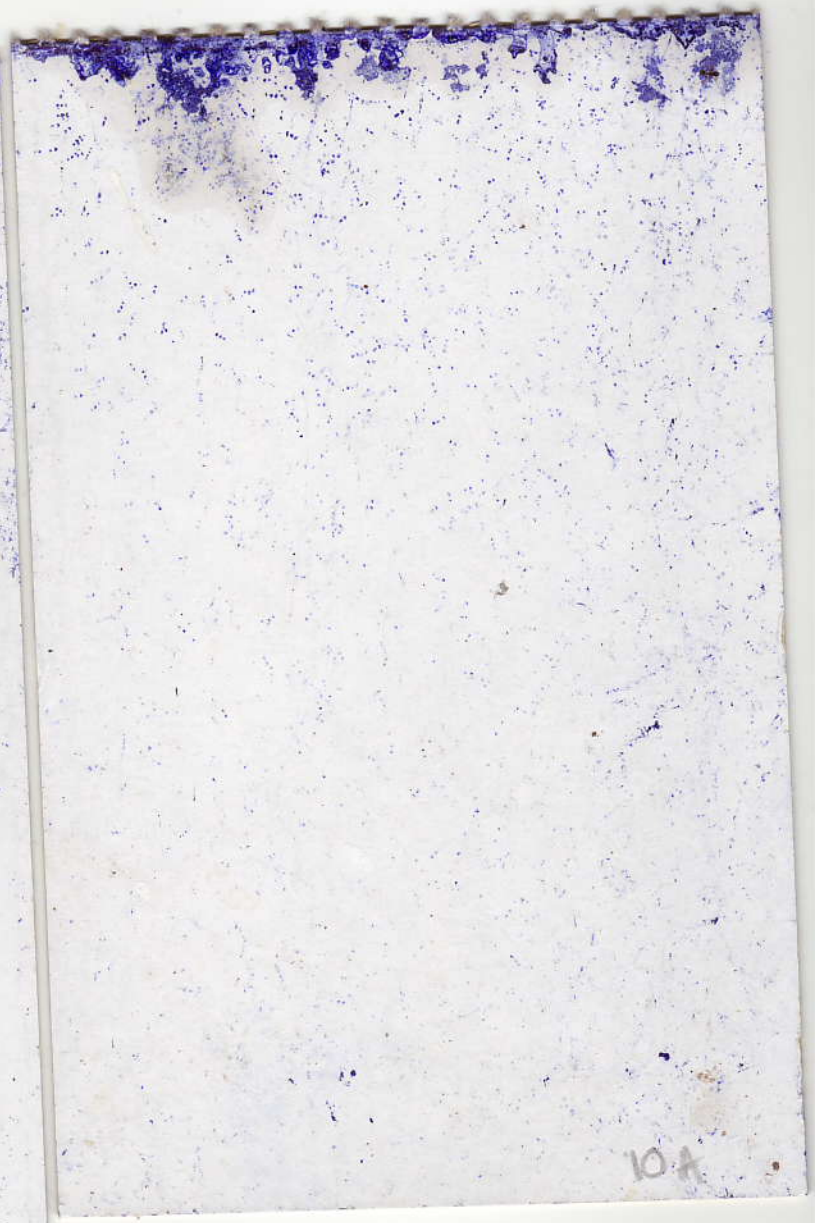
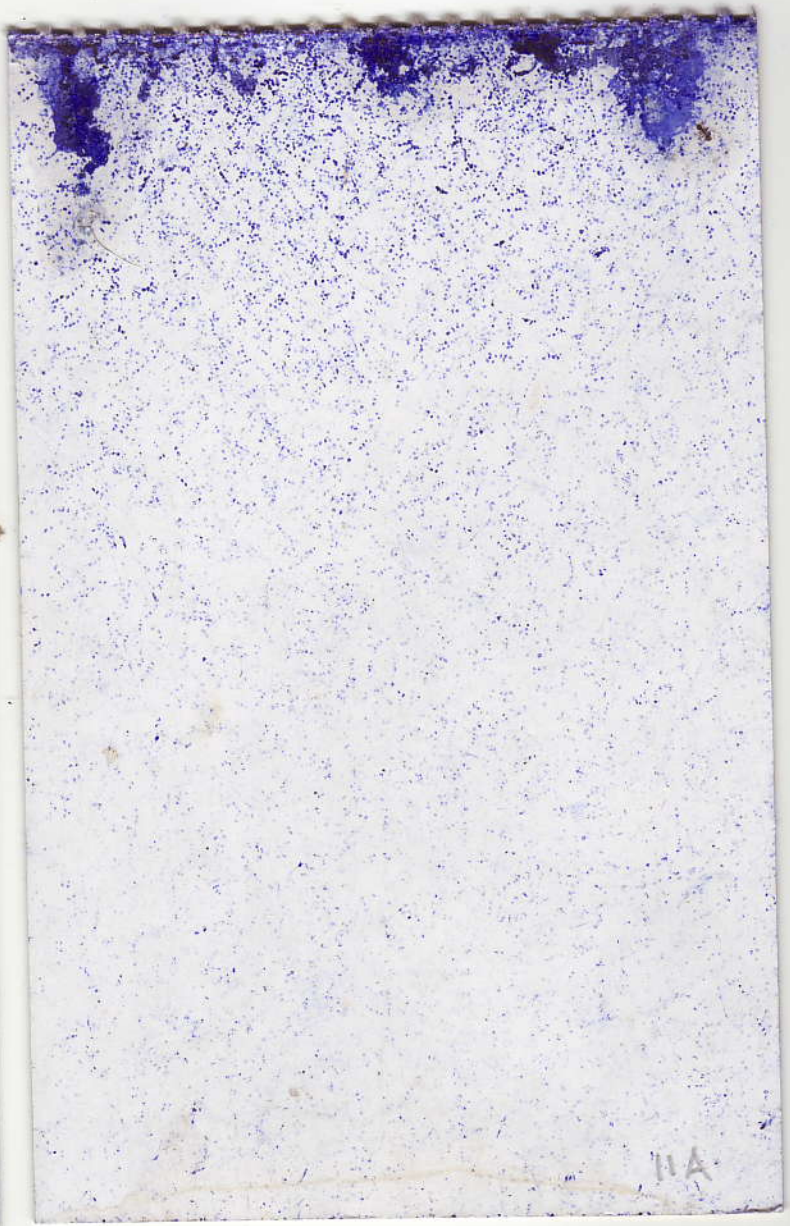

