



R E P O R T

O N

C A R N A C I S L A N D

S U R V E Y .

1955 - 1956.

(Compiled by Bruce Phillips.)

C A R N A C I S L A N D

Carnac Island is situated at approximately thirty-four degrees latitude south, and is positioned about eight and a half miles from the mainland, approximately two and a quarter miles from Garden Island between Garden and Rott-nest Island.

It is the smallest of the three islands off our coast, and occupies an area of approximately thirty-eight and a half acres.

Its choice for survey was made; due to comparatively virgin fauna, having never been opened up to tourists, and due to it possessing an almost exact quantity, for the purpose, of reefs and land surfaces.

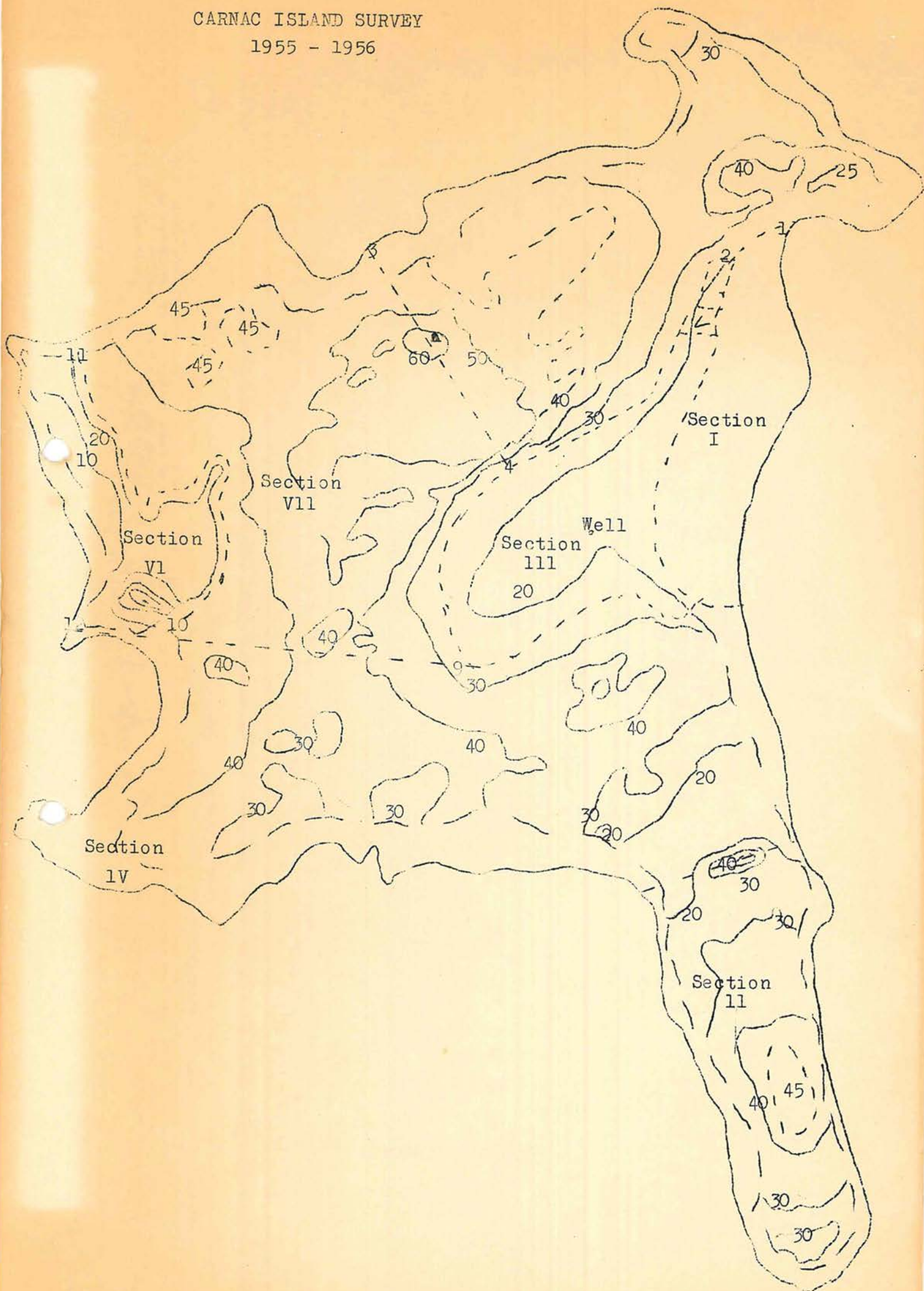
We have used as our object the presentation of a ground-work in ecology of the island, to which further studies of the island will enlarge into something of lasting value.

The attempt has been to exactly record notes upon all dominant species of land and marine forms; and it is our unanimous hope that this work may be continued both by ourselves, and others after us.

B.Phillips.

CARNAC ISLAND SURVEY

1955 - 1956



ACKNOWLEDGEMENTS.

Department of Fauna and Fisheries, especially Mr. Frazer, and the skipper of the "Silver Gull," the Government Patrol Vessel so kindly lent to supply the party's vessel.

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The University, which so kindly sponsored the expedition, with many thanks to Dr. Hodgkin who aided us in many ways.

The Licensee of Carnac Island Mr. Mews, who allowed our survey.

The W.A. Naturalist Club which supported us and from which most of our members were drawn.

H I S T O R I C A L

D A T A.

by

B. Phillips.

HISTORICAL DATA

Originally named Berthollet by the French expedition under FREYCINET, it was named Carnac Island by Captain Stirling after his first Lieutenant John Rivett Canac.

From "Swan River" Volume 17 we find that on 2nd June 1829 John Margin landed with 28 people including his family upon the sand spit now removed. This landing was caused by the necessity to lighten the "Success" and they remained here for five days before finally settling at Garden Island. This gives Carnac the honour of receiving the first settlers and also the first family settler.

In 1838 the Government declared the island to be used as a native prison; together with an attempt to gain a knowledge of the natives.

The settlement consisted of Mr. Lyon who was in charge, the three natives Yagen, Danmera and Ningina and two soldiers.

The settlement was made in October but only lasted until November of the same year, as the soldiers disliking their solitary existency aided the prisoners to escape.

In 1882 the "Enquirer" on 4th October P. 302. records the visit of a party to the island for the purpose of shooting rabbits for sport.

On 8/9/'84 the Government Gazette Page 160, proclaimed Carnac Island as the quarantine station and later in the same year allocated £900 to be spent on buildings there.

In 1917 from maps from the Department of Interior, we observe two huts in Section III and a lighthouse beacon in Section V.

HISTORICAL DATA CONCLUSIONS.

Information gained from this data and further research:

We note in 1829 the presence of a sand spit on the east side of the island now almost disappeared, at the period of our visit, although it was still there in 1917 by reference to the map.

We note the former presence of rabbits on the island at least in 1882, non-existent today as far as explored.

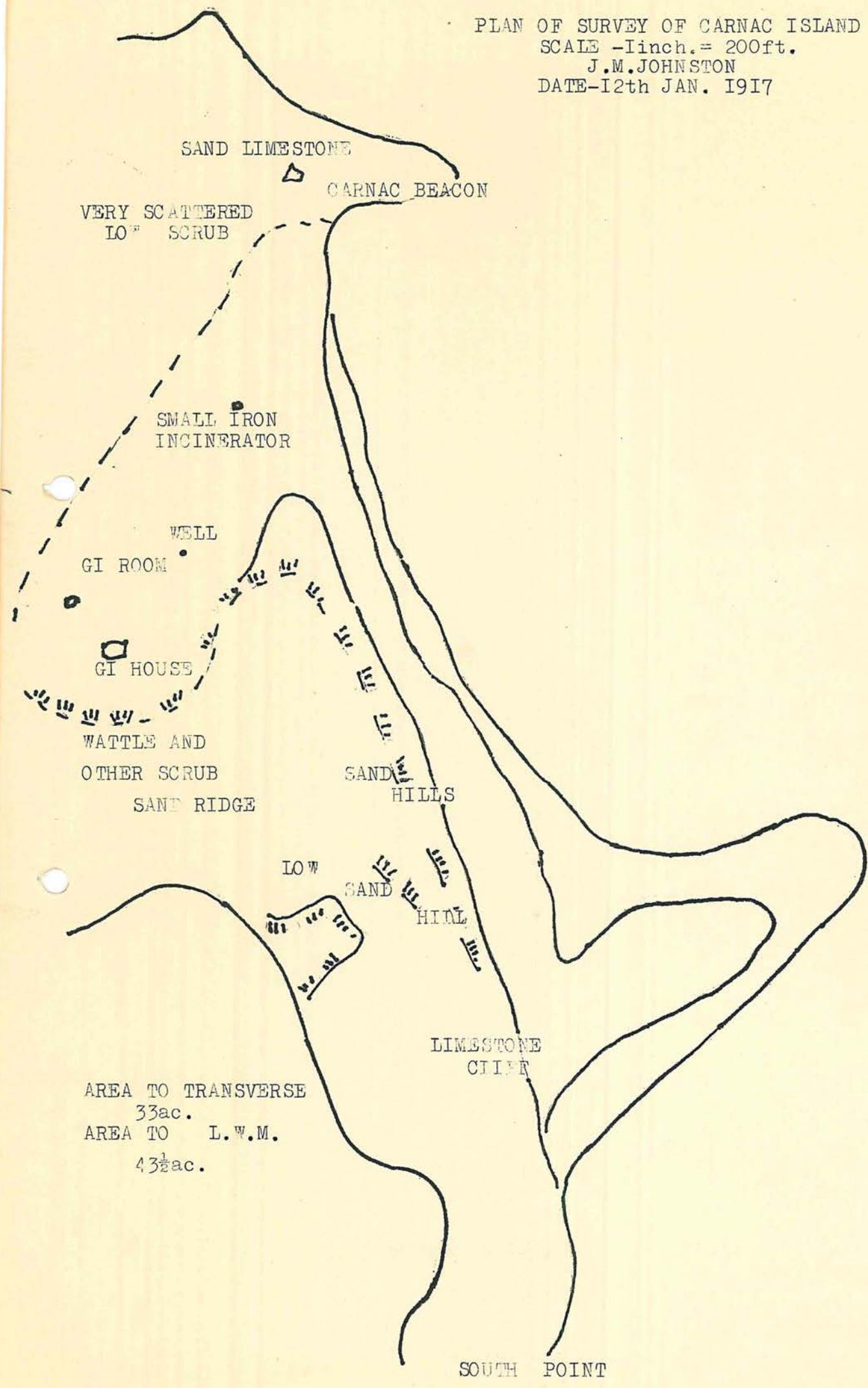
Joe Hope former surveyor for the Department of Interior and preparer of the recent map of Carnac records in 1944:-

That the grassy area of Section III of the 1917 map was still largely apparent, while today this area is largely overgrown with scrub.

This rate of this growth can be gauged, by the fact that the well, now overgrown with dead remains and living matted acacia, was in 1944 surrounded by a clear area and the nearest vegetation was approximately twelve feet away and composed of grasses.

No reason is yet advanced except perhaps fire, although not yet proven, for the presence of now dead acacia of a heavy luxuriant growth in 1944.

PLAN OF SURVEY OF CARNAC ISLAND
 SCALE -1inch.= 200ft.
 J.M.JOHNSTON
 DATE-12th JAN. 1917



AREA TO TRANSVERSE
 33ac.
 AREA TO L.W.M.
 43 $\frac{1}{2}$ ac.

B I R D S.

THE BIRDS OF CARNAC ISLAND, WESTERN AUSTRALIA.

by

J. A. L. Watson.

The bird fauna of Carnac Island has hitherto been little reported. Serventy (1938), in a paper on the land birds of Garden, Carnac and Rottnest Islands, listed the known species but apart from incidental references (Alexander, 1921; Serventy, 1948; Serventy and Whittell, 1951), no survey of the seabirds has been published. The observations in this account are mainly those made during January, 1956, supplemented with notes compiled by B. Phillips, D.L. Serventy and G.M. Storr during other visits to the island.

The physiography and geology of Carnac Island are discussed by McArthur (1957) in a paper dealing primarily with the plant ecology of the islands off Fremantle, and by Tiller elsewhere in this report. Having a small area and a uniform topography, the surface of Carnac (with the exception of portions of the limestone cliffs) is exposed to severe wind action, particularly from the west. This severity of wind action and the close proximity to the sea on all sides restricts the vegetation to a scrub of predominantly "sand dune" type (see Smith, 1957). On the western and southern areas of the island (Sections II, IV, V, VI, VII), the scrub is low and, apart from larger bushes of Olearia axillaris and isolated areas of wind-burnt Acacia cyclopis, the major part of the cover is close to the ground. The predominant plants are Scaevola crassifolia, Tetragonia spp., Suaeda maritima, Carpobrotus equilateralis, Rhagodia baccata, Calocephalus brownii and Lepidosperma gladiatum, with Nitraria schoberi on the northern talus slopes and a characteristic dense association of Frankenia pauciflora and Rhagodia baccata on the southern peninsula (Section II). However, adjoining the eastern beach and around the site of the old well there is a restricted area of dense Acacia rostellifera - Olearia axillaris thicket with trees, in places, up to ten to fifteen feet in height. This thicket is interspersed with Acacia cyclopis and shows a gradual transition at its margin to the typical Olearia scrub.

The island lacks any natural fresh water. However, a shallow timbered soak behind the eastern beach contained water during the period of the survey but, as the soak was uncovered, it probably silts up in winter. The water level showed tidal variation but the water was fresh.

The small size, the insularity and the exposure of the island are reflected in the bird fauna. Of a total of thirty three species recorded to date, eleven are land birds, eleven seabirds, ten wading birds and one an aerial vagrant, the Fork-tailed Swift. Of the eleven land birds, probably only four species are resident (in the sense of breeding on the island), the remaining seven being irregular visitors. By contrast, there are ten species of sea birds known to breed on Rottnest and at least sixteen resident land birds, excluding waterfowl, introduced game birds and two species which probably no longer occur on the island - the Bronzewing Pigeon (Phaps sp.) and a quail. (G.M. Storr, pers. comm.) Carnac, however, is noteworthy as the only area of overlap between the breeding ranges of the Little Penguin (northern limit of range) and the Wedge-tailed Shearwater (southern limit of range).

The species of birds recorded from Carnac are set out in the table below. The names in general are those given by Serventy and Whittell (1951) and the authorities are taken from the R.A.O.U. Checklist (1926).

TABLE 1. SPECIES OF BIRDS RECORDED FROM CARNAC ISLAND.

Abbreviations: B = breeding bird.
 M = migrant.
 R = resident land bird.
 S = sea bird.
 V = vagrant.
 W = wading bird.

Recorders: 1. Alexander (1921).
 2. Serventy, D.L. and Jenkins, C.F.H., 19.IX.1934.
 3. Royal Society of Western Australia Excursion, 30.III.1935.
 4. Serventy, D.L. and Serventy, V.N., 15.II.1951.
 5. Watson, J.A.L. January, 1956.
 6. Phillips, B. 10.III.1956.
 7. " " 4.XI.1956.
 8. Watson, J.A.L. 22.II.1957.
 9. Storr, G.M. 30.III.1958.

No.	SPECIES	STATUS	RECORDERS
SPHENISCIFORMES.			
1.	<u>Eudyptula minor</u> (Forster). Little Penguin.	S.B.	3, 5.
PROCELLARIIFORMES.			
2.	<u>Puffinus pacificus</u> (Gmelin). Wedge-tailed Shearwater.	S.B.	1, 3, 4, 5, 9.
PELECANIFORMES.			
3.	<u>Phalacrocorax varius</u> (Gmelin) Pied Cormorant.	S.B.	2, 3, 4, 5, 7, 8, 9.
LARIFORMES.			
4.	<u>Hydroprogne caspia</u> (Pallas). Caspian Tern.	S.B?	5, 8.
5.	<u>Sterna bergii</u> Lichtenstein. Crested Tern.	S.B?	2, 3, 4, 5, 8, 9.
6.	<u>Sterna nereis</u> (Gould). Fairy Tern.	S.B.	4, 5, 8.
7.	<u>Sterna anaetheta</u> Scopoli Bridled Tern.	S.B.	1, 4, 5, 8.
8.	<u>Larus novae-hollandiae</u> Stephens Silver Gull.	S.B.	2, 3, 4, 5, 7, 8, 9.
9.	<u>Gabianus pacificus</u> (Latham) Pacific Gull.	S.	3.
CHARADRIIFORMES.			
10.	<u>Arenaria interpres</u> (Linne) Turnstone.	W.M.	5, 8, 9.
11.	<u>Haematopus ostralegus</u> Linne Pied Oystercatcher.	W.B?	2, 5.
12.	<u>Haematopus fuliginosus</u> Gould Sooty Oystercatcher.	W.B?	5.
13.	<u>Squatarola squatarola</u> Linne Grey Plover.	W.M.	5, 8.
14.	<u>Charadrius ruficapillus</u> Temminck and Red-capped Dotterel. Laugier	W.B?	5, 9.
15.	<u>Cladorhynchus leucocephalus</u> (Vieillot) Banded Stilt.	W.M.	5
16.	<u>Numenius phaeopus</u> (Linne) Whimbrel.	W.M.	5

17.	<u>Tringa brevipes</u> (Vieillot) Grey-tailed Tattler.	W.M.	9.
18.	<u>Tringa hypoleucos</u> Linne Common Sandpiper.	W.M.	3, 4, 5, 8, 9.
19.	<u>Erolia ruficollis</u> (Pallas) Little Stint.	W.M.	4, 5, 9.
ARDEIFORMES.			
20.	<u>Demigretta sacra</u> (Gmelin) Reef Heron.	W.B?	5.
ACCIPITRIFORMES.			
21.	<u>Haliastur sphenurus</u> (Vieillot) Whistling Eagle .	V.	5.
22.	<u>Falco cenchroides</u> Vigors and Horsfield Kestrel.	V.	2.
23.	<u>Pandion haliaëtus</u> (Linne) Osprey.	V.	9.
STRIGIFORMES.			
24.	<u>Tyto</u> sp. Barn Owl.	V.	3.
PSITTACIFORMES.			
25.	<u>Neophema petrophila</u> Gould Rock Parrot.	V?	9.
CORACIIFORMES.			
26.	<u>Halcyon sanctus</u> Vigors and Horsfield Sacred Kingfisher.	V.M.	3, 5, 9.
27.	<u>Micropus pacificus</u> (Latham) Fork-tailed Swift.	V.M.	5.
PASSERIFORMES.			
28.	<u>Hirundo neoxena</u> Gould Welcome Swallow.	R.B?	3, 4, 5, 8, 9.
29.	<u>Hylochelidon nigricans</u> (Vieillot) Tree Martin.	V?	5.
30.	<u>Rhipidura leucophrys</u> (Latham) Black and White Fantail.	R.B.	2, 4, 5, 6, 8, 9.
31.	<u>Eopsaltria griseogularis</u> Gould Western Yellow Robin.	V.	5.
32.	<u>Zosterops australasiae</u> (Vieillot) Silvereye.	R.B.	2, 3, 4, 5, 8, 9.
33.	<u>Corvus coronoides</u> Vigors and Horsfield Raven.	R.B?	2, 5, 6, 8, 9.

Notes on Individual Species.

1. Eudyptula minor, Little Penguin.
Both adults and young showed nocturnal activity above ground during early January, 1956. By the end of January, most of the old birds had left the island but the young were still swimming at night in the sheltered bays. There was evidently considerable mortality among both young and adult birds during the breeding season but one fully fledged chick showed no signs of parasite infestation when examined shortly after death.
2. Puffinus pacificus, Wedge-tailed Shearwater.
The approximate distribution of burrows of this species at the time of the survey is shown in the map, but some of the burrows, probably originally excavated by Shearwaters, were then occupied by Penguins. No census was taken. During the survey, all burrows investigated contained either an egg or a small chick. D.L. Serventy recorded "half-grown young" on 11.II.1951

and on 30.III.1958 G.M. Storr noted that the chicks were fat and downy, but were not leaving the burrows at night.

The guano mound at the mouth of one burrow (under the travertine on the southern peninsula) was found to contain both sexes of a flea of the genus Parapsyllus but none of these parasites was recovered from the birds themselves. A small hippoboscoid fly was also seen on one bird but attempts to collect these insects failed.

3. Phalacrocorax varius, Pied Cormorant.

No nesting activity was recorded in January, 1956, although one shattered egg was found in a dune on the northwestern corner of the island. On 30.III.1958, approximately fifty pairs were commencing to breed on Flat Rock (G.M. Storr).

6. Sterna nereis, Fairy Tern.

No breeding congresses of this species have been recorded from Carnac. However, one bird was observed with an egg on an exposed rock platform on 9.I.1956 but the egg was deserted shortly afterwards.

7. Sterna anaetheta, Bridled Tern.

Large numbers nest in crannies in the cliffs both of the main island and also the subsidiary islets. Many young birds were in the late down - early feather stage at the time of the survey, although one egg and two newly hatched birds were located. Breeding birds were also present on 2.II.1957 (J.A.L.W.) and 11.II.1951 (D.L.S.), but not on 30.III.1935 (D.L.S.) or 30.III.1958 (G.M.S.).

8. Larus novae-hollandiae, Silver Gull.

Gulls have been recorded nesting in the period September - January, with eggs and young on 19.IX.1934 (D.L.S.) and many fully fledged young in January, 1956. On 11.II.1951, no occupied nests were recorded (D.L.S.) and there was no breeding in progress on 30.III.1958 (G.M.S.).

10-19. Wading Birds.