9A


10B

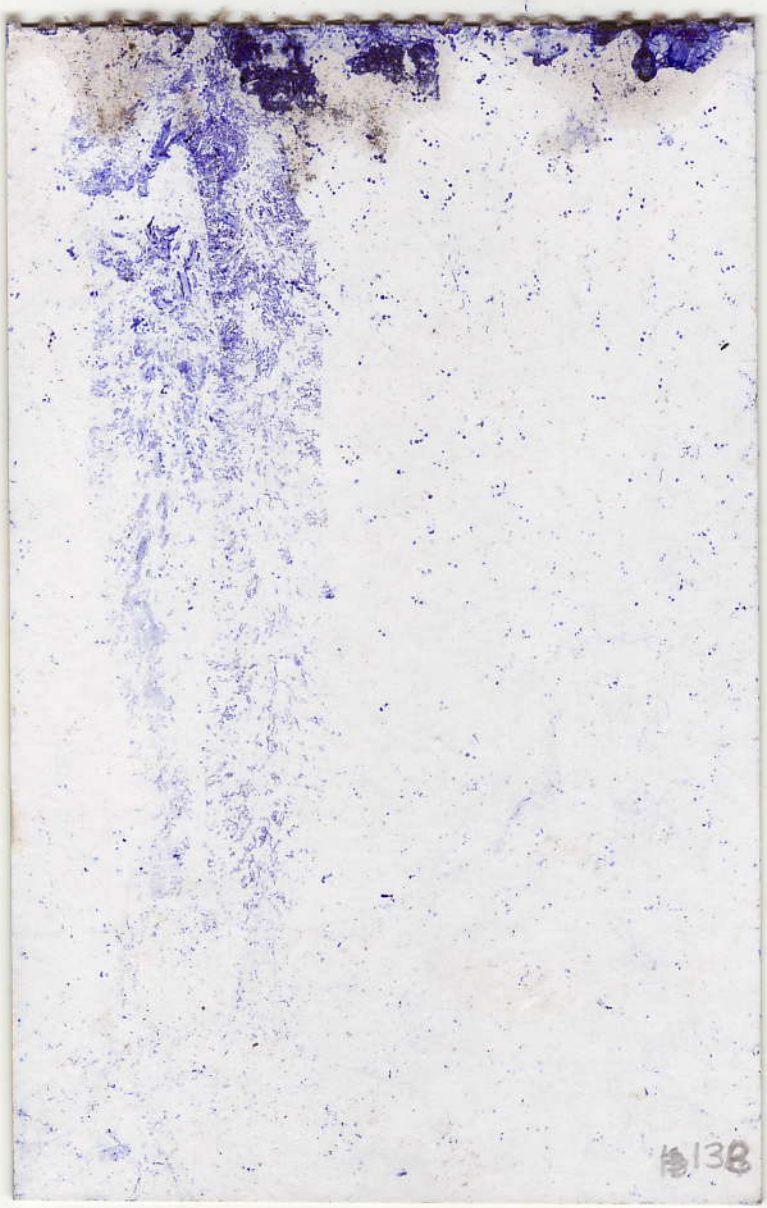

10A


11B

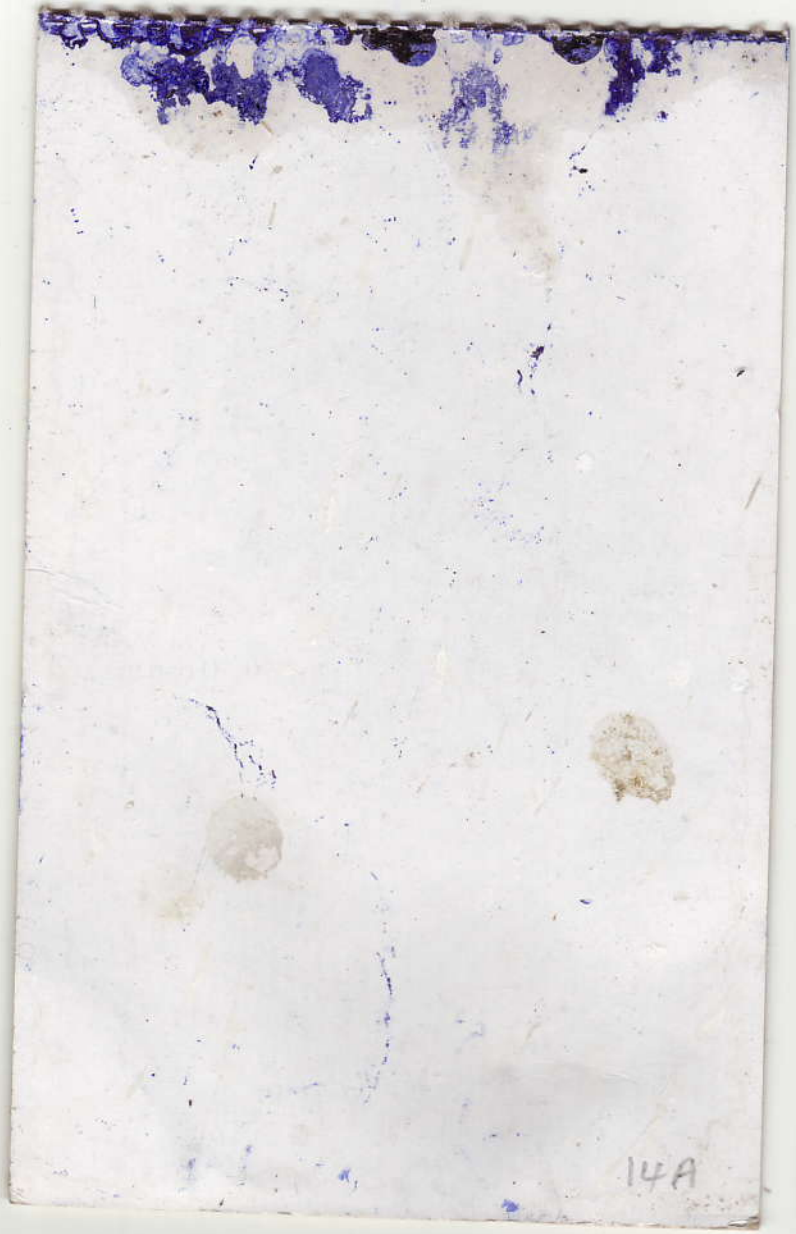

11A


12A


12B

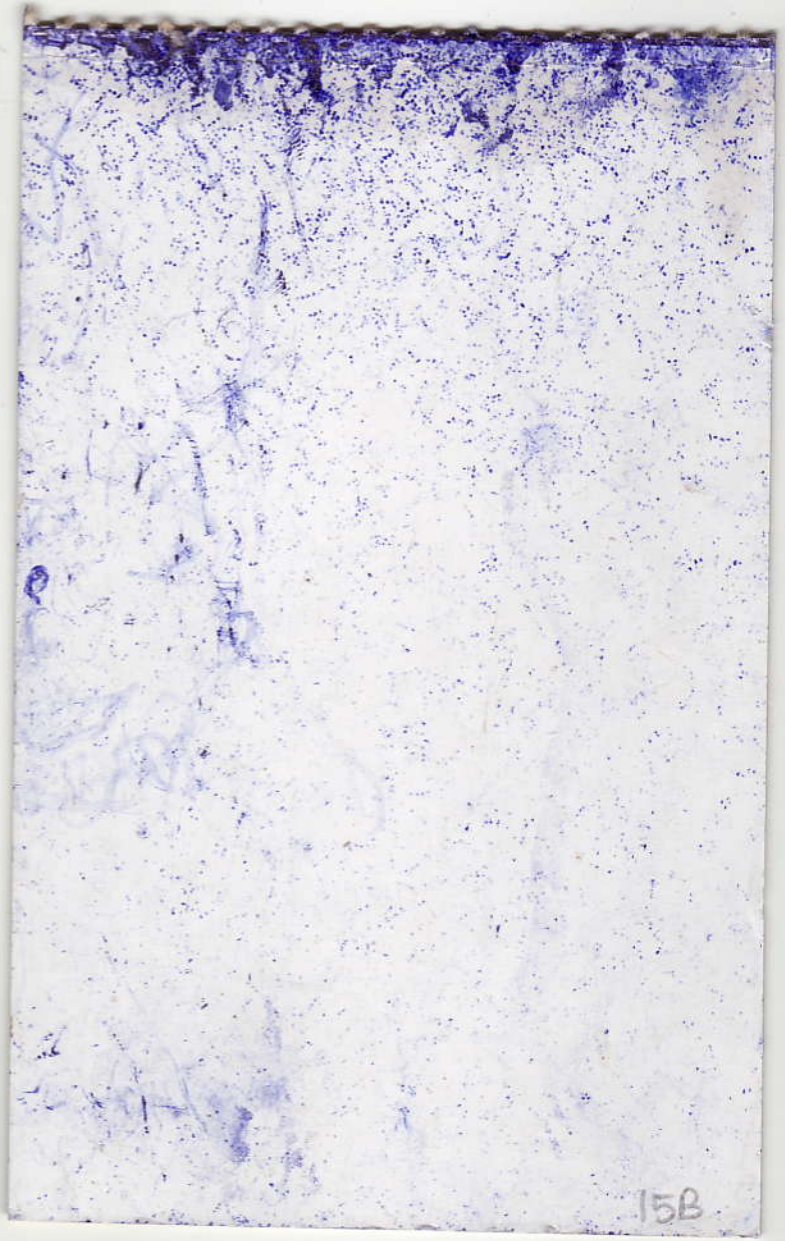

13B


13A


14A


14B