A mixed flock of waders was present during the entire survey period, feeding either on the exposed reef flats or on the bank of Posidonia on the eastern beach. Arenaria interpres, the Turnstone, and Erolia ruficapillus, the Little Stint, were the most numerous species. A flock of Cladorhynchus leucocephalus, the Banded Stilt, was intermittently present during this time, the birds feeding inshore in the eastern bay but, on disturbance, flying out and alighting on deeper water. The flock contained many young birds, the young : adult ratio being approximately 2 : 1.

20. Demigretta sacra, Reef Heron.

All individuals of this species recorded were of the dark grey phase. Between one and three birds were recorded almost daily by survey members.

27. Micropus pacificus, Fork-tailed Swift.

Two influxes of Swifts were recorded during the survey. On 1.I.1956, only a few birds were present but between 21-25.I.1956, larger parties were observed. On 25.I.1956, following strong easterly winds and high temperatures, a large flock built up on the western lee of the island, the birds flying in from the east and north and out towards the south. Associated with the Swifts were large numbers of the dragonflies Anax papuensis (Burm.) and Hemicordulia tau Selys, but the Swifts appeared to be feeding mainly on smaller insects above the dragonfly flock although some Hemicordulia were taken. This second irruption was probably continuous with that mentioned by Ford (1958).

28. Hirundo neoxena, Welcome Swallow.

One of the commonest of the land birds, which almost certainly breeds under the limestone cliffs although no nests have been recorded.

30. Rhipidura leucophrys, Black and White Fantail.

Two pairs of adults were present in January, 1956, together with at

least two young. No nests were located, but the adults were seen chasing the young near the campsite. This species is the only land bird resident at Carnac which is not also resident on Rottnest. It is common on Garden Island.

32. Zosterops australasica, Silvereye.

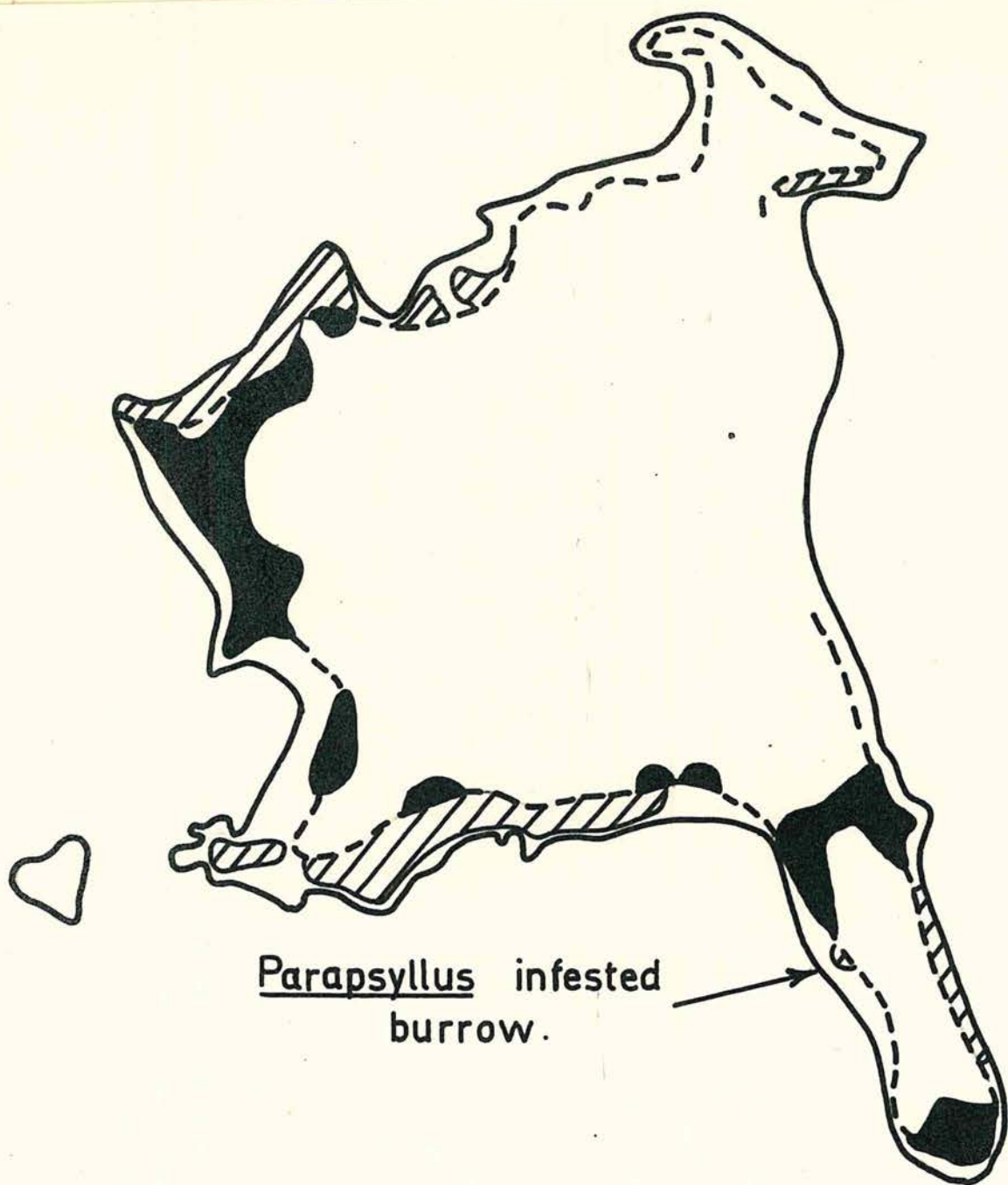
During the survey period, this species was the commonest land bird on the island, with the greatest concentration of numbers in the Acacia thicket around the campsite. The birds made abundant use of the soak for drinking and bathing (see photograph) and were feeding on seeds of Acacia and grasses, together with insects both from the ground and from the Acacia.

33. Corvus coronoides, Raven.

A large deserted nest, possibly that of a Raven, was collected from a dead Acacia rostellifera on 6.1.1956 (see photograph). There is no other evidence to confirm that the birds are resident, although they have been recorded regularly.

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Parapsyllus infested
burrow.

APPROXIMATE DISTRIBUTION OF
SHEARWATER BURROWS,
CARNAC ISLAND, JAN., 1956.

- Burrows above cliffs
- ▨ Burrows below cliffs



E N T O M O L O G Y.

by

J.A.L. Watson

The identification of terrestrial arthropods collected on Carnac Island during January, 1956, is still incomplete and no comprehensive account can yet be given. However, notes on some groups may be included with these reports.

1. As Carnac lacks any permanent fresh water and hence, breeding sites for freshwater insects, the dragonfly fauna is restricted to forms which range wide from water. Although the number of dragonflies around the island was, at times, very large, the insects were not present continuously during the survey. The numbers occurring appeared to be related in part to the prevailing winds, with the largest numbers after periods of strong easterlies. The two species most frequently observed were the common Australian wide forms

Anax papuensis (Burn) (Aeshnidae)

and Hemicordulia tau Selys (Corduliidae), both of which are well known wanderers.

Other species recorded were:-

Aeshna brevistyla Rambur (Aeshnidae)

Diplacodes bipunctata (Brauer) (Libellulidae)

Austrothemis nigrescens (Martin) (Libellulidae)

Iscinura aurora (Brauer) (Coenagriidae)

Xanthagrion erythronurum Selys (Coenagriidae)

2. On 19.1.58 a single specimen of a water boatman, probably a species of Porocorixa (Corixidae), was seen at the light but was subsequently lost. This record, following several days of prolonged easterly winds, serves to emphasize the ease with which many flying insects can cross to the island.
3. The parasites found in association with the shearwaters have been discussed in the bird report above (q.v.)
4. No Cicadidae have been recorded from Carnac, either during the survey or on a visit made on 22.II.1957.
5. The two species of Acacia on the island, A. cyclopis and A. rostellifera, were found to support different insect faunas. Samples were taken by shaking the foliage into a calico net and preserving the entire sample of material. The numbers of insects of the dominant species represented are shown in Table 1. The following species were scored:-

Orthodera ministralis Fabr. (Orthoptera - Mantidae)

Sextius depressus Goding ? (Hemiptera - Membracidae)

2 species of psyllids (Hemiptera - Psyllidae)

Catasarcus spinipennis Tho. (Coleoptera - Curculionidae)

Lammodacus querulus Pasc. (Coleoptera - Curculionidae)

1 small species of curculionid (Coleoptera - Curculionidae).

TABLE I.

DISTRIBUTION OF INSECTS ON
TWO SPECIES OF ACACIA

Sample No.	Species	Form	Gasteranrus	Curculionid	Laemosaccus	Psyllidae	Sextius	Orthodera
1.	<i>Acacia rostellifera</i>	3'-4' high; straggly bush	10	4	-	1	1	1
2.	"	2' ; young, badly eaten tips	13	1	-	-	1	-
3.	"	5' ; good condition	1	1	1	-	2	-
4.	"	5' ; large bush, yellow foliage	-	1	-	-	1	-
5.	"	3' ; spread, good condition.	3	8	3	2	4	2
6.	"	3' ; small, good condition	20	6	-	-	1	4
7.	"	6' ; clump of three, good condition	16	3	1	1	4	2
13.	"	6' ; two bushes, good condition.	4?	2	14	1	10	1
TOTAL SAMPLE			67	26	19	5	24	10
PERCENTAGE			45	17	12	3	16	7
8.	<i>Acacia cyclops</i>	20'x6' ; in flower, sample incomplete	2	-	-	120	3	6
9.	"	7'x4' ; flowering, wind burnt	-	-	-	100	2	3
10.	"	8'x3' ; flowering, wind burnt	2	-	1	27	2	1
11.	"	20'x7' ; no flower, sample incomplete	-	-	-	40	2	6
12.	"	15'x6' ; flowering, good condition.	-	-	-	45	3	9
14.	"	several bushes involved	-	-	-	80	14	2
TOTAL SAMPLE			4	-	1	410	26	27
PERCENTAGE			1	-	-	87	6	6

It is clear that there is a preponderance of Psyllidae on *A. cyclops* and of Curculionidae on *A. rostellifera* while the proportion of a predator, *Orthodera*, is similar in terms of total numbers in the two species.

6. A series of six ghost crabs of the genus *Ocypode* was collected from burrows at high water mark on the eastern beach. These were all males and had the measurements shown in Table II.

OCYLODE MEASUREMENTS (mm.)

No.	Larger Chela	Large Chela		Small Chela		Carapace Width
		Width	Length	Width	Length	
1.	Left	24.2	38.2	12.1	24.0	42.7
2.	Left	25.5	41.0	13.0	26.3	45.1
3.	Left	22.6	38.3	12.2	24.5	42.8
4.	Right	24.0	37.0	12.5	24.0	42.4
5.	Right	23.1	35.0	11.2	22.6	39.7
6.	Left	21.8	33.0	11.2	22.5	39.5

These measurements do not differ significantly from measurements of *Rottiers* animals, taken in November, 1955.

7. Despite the dryness of the soil and leaf litter, soil samples showed the presence of an abundant arthropod fauna, particularly under the *Acacia rostellifera* thicket. The fauna included Collembola (predominantly Entomobryidea), Thysanura (Lepismatidae, Sminthurina, Orthoptera (Blattidae), Thysanoptera (Phloeotaripidae), Coleoptera (Carabidae, Iselaphidae), Acarina, pseudoscorpionida, Araneida and Scolopendromorpha (Scolopendriidae - *Cornocephalus*).

(Two other myriapods, probably a lithobiid and a geophiliid, were seen but could not be collected).

The collections of terrestrial Arthropoda from Carnac will be lodged in the Western Australian Museum.

G E O L O G Y.

GEOLOGY OF CARNAC ISLAND

by

K. Tiller

Carnac Island is situated $32^{\circ} 7' 12''$ S by $115^{\circ} 39' 36''$ E on the West coast of Australia and lies approximately $5\frac{1}{4}$ nautical miles south-west of Fremantle. Along with Rottneest and Garden Islands this group was originally named "Les Iles Louis Napoleon" by M. Louis Freycinet. This has now been displaced by Carnac Island.

The rocky island of Carnac is only one of a series of rocky ridges or islands and reefs which parallel the coast with a north-south orientation. The first ridge is the submerged Five Fathom Bank some two and half nautical miles west of Carnac Island with Hawley Shoal, Casuarina Shoal and Seaward Reef as the higher parts of this formation. This ridge begins at Rottneest and continues southward for over 30 nautical miles. The second ridge is represented by a series of islands and headlands represented by Rottneest Island, The Stragglers, Hewstone, Carnac, Garden, Seal and Penguin Islands and the island reduced to mean sea level at the Murray Reef. These remnants vary in height with the highest point of 195 feet on Garden Island. The third ridge is now represented by the submerged reef of Entrance Rocks, Beagle Rocks, Minden Reef, Fish Rocks, Woodman's Spit and thence to James Point. This ridge is a more or less continuous reef at varying depths and forms protection for Owen Anchorage and Jervoise Bay. The fourth ridge is a series of hills of coastal limestone running North, and South of Fremantle to Woodman's Point, flanking the eastern side of Cockburn Sound and continues as far south as Mandurah and forms the actual coastline.

These rocky ridges represent the remnant cores of littoral dune ridges wherein false or current bedded coastal limestones have been cemented to form Aeolianite (Fairbridge, 1950). Fairbridge accounts for the variation of levels as being due to eustatic changes of pre-existing strandlines.

The structural and petrological features of Carnac Is. are similar to those found at Rottneest and at Pt. Peron and the orientation of the major dip of many of the current bedded layers under the continued effect of the dominant S.W. and N.W. winds have determined the present configuration of the island. On the eastern side the cliffing by marine erosion is not so marked because of the lack of reach of the easterlies, while the more exposed westerly side the marine planation has produced the wide reefs and in places has separated the more resistant areas as isolated islets. Under the influence of the strong north-westerlies large erosion indentations occur with marine abrasion attacking more or less parallel to the strike of the dominant layers or strata and so the attack is directed along the bedding planes. The presence of well developed solution pipes which reach well below sea level and which vary from a few inches to many feet in diameter form the major obstacle against the marine erosion from this direction resulting in the spectacular stacks or columns which support the more resistant travertine or capstone in the form of large caverns where wind erosion continues the undersapping of the softer layers.

Deflation by winds of a westerly component particularly those from the south-west have tended to form scour channels in the sandy surface where vegetation has failed to fix the soil cover. Such deflation has reached base level of the travertine or capstone.

Conclusions.

1. That Carnac Island is an erosion remnant of a one-time continuous coastal limestone rampart that lies to the west of the main coastline.

2. That the dominant westerlies have been responsible for the marine erosion that has produced the wide reefs and isles on the western margin.

3. That the structure and dip of the false or current bedding influences the rate of marine erosion.

4. That once a cliff of marine abrasion has been established, wind erosion takes over and by sapping produces the caverns that upon collapsing allow for further reduction of these tumble blocks by wave action under storm conditions.

References:

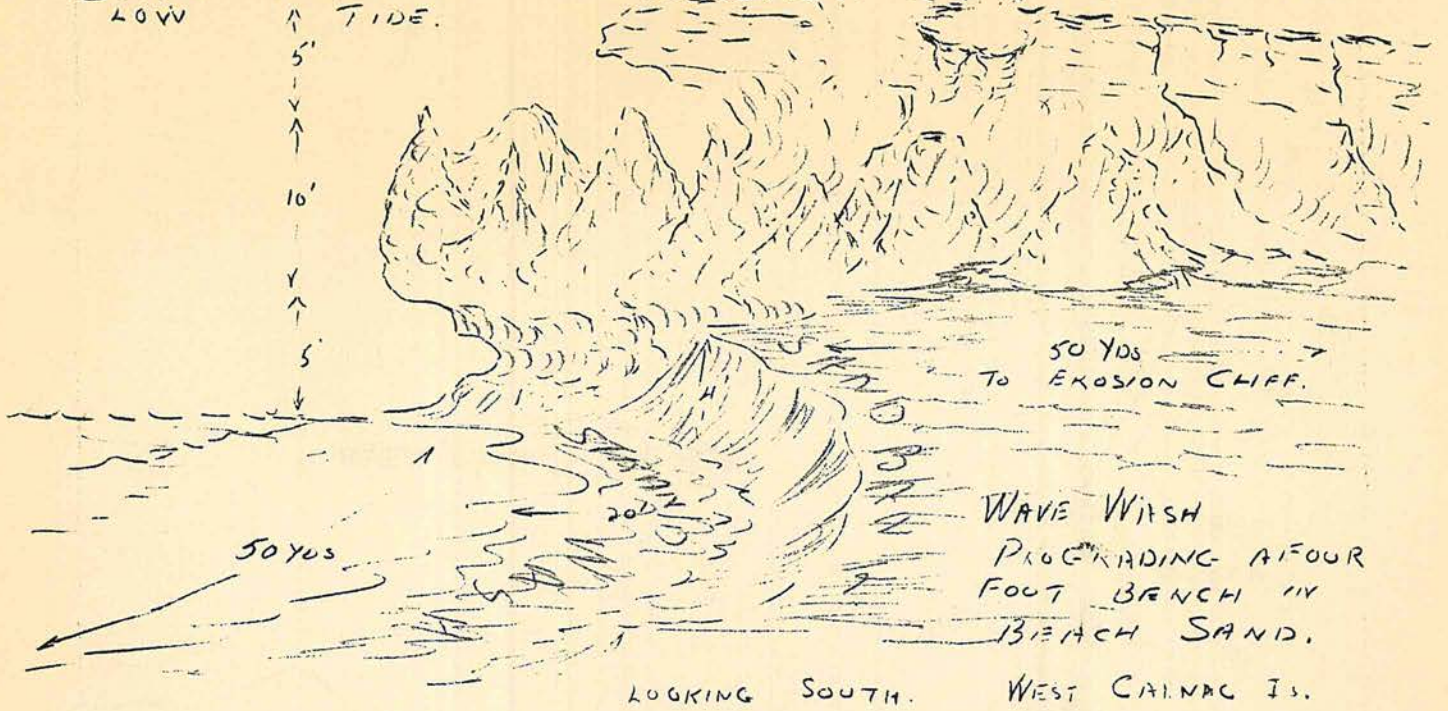
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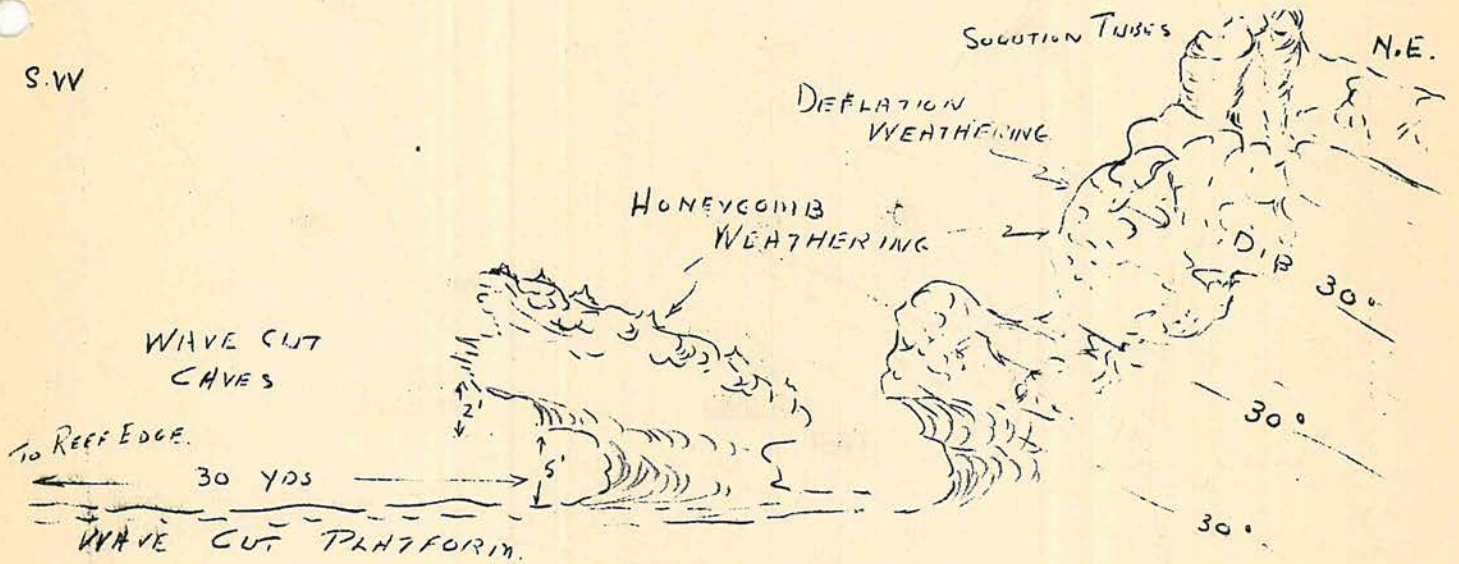
CAVE Pt. 7-1-56
LOW TIDE.

S-E WIND SKNTS.