15A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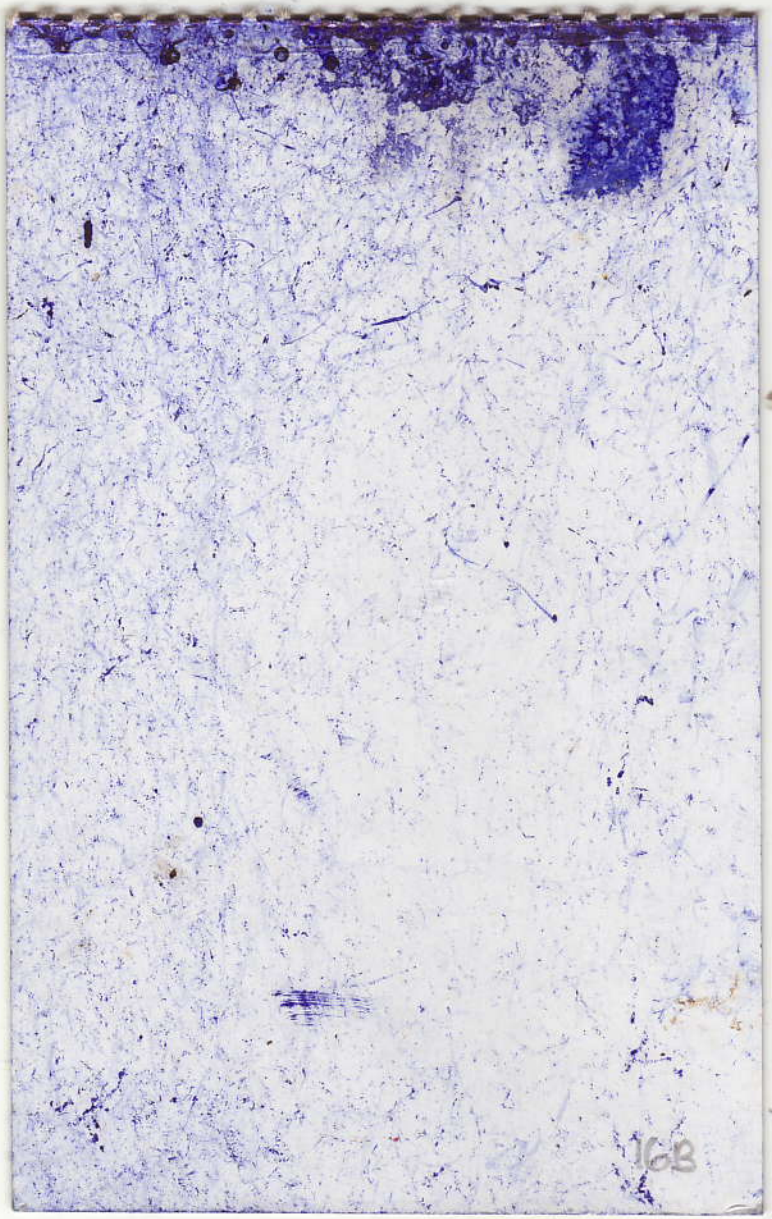
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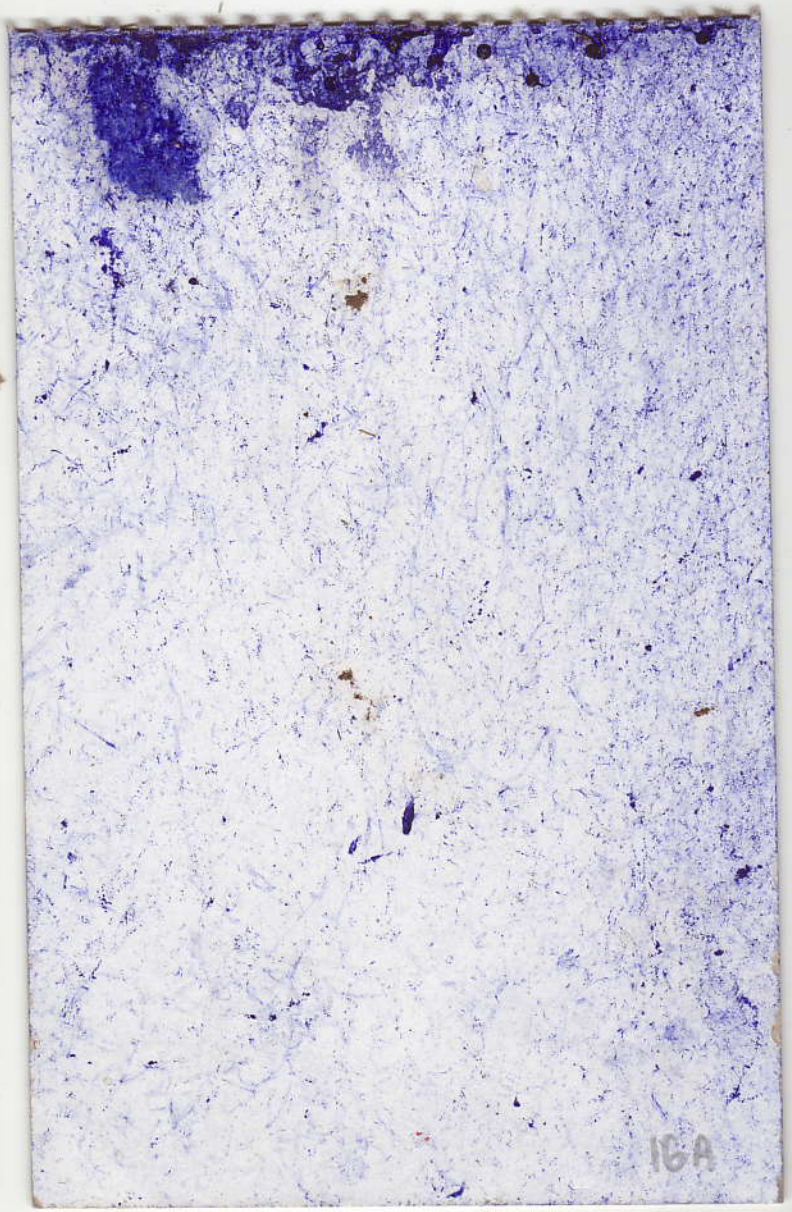
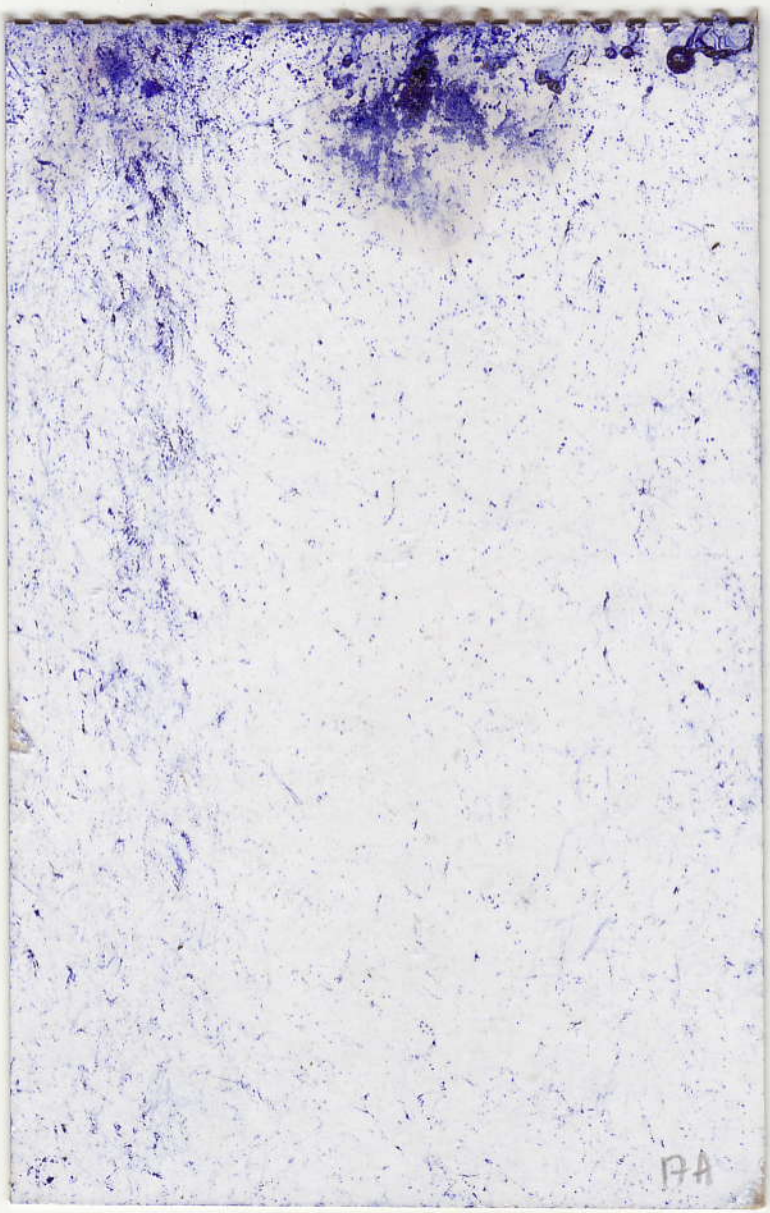