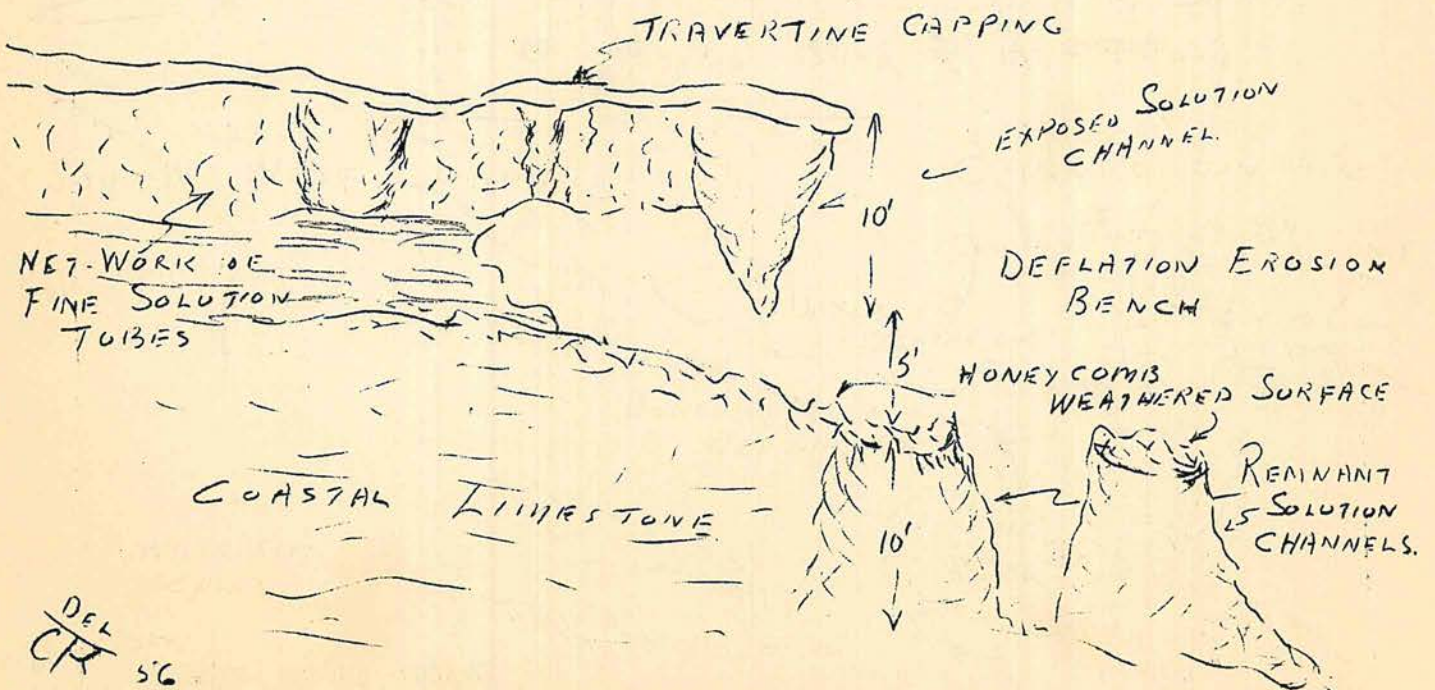


SOUTH~WEST CORNER.

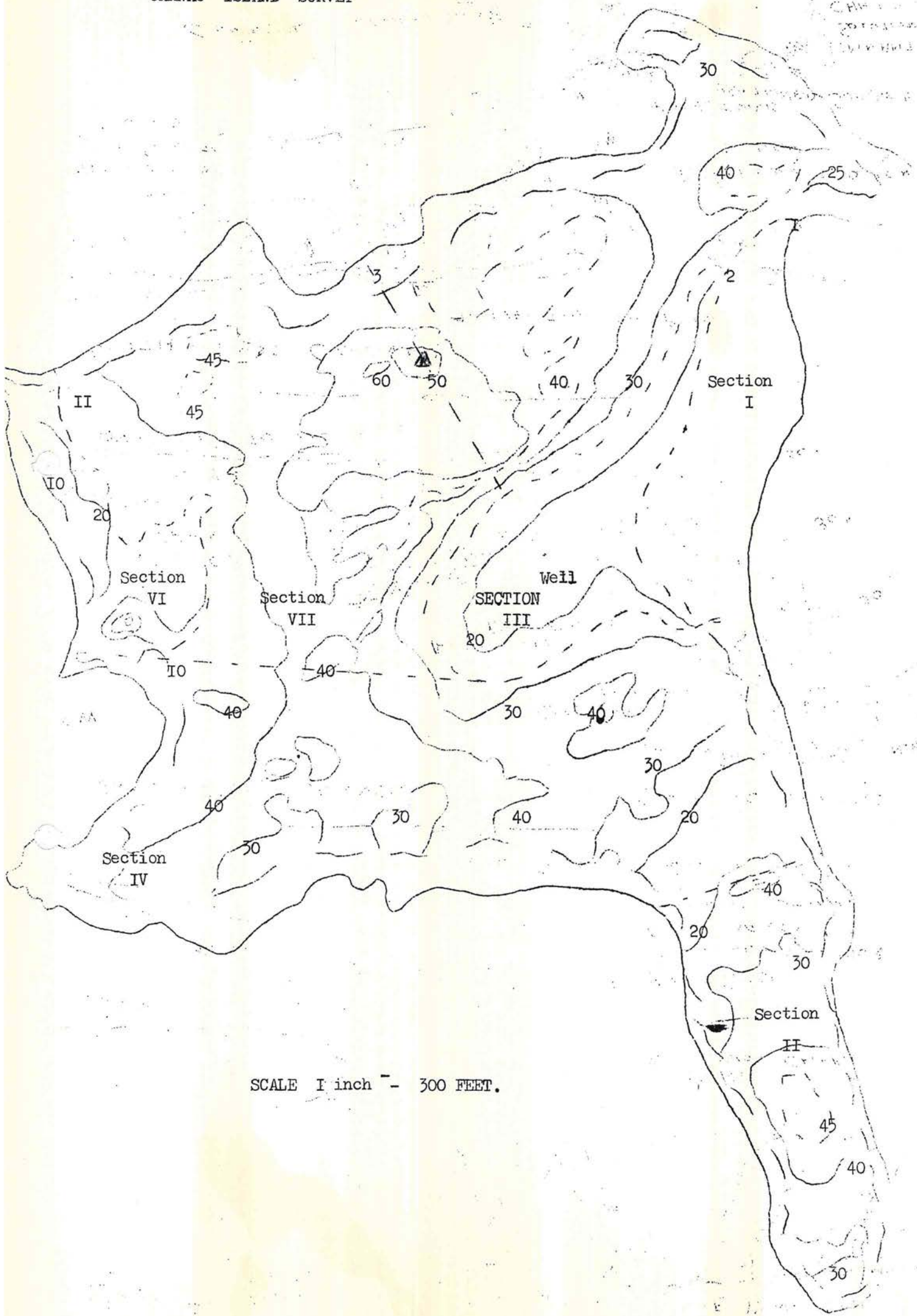
CARMAC JAN 1956.



SOUTH~EAST CORNER.

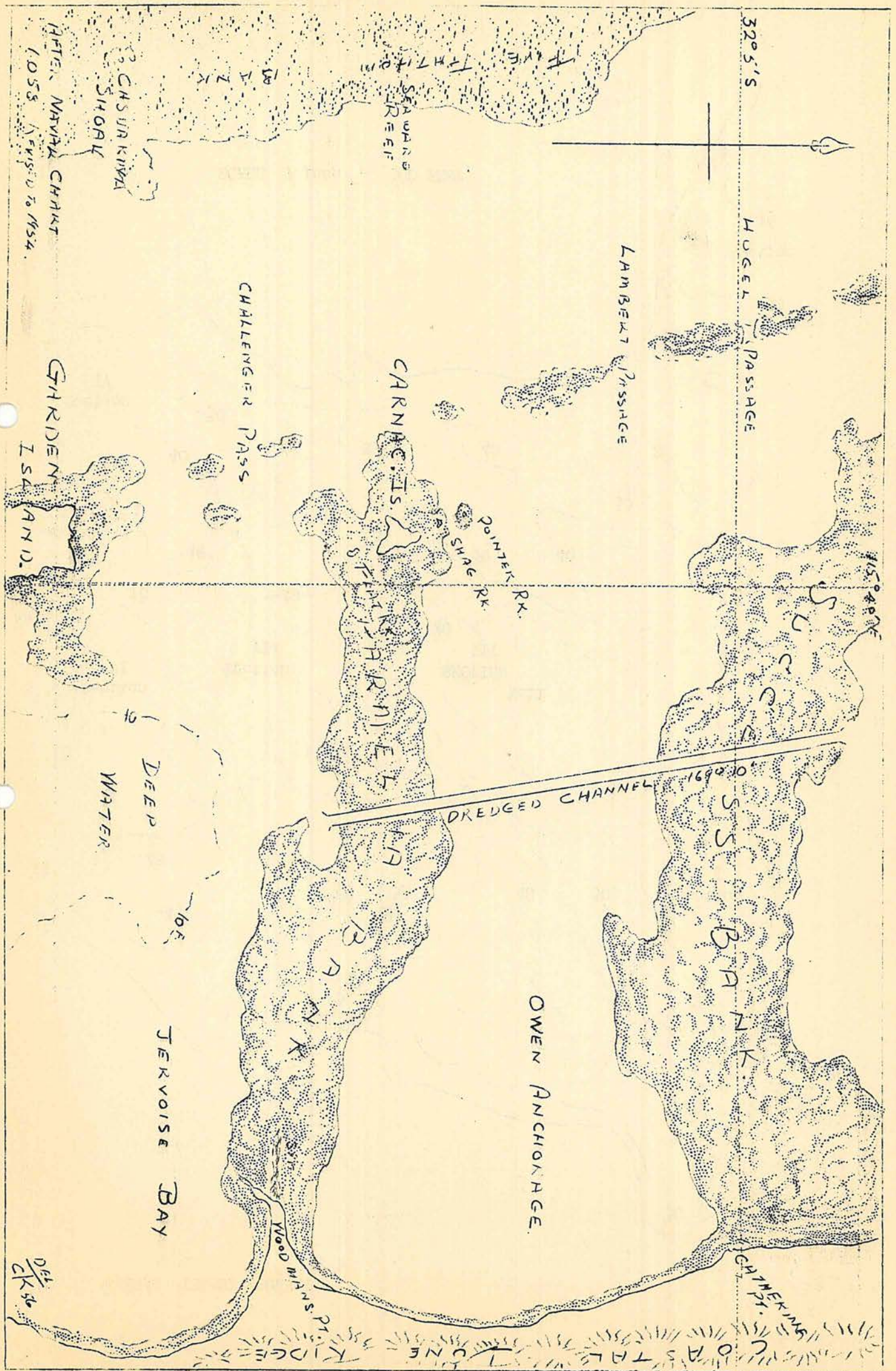


CARNAC ISLAND SURVEY

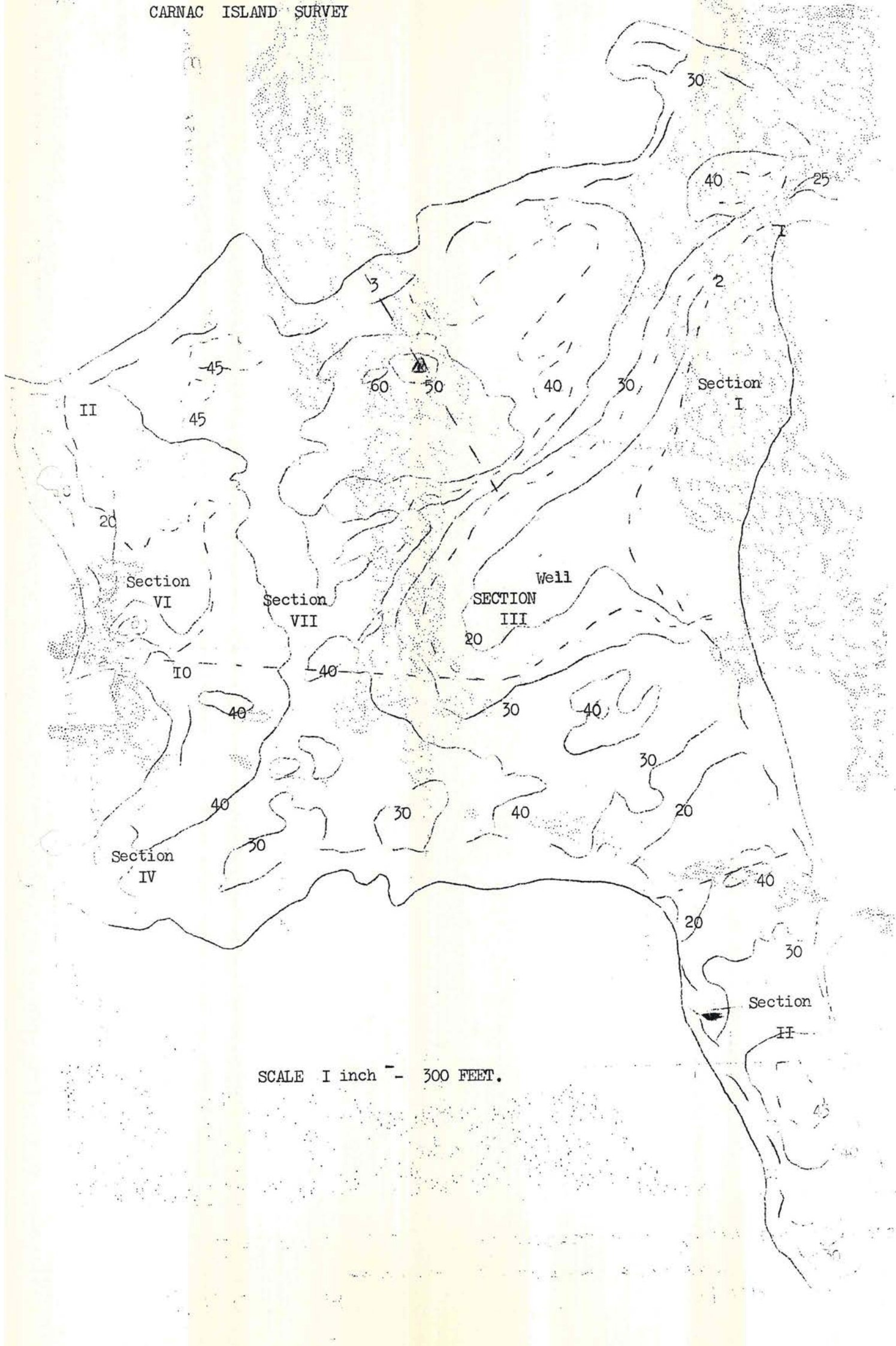


SCALE 1 inch = 300 FEET.

SKETCH MAP
 SHOWING RELATION BETWEEN
 CARNAC IS & SUCCESS AND PARNELIA BANKS.

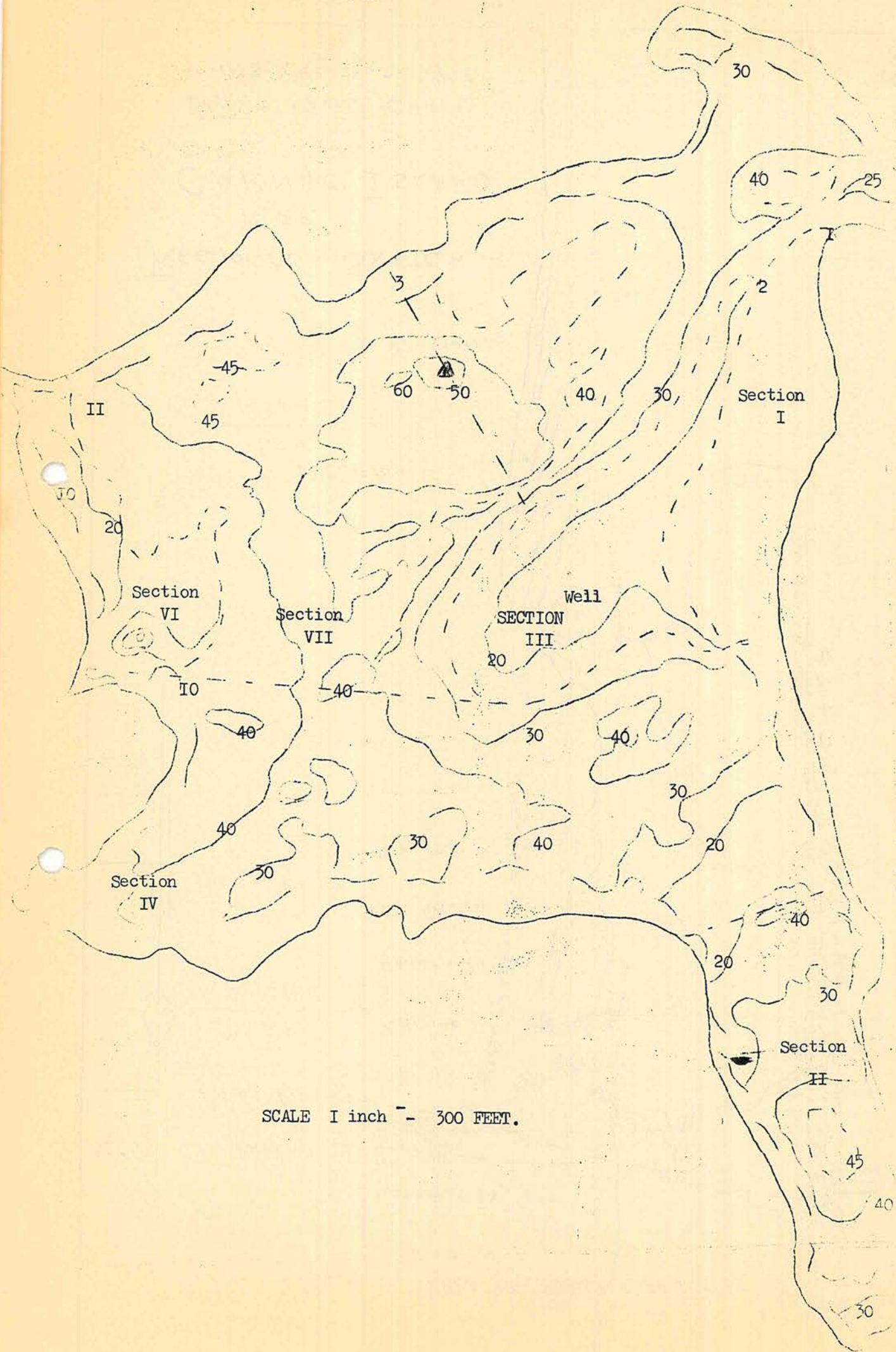


CARNAC ISLAND SURVEY

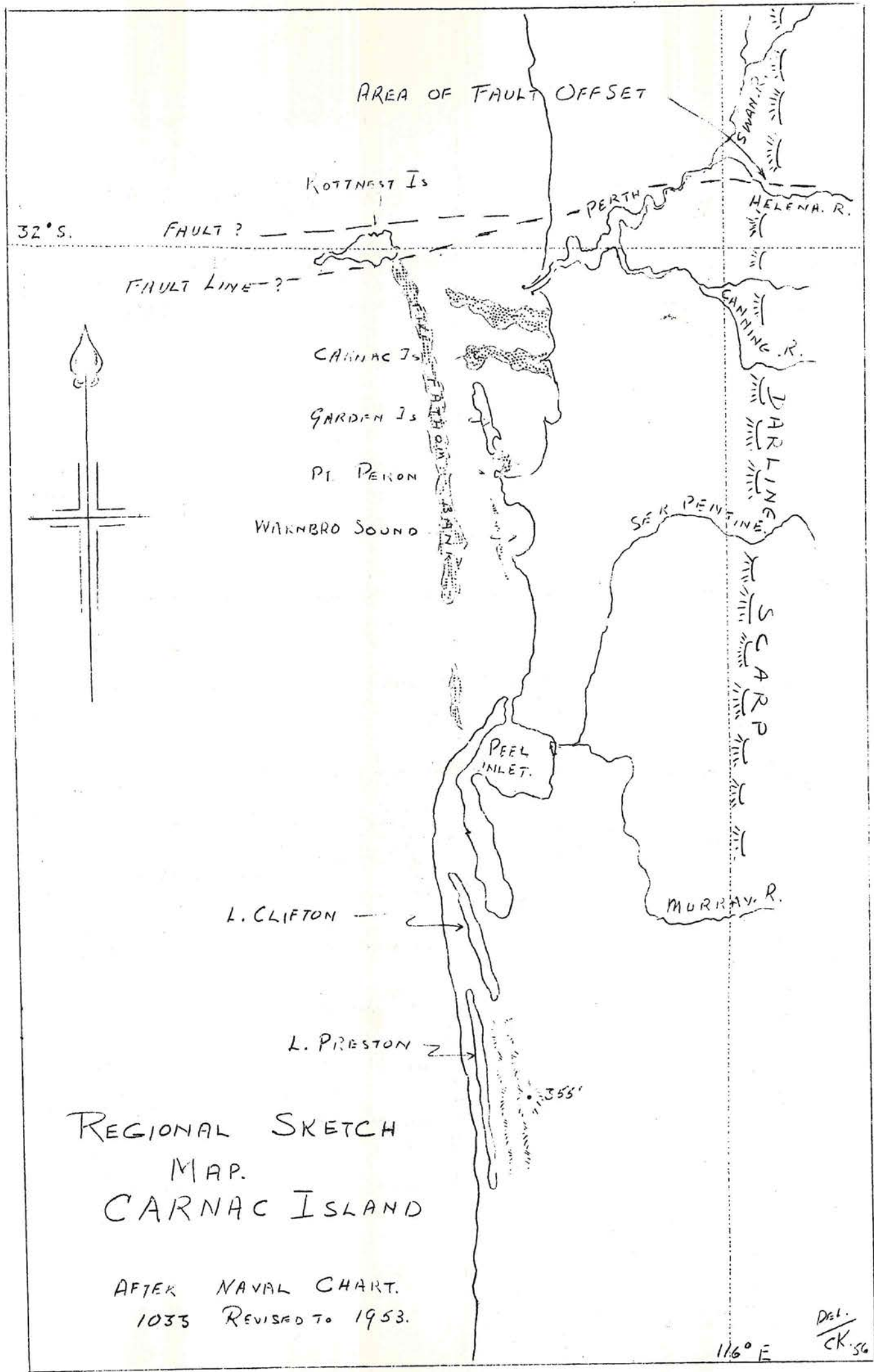


SCALE 1 inch = 300 FEET.