16A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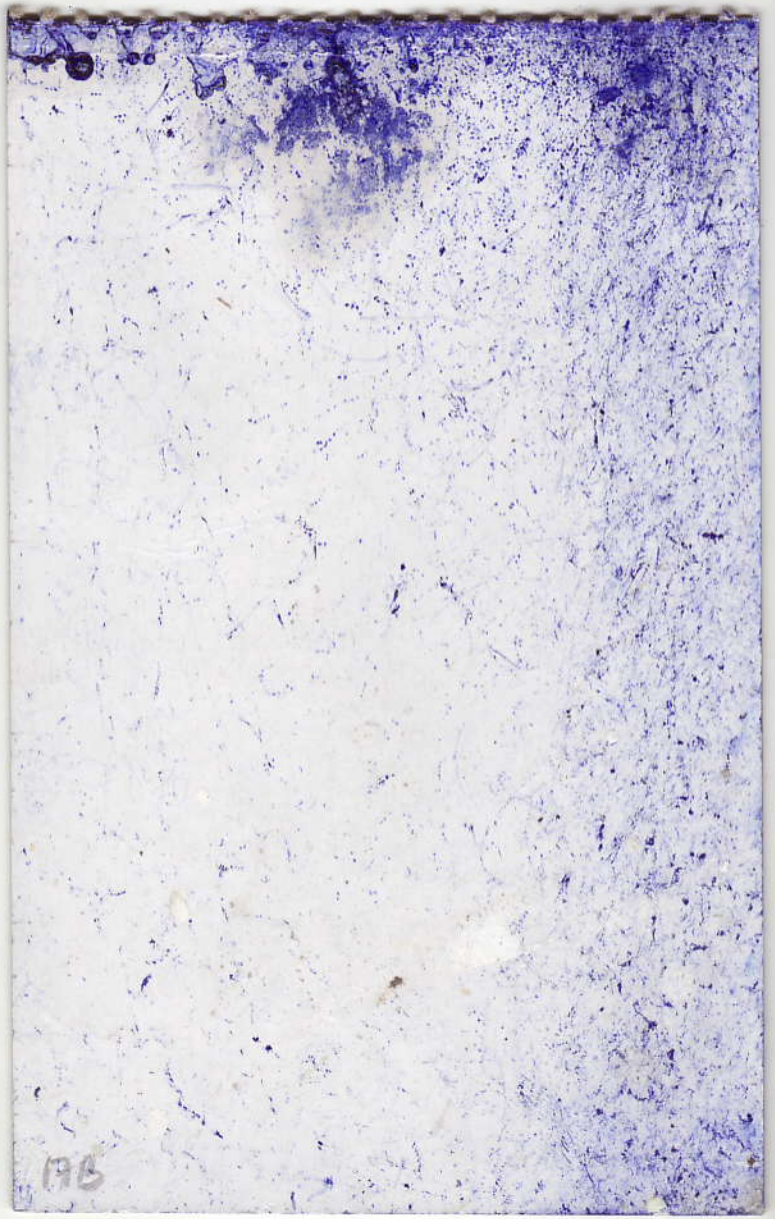

19B


18B


18A

APPENDIX 2:

SIMPLIFIED METHOD TO ESTIMATE THE RATE OF EGG-LAYING OF SEABIRDS

(MCCORMACK 1991, UNPUBL. MSS.)

Appendix

A simplified method to estimate

THE RATE OF EGG-LAYING OF SEABIRDS

Simplified and standardised by Gerald McCormack (January 1991)
Illustrated by Judith Kunzle

Summary:

The most important information to obtain about a seabird colony is the number of birds laying eggs at each time of the year. This information is difficult to obtain for the large seabird colonies which live on remote, rarely-visited islands, such as Takutea and Suwarrow. When such islands are visited it is important that information be collected in a standardised manner to enable realistic comparisons.

The most important task is to make an estimate of the total number of nests for each species at the time of the visit. In doing this, it is important that the sampling methods are related to the nesting habits of each species.

This paper describes a system to estimate the ages of a hundred nestlings from their feather development. When this data is combined with the estimated number of birds nesting during the visit it is possible to estimate the rate of egg-laying for several months BEFORE the visit.

The method has been simplified to enable it to be used by laymen and college students, and standardised so that data collected by different groups are comparable.

Background:

In 1962 Dorward collected detailed information on the plumage stages of Brown Booby and Masked Booby nestlings on Ascension Island. He suggested that "This scheme could be used for making a quick estimation of the age-composition of the chicks in a colony ..... Thus an approximate date of a laying peak could be calculated more precisely than from vague records such as 'mostly well-grown chicks'." In 1963, Stonehouse and Stonehouse used eight plumage stages of Ascension Frigatebird nestlings to constuct a graph of the rate of egg-laying over two breeding seasons. In 1969 Cameron Kepler prepared graphs of the egg-laying of the Masked Booby colony on Kure Atoll in the Hawaiian Leeward Chain.

In 1978 Cameron Kepler used the data available on the rates of development to estimate the rate of egg-laying for several species on Monito Island in Puerto Rico. This was the first time the system was used to enable a researcher to obtain extensive information on the breeding cycle of seabird colonies on remote islands. The system has also be used by Kepler on Jarvis Islands (1984) and Caroline Island (1990).

The system described in this paper, based on that of Kepler, has been simplified and standardised as follows:

a. The days of each plumage stage have been rounded into weekly intervals to simplify the calculations. This is realistic in that the exact duration of each stage is dependent on the availability of food, and the judgement of the end-points of stages is not exact.

b. A single system is used for the three booby species. The main difference being that the tree-nesting Red-footed Booby spends less than a week as a non-flying juvenile, while the larger, ground-nestering species spend two weeks in this stage.

c. A single system is used for the two frigatebird species. At present there is insufficient data to indicate that these two similar-sized species should be treated differently.

c. The stages are illustrated to make recognition easier.

d. The method of processing the raw data and relating it to the estimated breeding population at the time of the visit has been standardised.

e. Standardised graphs have been prepared for each seabird group.

Method:

1. Record the age-category of the contents of 100 nests. Within the table use the symbols from the tops of the columns to show the stage. Do NOT use "ticks" or "crosses". When there is more than one adult, egg or nestling indicate the number before the symbol: e.g. **E** or **2E** or **3E**.

   See Figure 1 for the details of the age-categories for each group of seabirds.

   See Figure 2 for a completed survey for the Red-tailed Tropicbird.

2. Add the number of nests in each category and enter the totals to the table.

3. a) If you recorded the stage of every nest in the colony then proceed to step 4 below.

   b) If you did not record the stage of every nest in the colony, then you need to incorporate your estimate of the size of the colony at this stage. This is done by multiplying the number in each category by the estimated total number of nests and dividing by the number of nests sampled.

4. Divide each category-total by the length of the stage in WEEKS to obtain a measure of the RATE OF PRODUCTION of the category, in CLUTCHES PER WEEK for the whole colony.

5. Select a suitable vertical scale for the graph and make a bar graph to show the rate of egg-laying throughout the months before your visit.

References:

Dorward, D.F. (1962) Comparative Biology of the White Booby and the Brown Booby *Sula* spp. at Ascension. **Ibis** 103b: 174-220.

Kepler, Cameron B. (1969) Breeding Biology of the Blue-faced Booby (*Sula dactylatra personata*) on Green Island, Kure Atoll. **Publications of the Nuttall Ornithological Club** Number 8.

Kepler, Cameron B. (1978) The Breeding Ecology of Sea Birds on Monito Island, Puerto Rico. **Condor** 80: 72-87.

Kepler, Cameron B. (1984) Jarvis Island Trip Report. Unpublished.

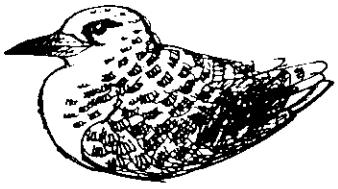
Kepler, Cameron B., Kepler, Angela K., and Ellis, David H. (1990) Part II: Seabirds, Other Terrestrial Animals, and Conservation in **Ecological Studies of Caroline Atoll, Republic of Kiribati**. Unpublished report.

Stonehouse, Bernard, and Stonehouse, Sally. (1963) The Frigate **Bird** *Fregata aquila* of Ascension Island. **Ibis** 103b: 409-422.

Figure 1

Red-tailed Tropicbird:

A(dults): adults at the nest; i.e. **A** or **2A**.
E(ggs): number of eggs; i.e. **E** or **2E**. LASTS: 6 weeks.



J(uvenile):
Down gone except for wisps on neck, lower back and flanks.
Not yet flying.
LASTS: 6 weeks.

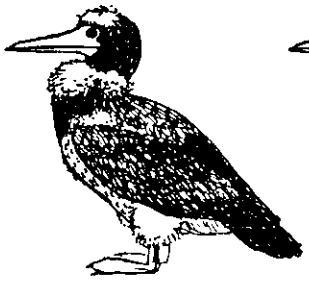
W(ings or Tail):
Dark tail-feathers or primary wing-feathers (on outer section) visible.
LASTS: 3 weeks.

S(capulars):
Dark scapular (shoulder) feathers visible above down. Dark wing and tail feathers NOT visible.
LASTS: 2 weeks.

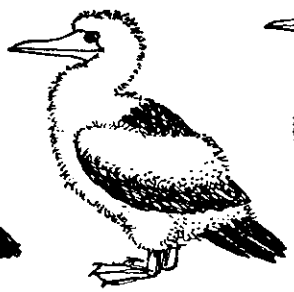
D(owny):
partly or completely covered in white down-feathers. Dark shoulder feathers NOT visible.
LASTS: 2 weeks.

Boobies:

A(dults): Adults at nest; i.e. **A** or **2A**.
E(ggs): Eggs present; i.e. **E** or **2E**. LASTS: 6 weeks.



J(uvenile):
A little wispy down may persist on the neck, flanks and forward angle of the wing.
Not yet flying.
LASTS: 2 weeks.



S(capulars):
Dark scapular (shoulder) feathers visible above down.
LASTS: 5 weeks.

W(ings and Tail):
Dark wing-feathers visible outside down. Tail feathers visible later during this stage.
LASTS: 5 weeks.

D(owny):
Partly or completely covered in white down. No dark feathers visible.
LASTS: 4 weeks.

N(aked):
Without any down.
LASTS: 1 week.

Frigatebirds:

A(dults): Adults at nest; i.e. **A** or **2A**.
E(ggs): if adult is sitting on nest DO NOT DISTURB. Record it as an **E**.
LASTS: 8 weeks (egg 7 weeks and naked nestling 1 week)

To be done next visit.

J(uvenile):
Down gone except for on the throat and breast.
Not yet flying.
LASTS: 5 weeks.

W(ings or Tail):
Dark wing-feathers or tail-feathers visible above down.
LASTS: 12 weeks.

S(capulars):
Dark scapular (shoulder) feathers visible above down. Wing and tail feathers NOT visible.
LASTS: 3 weeks.

D(owny):
Partly or completely covered in white down. No dark feathers visible above the down.
LASTS: 3 weeks.

Figure 2

Simplified BREEDING PHENOLOGY

Species **Red-tailed Tropic**

Island Takutea

Date 5 Sept 1990

Time start 08.00 Finish

Observers Anna, Masey, Lynette, Terepai, Tekena, Upokoino, Teremoana

Weather Sunny.