CARNAC ISLAND SURVEY



SCALE 1 inch = 300 FEET.



REGIONAL SKETCH
 MAP
 CARNAC ISLAND

AFTER NAVAL CHART.
 1033 REVISED TO 1953.

DEL.
 CK. 56

M A M M A L I A .

by

B. Phillips.

THE MOUSE (DOMESTIC).

These appeared in profuse numbers over the whole island surface.

Upon reference, it is upon them that we are able to base the changing population of the tiger snake, and partly due to the tiger snake itself the varying population of the mice was observed.

A series of trap lines were laid around the island, yielding proof of their existence over the whole surface; while also, but not conclusively, showing a tendency towards the higher ground and a dislike of the bare sand dune patches.

They appeared omniverous in their eating habits, the traps being baited with raisins, and even cannibalistic on occasions when collected alive and placed in cages.

They occupied the position as scavengers of the camp and approached into the very beds of the party.

A peculiar game of chasing and bounding was observed by the party, in the gleam of the firelight. Their appearances were almost entirely at night.

Attached is a map of the trap lines laid, and the results of those.

Specimens were collected.

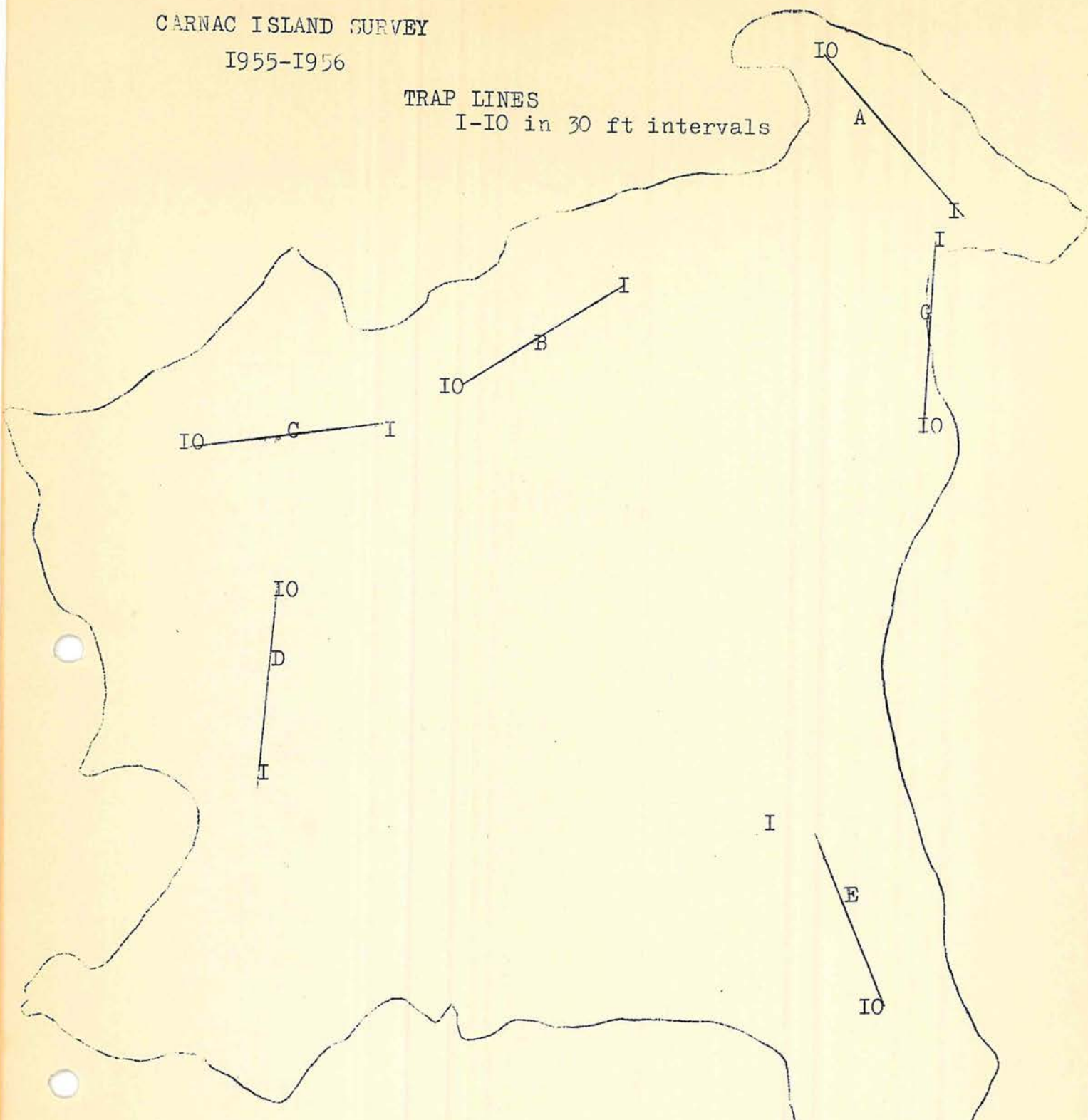
Below is one of the aluminium mammal traps (about 10 inches long) used in the mouse survey.



CARNAC ISLAND SURVEY

1955-1956

TRAP LINES
I-10 in 30 ft intervals



A	4th JAN.	I	2	3	4	5	6	7	8	9	10
	5th JAN.	I	2	3	4	5	6	7	8	9	10
B	6th JAN.	I	2	3	4	5	6	7	8	9	10
	7th JAN.	I	2	3	4	5	6	7	8	9	10
	8th JAN.	I	2	3	4	5	6	7	8	9	10
C	9th JAN.	I	2	3	4	5	6	7	8	9	10
	10th JAN.	I	2	3	4	5	6	7	8	9	10
	11th JAN.	I	2	3	4	5	6	7	8	9	10
D	12th JAN.	I	2	3	4	5	6	7	8	9	10
	13th JAN.	I	2	3	4	5	6	7	8	9	10
	14th JAN.	I	2	3	4	5	6	7	8	9	10
E	15th JAN.	I	2	3	4	5	6	7	8	9	10
	16th JAN.	I	2	3	4	5	6	7	8	9	10
	17th JAN.	I	2	3	4	5	6	7	8	9	10
F	18th JAN.	I	2	3	4	5	6	7	8	9	10
	19th JAN.	I	2	3	4	5	6	7	8	9	10
	20th JAN.	I	2	3	4	5	6	7	8	9	10
G	21 st JAN.	I	2	3	4	5	6	7	8	9	10
	22 nd JAN.	I	2	3	4	5	6	7	8	9	10
	23 rd JAN.	I	2	3	4	5	6	7	8	9	10

RAISINS as BAIT

I
F
10

SEALS (Neophoca cinerea)

A large male specimen 8-10 ft long, with a white top to the head, was observed on several occasions during our visit in January, 1956. When seen it was usually asleep on a particular bed of Posidonia (Plate 6b) on a mound beneath the cliffs shown in plate 1b.

At approximately the middle of January it returned after one of its many trips with another seal, sex not determined. Barnacles were observed upon its back.

A dead specimen was found on the beach of the island to the south. Judging by the skeleton and in particular the teeth it was that of an old male. The cause of death was not established, but it was presumed to be age.

R E P T I L I A .

by

B. Phillips.

KING SKINK (EGERNIA KINGII).

These occupy the position of the most prominent member of the islands landed population; and far from being timid they were almost constantly to be seen throughout the daylight hours. Omniverous in their habits, they ate of our table foods equally well as on a mouse which one was seen to catch and swallow alive. They were noted drinking on several occasions at the small soak by the camp, and were partial to juicy fruits etc., such as tomatoes. A large proportion of the population appeared to be adults a semi-mature species but a small number of young lizards were noted. Their presence was noted over the whole surface, where they were disturbed underfoot. Insects appear to be a part of the natural diet. Specimens were collected.

Marble Geckoes.

The presence of marble geckoes on the island was noted and also a number of eggs. Their presence was noted in the signal box and under the fork of the dead acacia on the path to trig., Section V.

Specimens were collected.

Striped Skink.

Presence noted on island of number of small striped skinks.

No specimens were collected.

TIGER SNAKE Notechis (scutatus).

On evidence of specimens either seen or collected and the castings of fresh moultings, I have ascertained their presence over the whole surface.

At present the population appears to be at a low level as only 5 specimens were obtained and another 2 seen during the whole month.

On information obtained from visitors to the island, a high population appears to have occurred in the early spring months.

Most specimens collected were of a semi-mature age, but one was a comparatively young animal.

Their presence was noted in the Sheer Water burrows and sunning upon the rough paths around the island. Two specimens collected from the well appear to have fallen in as no other means of entrance was observed.

Their diet appears to be almost exclusively the domestic mouse, supplemented probably by young birds, and their numbers are regulated by its supply.

The presence of a specimen in the camp area at approximately 12.30 p.m., I attribute to the attraction of a number of caged mice in the area.