	J Juvenile	W Wings + Tail	S Scapulars	D Down ONLY	E EGGS	A ADULTS	Plots
1	J						
2		W					1
3					E	A	
4	J						
5	J						
6	J						
7	J						2
8	J						
9	J						
10					E	A	
11					E	A	
12	J						
13					E	A	
14	J						3
15					E	A	
16					E	A	
17					E	A	
18					E	A	
19	J						4
20	J						
21					E	A	5
22	J						
23			S				
24				D		A	
25	J						6
	13	1	1	1	9		

	J	W	S	D	E	A	
26	J						6
27	J						
28		W					
29		W					
30	J						
31	J						
32					E	A	7
33	J						
34	J						
35					E	A	
36	J						
37					E	A	
38	J						
39					E	A	
40				D		A	8
41	J						
42				D			
43					E	A	
44	J						
45	J						
46	J						9
47	J						
48	J						
49					E	A	
50			S				
	14	2	1	2	6		

	J	W	S	D	E	A	
51	J						
52	J						
53			S				
54			S				
55		W					
56					E	A	10
57	J						
58	J						
59	J						
60	J						
61			S				
62			S				11
63	J						
64	J						
65	J						
66	J						12
67		W					
68				D		A	
69				D			
70	J						
71			S				
72					E	A	
73			S				13
74	J						
75		W					
	12	3	6	2	2		

	J	W	S	D	E	A	
76	J						← Step 1
77					E	A	
78	J						
79	J						
80				D		A	14
81					E	A	
82					E	A	
83				D		A	
84		W					
85		W					
86	J						
87	J						
88	J					A	
89		W					
90	J						
91			S				
92			S				
93	J						
94	J						
95		W					
96	J						
97	J						
98	J						
99	J						
100		W					
	13	5	2	2	3		

If population of nests is greater than the SAMPLE, give an estimate here:

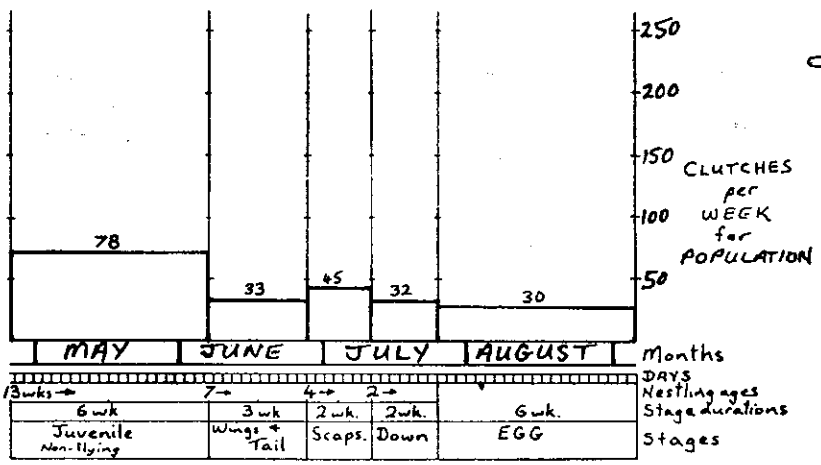
14 perimeter plots = 68 nests

Est total perimeter nests = 721

+0.25 for interior nests

Grand Total = 901 nests.

	J	W	S	D	E
TOTALS for each CATEGORY in sample	52	11	10	7	20 ← Step 2
If POPULATION has more nests than sample: × $\frac{\text{POPULATION}}{\text{SAMPLE}} = \times \frac{901}{100} = \times 9.01$	469	99	90	63	180 ← Step 3b
DIVIDED BY (WEEKS for each category)	6	3	2	2	6
= CLUTCHES PER WEEK OF POPULATION	78	33	45	32	30 ← Step 4



← Step 5

APPENDIX 3:
SEABIRD NESTING DATA

Vatuira - All island nest count **18-19 August 2008**

Count Tree # Running Tree number of Nest Count This survey trees not marked

Vili Tree # Vili's tree number (June survey trees marked)

		Red Footed Booby							Lesser Frigate							
Count Tree #	Vili Tree #	J	S	W	D	N	E	A	J	W	S	D	N	E	A	Count Tree #
1										1				4		1
2	1						2									2
3							1									3
4	2						1									4
5	3						2									5
6	4				1			1						1		6
7										1						7
8							2									8
9	6						1									9
10	7						1			1	2			1		10
11	5						1									11
12									1	1				1		12
13										1			1			13
14	14													3		14
15													1	1		15
16							1									16
17	13						1									17
18								1								18
19	16							1								19
20							1							1		20
21														2	1	21
22	11						1									22
23	8						1							1		23
24							1									24
25							3	2								25
26							1						1			26
27							1									27
28							2									28
29							1									29
30										1						30
31	9						1							1		31
32	12												1	2		32
33						1	1									33
34	18							1								34
35							1									35
36	dot						2									36
37							2	1								37
38							1									38
39								1								39
40	26						3									40
41							1									41
42							1	1								42
43							1									43
44							2									44
45					1											45
46						1										46
47							1									47
48	28						1							1		48
49	29						2									49
50							1	1								50
51							1									51
52							1									52
53										1		1				53
54							1			1						54
55							2									55
56	21						1									56
57	20						2									57
58							1									58
59							1									59
60							3									60
61							1					1				61
62							1									62
63	22						2									63
64							1									64
65							2	1								65
66					1											66
67							2									67

		Red Footed Booby							Lesser Frigate							
Count Tree #	Vili Tree #	J	S	W	D	N	E	A	J	W	S	D	N	E	A	Count Tree #
68	36													2		68
69	35						1			1				1		69
70	32										2					70
71											1					71
72	33						1							1		72
73							1				1					73
74							2				1					74
75							1									75
76												1				76
77							1									77
78	40											1				78
79										2						79
80											1					80
81							1									81
82	41						2									82
83											1					83
84	37						1							1		84
85							1							1		85
86	34						1							1		86
87						1	1									87
88							1									88
89					1											89
90							2									90
91		1		1												91
92				1												92
93							1									93
94							1									94
95						1	1							1		95
96							2				1			2		96
97							1							1		97
98							1			1						98
99							1									99
100							1		1	2	1	1				100
101					1		1							1		101
102	42						1									102
103							1									103
104							1									104
105						1										105
106									1	1	1	2		3		106
107							3									107
108	44						1									108
109							2									109
110											1					110
111				1												111
112							1									112
113							1									113
114							1									114
115							1									115
116							1									116
117						1										117
118												1				118
119							2				1					119
120							1									120
121					1	1										121
122					1		1							3		122
123							1									123
124												1		2		124
125				1			1									125
126				1							1					126
127							2									127
128							1				1					128
129		1					2				1					129
130									1	1	1					130
131										1		1				131
132									2							132
133							1			2				1		133
134												1				134
135						1					1	1				135
136							1									136
137							1									137
138							1									138
139						1	2							1		139

		Red Footed Booby								Lesser Frigate							
Count Tree #	Vili Tree #	J	S	W	D	N	E	A		J	W	S	D	N	E	A	Count Tree #
140							1										140
141										1		2			2		141
142							1										142
143					2		1										143
144				1	1		1					2			1		144
145															3		145
146							1										146
147							2					1					147
148							1										148
149							1										149
150							2										150
151							1										151
152							1										152
153						1	3										153
154							1										154
155							1										155
156							1										156
157							1										157
158				1			4										158
159													1				159
160							1										160
161					1		1										161
162							3										162
163							3						1				163
164								1									164
165							1										165
166				1			1										166
167								1									167
168							7										168
169							1										169
170							1	2									170
171							2	2									171
172					1		5										172
173					1		1										173
174							3										174
		2	0	8	13	10	180	17	1	7	19	25	12	4	47	1	

Total Red Footed Booby Nests 213
Total Lesser Frigate Bird Nests 114

Key:

A	Adults at nest
E	Egg(s)
N	Nestling
D	Downy
W	Wings & Tail
S	Scapular
J	Juvenile

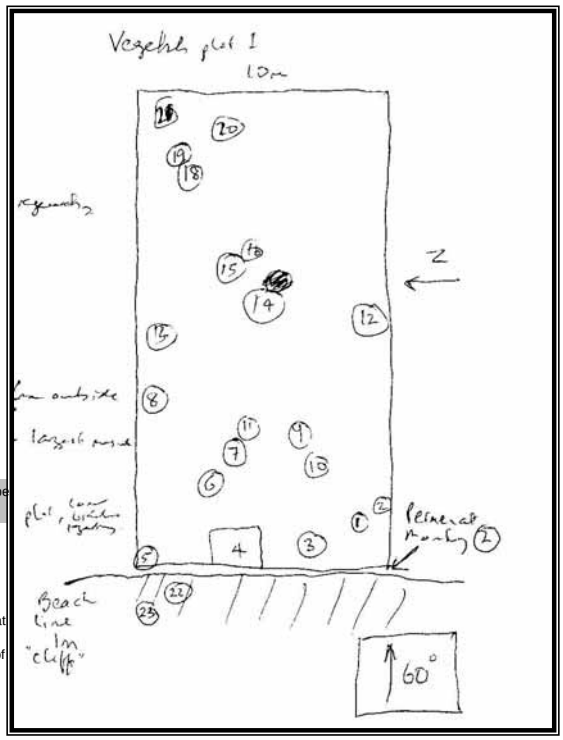
APPENDIX 4:
PERMANENT VEGETATION PLOT DATA AND PHOTOGRAPHS

PERMANENT VEGETATION PLOT 1

No	Species	Circumf.	Comment
1	*Pisonia*	91	
2	*Pisonia*	84	Reclining
3	*Pisonia*		Broken branches regenerating
4	*Lepturus repens*	2 m sq	Grass - sprayed with herbicide but regenerating
5	*Pisonia*	37	
6	*Pisonia*	114	
7	*Pisonia*	151	
8	*Pisonia*	95	
9	*Pisonia*	115	
10	*Pisonia*	102	
11	*Pisonia*		Broken branches regenerating
12	*Pisonia*	73	Fallen tree from outside
13	*Pisonia*		Broken branches regenerating
14	*Pisonia*	57	Group of 4 largest measured
15	*Terminalia*	5	2m regeneration
16	*Pisonia*	34	
17	*Pisonia*		Fallen tree from within plot, some branches striking
18	*Pisonia*	70	
19	*Pisonia*	55	
20	*Pisonia*	66	
21	*Pisonia*		
22	*Cordia*		Regeneration 10 cm - outside plot below beach slope
23	*Barringtonia*		Regeneration 15 cm - outside plot

Description:

Permanent Monitoring Plot 2 @ SW corner - 20 m bearing 60 degree. Almost 100% Pisonia of 7-10m. Borders with High Tide Mark, a small beach cliff of c. 1m. No regeneration within plot but two outside at HTM. C.2m2 of grass had been sprayed but now regenerating. A lone tavola regeneration in middle of plot. 95% canopy cover; Soil sandy at front but quickly giving wat to Pisonia leaf mulch inland.

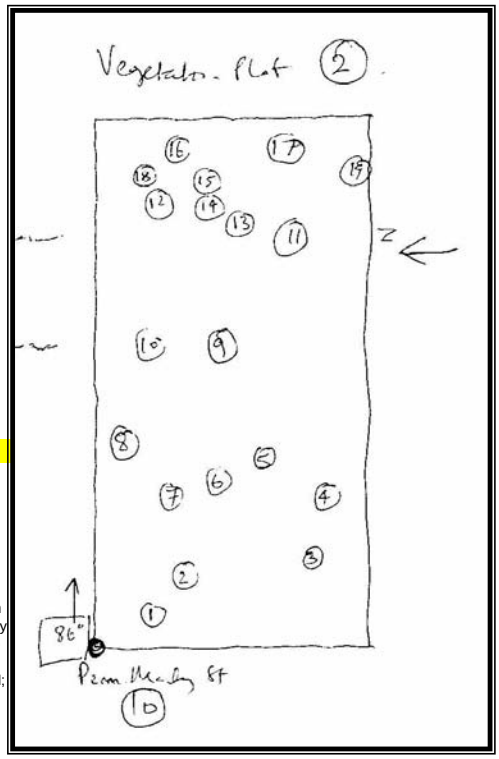


PERMANENT VEGETATION PLOT 2

No	Species	Circumf.	Comment
1	*Pisonia*	162	
2	*Pisonia*	136	
3	*Pisonia*	142	
4	*Pisonia*	97	Group of 3 largest measured
5	*Pisonia*	159	
6	*Pisonia*	120	
7	*Pisonia*	88	
8	*Pisonia*	130	Group of 3 largest measured
9	*Pisonia*	162	
10	*Pisonia*	103	
11	*Pisonia*	56	
12	*Niu*	127	
13	*Pisonia*	72	
14	*Pisonia*	41	
15	*Pisonia*	38	
16	*Pisonia*	36	
17	*Pisonia*	45	
18	*Barringtonia*		One metre regeneration
19	*Pisonia*		Fallen tree from outside

Description:

Permanent Monitoring Plot 10 @ NE corner - 20 m bearing 86 degree. Inland Plot vastly dominated by Pisonia fo 8-11 m. No regeneration except for lone Vutu not looking healthy. A single fruiting coconut. 100% canopy cover; 100% Pisonia leaf mulch-soil;

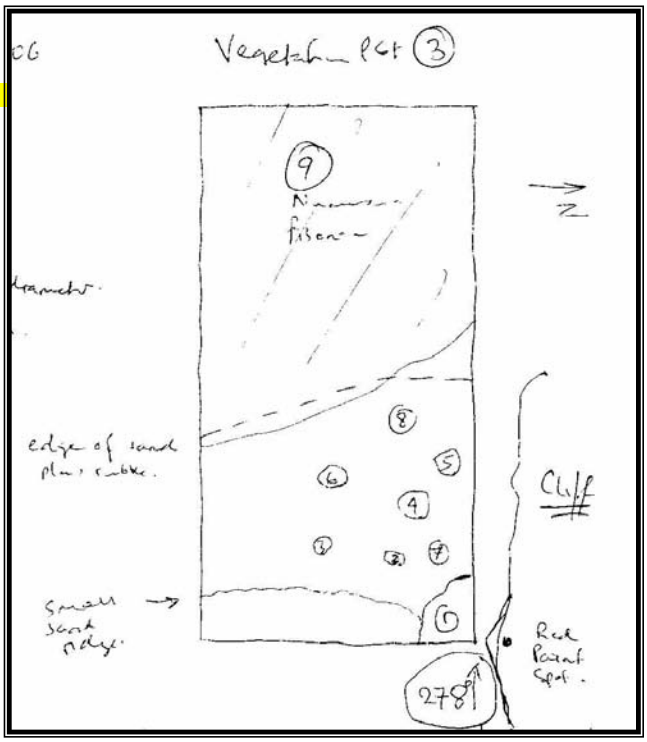


PERMANENT VEGETATION PLOT 3

No	Species	Circumf.	Comment
1	*Cyperus stoloniferus*		sedge
2	*Tournefortia*		
3	*Tournefortia*		25 cm regeneration
4	*Tournefortia*		
5	*Tournefortia*		
6	*Tournefortia*		
7	*Niu*		1m tall
8	*Niu*		2m tall
9	*Pisonia*		Numerous 5-6 m small diameter. Counted as 20 - too difficult to get in and measure without cutting
10	*Tournefortia*		

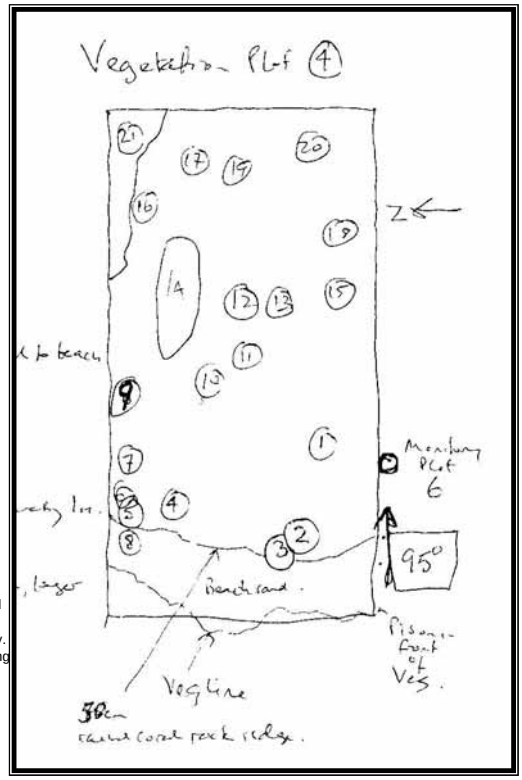
Description:

Adjacent to cliff at southern end of eastern hillock. Red paint on clif marks the NE corner. Bearing at 278 degrees. A strand situation on eastern side. No measurements taken - too numerous small diameter Pisonia and fewer Tournefortia. Single regeneration of Tournefortia. Paku sedge in one corner. 100% canopy cover @ 4-7 m. Sandy substrate to half way; Pisonia leaf mulch thereafter



PERMANENT VEGETATION PLOT 4

No	Species	Circumf.	Comment
1	*Pisonia*	115	
2	*Pisonia*	103	.
3	*Pisonia*	104	
4	*Pisonia*	100	
5	*Pisonia*	116	
6	*Pisonia*	51	
7	*Pisonia*	70	
8	*Pisonia*	58	Fallen forward to beach
9	*Pisonia*	97	
10	*Pisonia*	72	
11	*Pisonia*	20	
12	*Pisonia*	197	
13	*Pisonia*	64	
14	*Pisonia*		Broken branches regenerating
15	*Pisonia*	140	
16	*Pisonia*	104	
17	*Pisonia*	122	Double trunk, larger trunk measured
18	*Pisonia*	48	
19	*Pisonia*	131	
20	*Pisonia*	150	
21	*Cyperus stoloniferus*		Part of a much larger field of this sedge



Description:

Plot 6 on southern side c. 6 m from the SW corner, bearing of 95 degrees. North west corner of the island before the large stack isthmus. Front is strand along the beach. A raised coral rock ridge c. 50 cm crosses about 3m in. Dense low Pisonia at the front, increasing in height to the back c- 7 m canopy. No regeneration of anything. One area or fallen Pisonia branches regenerating (14). Beach sand for front 3 m - sandy leaf mulch thereafter; 100% canopy cover.

APPENDIX 5:
VATUIRA PHOTOGRAPHS

Plate 7: View of Vatuira, approaching from the west with the Southern Hill to the right and the Northern Stack clearly visible to the left.

Plate 8: View of the Pisonia clad Southern Hill from the Eastern Stack

Plate 9: View of the Pisonia clad Southern Hill from the tip of the Northern Stack

Plate 10: View of Vatuira looking from the lighthouse foundation, north to the Northern Stack over the 'lowland' area of Pisonia. Eastern stack and ridge on the upper right of the photograph.

Plate 11: Southern Cliffs – favoured roosting site of Brown Booby

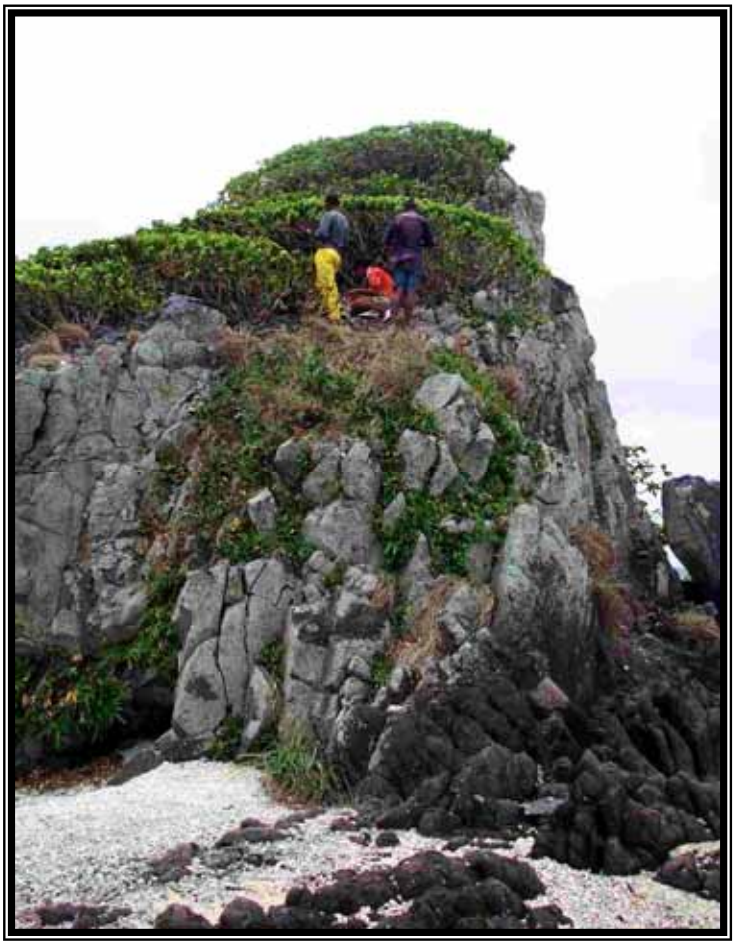


Plate 12: PMS 7 on the Northern Stack

Plate 13: Eastern Stack

Plate 14: Beach Sedge *Cyperus stoloniferus* a common sedge of beach cays and small islands. Root nodules are aromatic and used by Fijians for scenting coconut oil (*Malaga* or *Paku*).

Plate 15: Typical view inside Pisonia woodland on the island flat. Completely bare substrate with Pisonia leaf mulch

Plate 16: Another ypical view inside Pisonia woodland on the island flat. Completely bare substrate with Pisonia leaf mulch. PMS 9.

Plate 17: Picture taken in December 2003 when the Black Noddys breed on the island in very large numbers.