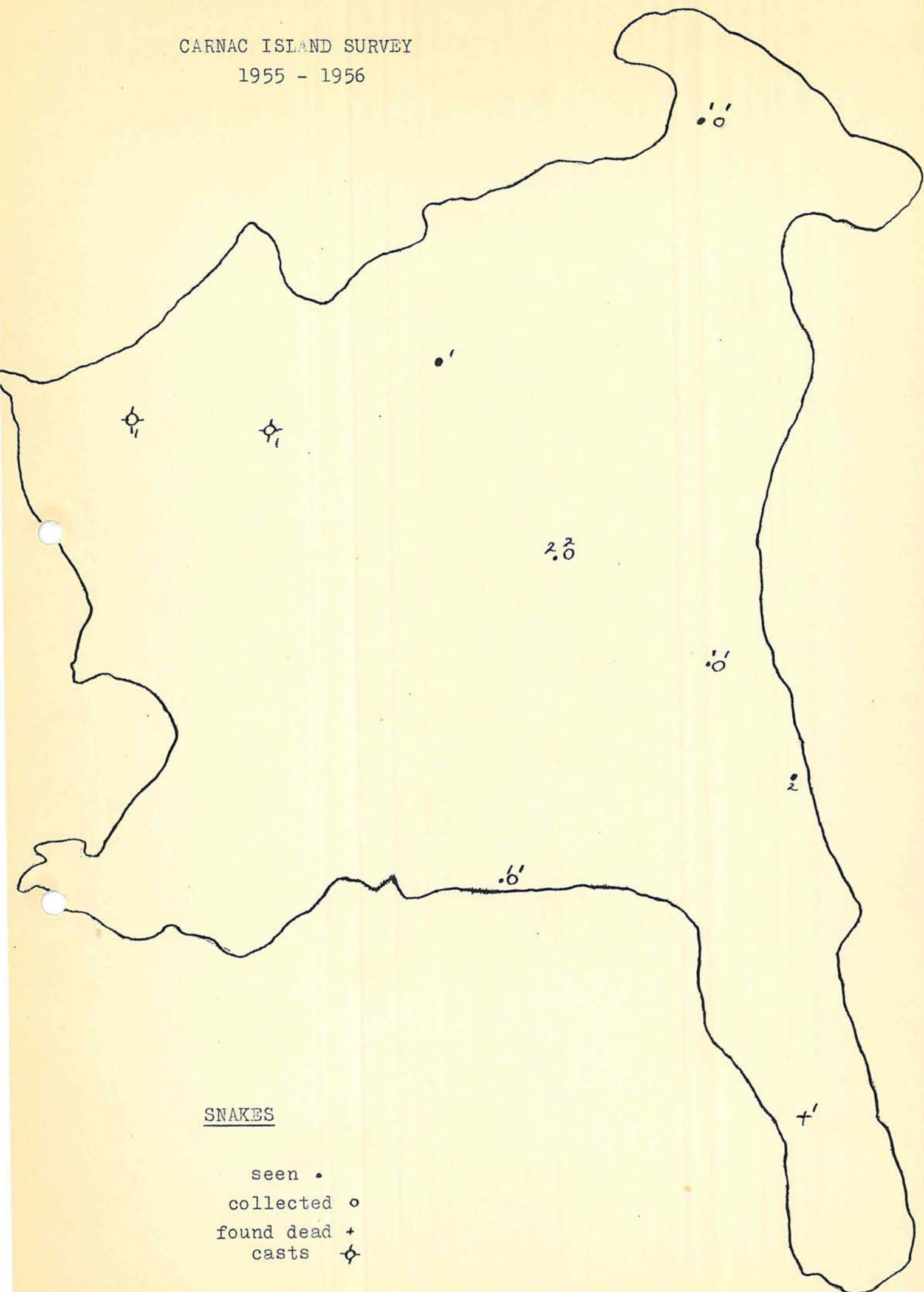
A point of interest noted in a specimen is accounted here:-

- (1) A specimen of a live, domestic species of mouse was placed in together with a newly captured specimen of a tiger snake, as the evening was approaching.
- (2) During the evening the mouse, untouched by the snake, was seen to proceed to attack the snake and attempt to eat it alive, so to speak, by tearing off portions of flesh and scales and eating them. The snake writhed away from it but appeared unable to hit it with its wild striking, even though the mouse was often within an inch of its nostrils.
- (3) On inspection at dawn the mouse was dead.
- (4) The snake lived for several days in captivity before dying although not necessarily of its wounds.

An attached map shows the position of specimens either seen or collected.

CARNAC ISLAND SURVEY

1955 - 1956



S N A I L S.

SNAILS.

Three species of snails were found on Carnac Island and these have been identified by George Kendrick:

Helix pisana (Thebe),	exotic.
Austrosuccinea contents,	native.
Cochlicella acuta,	exotic.

Specimens were hard to obtain, as the island was visited during the dry summer months.

Collected:-

Helix - over most of island surface. Austrosuccinea only collected in dead state and from shrub areas east coast in Section VI. Cochlicella - heavy population over most of island.

Specimens were collected but further observations are needed to present a clear picture of this group.

MARINE BIOLOGY.

SUB-LITTORAL ALGAE.

by R.Howlett.

INTRODUCTION.

The algae that were collected were practically all fairly deep water specimens -15'-30', since almost no collecting by divers of algae actually growing in the deep water regions has been done anywhere in the world. All of the specimens collected are known species and have been seen before, but only as washed up plants on the beach, and not growing in their natural environment as regards depth, etc. By diving and actually seeing the living plants in their environment much valuable information about them was gained.

I did not collect the reef top algae as they have been fairly intensely studied, but of course quite a number of them extend over the reef edge onto the vertical reef face.

SUBMARINE TOPOGRAPHY.

Almost the whole of the island and the sub-islands near it, had flat reef tops round them covered by 1'-2' of water, and at the outer edge passed down vertically - or more correctly at a steep angle inwardly - to a sandy sea floor at 10'-20', thus forming a reef face overhanging at the top. The reef faces were consequently rather shaded with few algae growing on them - instead flat sponges were the dominant life here. On the sea floor wherever rock (coastal aeolian) occurred away from the shaded reefs, and light intensity was sufficient for photosynthesis, algae were prolific.

The east side of the island had a large and relatively sheltered fairly shallow bay, whose floor was completely covered with Posidonea or Sea Grass. When standing on Carnac many other patches of Posidonea could easily be picked up as dark blue patches in the lighter blue of the ocean all round the Island, and in fact all the way across to the mainland. The Posidonea forms a very dense mat of plants with fibrous roots, which hold much fine silty material round them. In this mat is a wealth of marine worms of various kinds, and herbivorous molluscs such as the Baer, and Plankton feeding Pinna shells in the sandy patches amongst the Posidonea. The decaying vegetation no doubt increases the Planktonic concentration of the water.

ALGAL ZONING RELATED TO LIGHT INTENSITY.

As water deepens, the light intensity naturally falls off and only the end colours of the spectrum reach the deeper water. Near the surface algae are generally bright green, further down are brown and still further, red. From the specimens collected the following colours related to depth were noted. From shallow water to deep they are:-

Bright green
Olive green
Pale browns
Pale brown with mauve or reddish tips
Copper browns
Reds.

FIRST RECORDING OF APJOHNNIA LAETEVIRENS IN W.A.

This green algae was known previously only as for west and south Australia, but its range has now been extended to W.A. by this find. In appearance it is rather like a bunch of branching, bright green pine needles. It was found on the edge of the reef top and the reef face which at this particular area was covered by about 3' of water.

ALGAE OF SECTION 1

<u>NAME</u>	<u>COLOUR</u>	<u>LOCALITY</u>
Gracilana furcellata	Pale yellow green stems, white fronds with pink tips	Growing on Turbo shell in Posidonia Bay
Zonaria sp.	Pale brown	Reef face 5' - 6'
Lamencea sposcliny	Brown with white tips	Growing on Turbo shell in Posidonia Bay
Caulerpa simplisusaila	Green	Reef face 5' - 6'
Caulerpa salpelliformes	Dark green	do
Reterosiphana sp.	White stems, light brown fronds	do
Pterocladia lucida	Reddish brown	do
Cladostephus vertical-atus	Dirty, light brownish green	do
Plocanium procerum	Russet pink	Small reef 50 yds. S.E. of N. Island. 50' reef face.
Laurencia	Pinkish brown	do
Caulerpa Sonderi	Dark green	do
Caulerpa Paspaloidea	Green	do
Pollefenia pedicellata	Dark khaki brown	do
Sporochnus scoparius	Light green	N. reef 20'-15' reef face
Kallymenia Cribosa	Light mauve	do
Sargassum laucerifolium	Light yellow brown	N. reef 20' reef face
Sargassum sp.	Light yellow brown	do
Sargassum spinuligrum	Brown	do
Cladophura valonidoides	Pinkish mauve	do
Chrysomenia Brownie	Russet pink	E. side of N. Island reef face.

ALGAE OF SECTION 2

Caulerpa piforia	Green	Growing of molluse-Megaloctractus in Posidonia Bay.
Cymodocea aufarchea	Green	Growing in sand 10'
Systophara rehoflesea	Light yellow brown	10' rock reef face
Halophila ovali	Lettuce green fronds, white stems	do
Cladostephus verticial-atus	Yellowish (dirty) brown	do
Zostrea muellen	Green	In sand 10'

ALGAE OF SECTION 3

<u>NAME</u>	<u>COLOUR</u>	<u>LOCALITY</u>
Sargassum sp.	Light brown	15'-20' on rock reef face
Caulerpa hypuordes	Dark green fronds, paler stems and rumours	do
Halimeda macroloba	Dark green	do
Caulerpa sonderior obscura	Pale turquoise green	do
Hennedya sp.	Reddish brown	do
Laurencia sp.	Green, with frond tips light mauve	do
Laurencia grevilliara	Fronds pinkish brown which fades to colourless in stems	do
Hypnea episcopales	Pale brown	do
Myclodea sp.	White stems, fronds chocolate brown	do
Cladostephus or pullates	Green, furry fronds at tip	do
Gelinaria sp.	Dark mauve on lower parts merging into mustardish green on upper parts	N.W. Reef 15' reef face
Rhodymenia auspolis	Pinkish brown	do 20' rock on bottom
Rhabdonia robusta		do do
Davya sp.	Reddish brown	do 10' reef face
Caulerpa hypuodes	Green with pinkish tips to fronds	do 3' do

ALGAE OF SECTION 4

Sporrchinus secparius	Pale yellow brown	15'-20' reef face
Lobospira vicuspidata	Light brown	do
Thysanocladia oppositifolia	Reddish brown	do
Laurencia sp.	Mauve	10' do
Sargussum	Olive green	N.E. Island 20' reef face
Codium tomenrosum	Dark green	do

ALGAE OF SECTION 5

<u>NAME</u>	<u>COLOUR</u>	<u>LOCALITY</u>
<i>Apjohnie laetevirens</i>	Bright green	200 yds. S. of S. Island 3'. Corner of reef face and reef top.
<i>Scaberia aghardii</i>	Dark olive green	200 yds S. of S. Island 15' rock on bottom.
<i>Sporochnus scoparius</i>	Yellow brown stems, green fronds	200 yds S. of S. Island 15' rock on bottom
<i>Scytothalia dorycarpa</i>	Dark yellow brown	200 yds S. of S. Island 15' rock on bottom
<i>Hypnea musciformis</i>	Pinkish brown	2-00 yds S. of S. Island 15' rock on bottom
<i>Struvea plumosa</i>	Bright lettuce green	200 yds S. of S. Island 4' reef face
<i>Coelorthrium muellen</i>	Pinkish brown	200 yds S. of S. Island 15' rock on bottom
<i>Dictyota</i> sp.	Green	200 yds S. of S. Island 15' rock on bottom
<i>Metamastophea plana</i>	Pale mauve	200 yds S. of S. Island 15' shady underpart.
<i>Mospora aushalis</i>	Dark pink	200 yds S. of S. Island 15' rock on bottom.

North Island

Marine Algae of Carnac Island

Shag Rock

Sc. I

Sc. 3

North West Reef

North East Island

CARNAC ISLAND

Posidonea Bay

Sc. 2

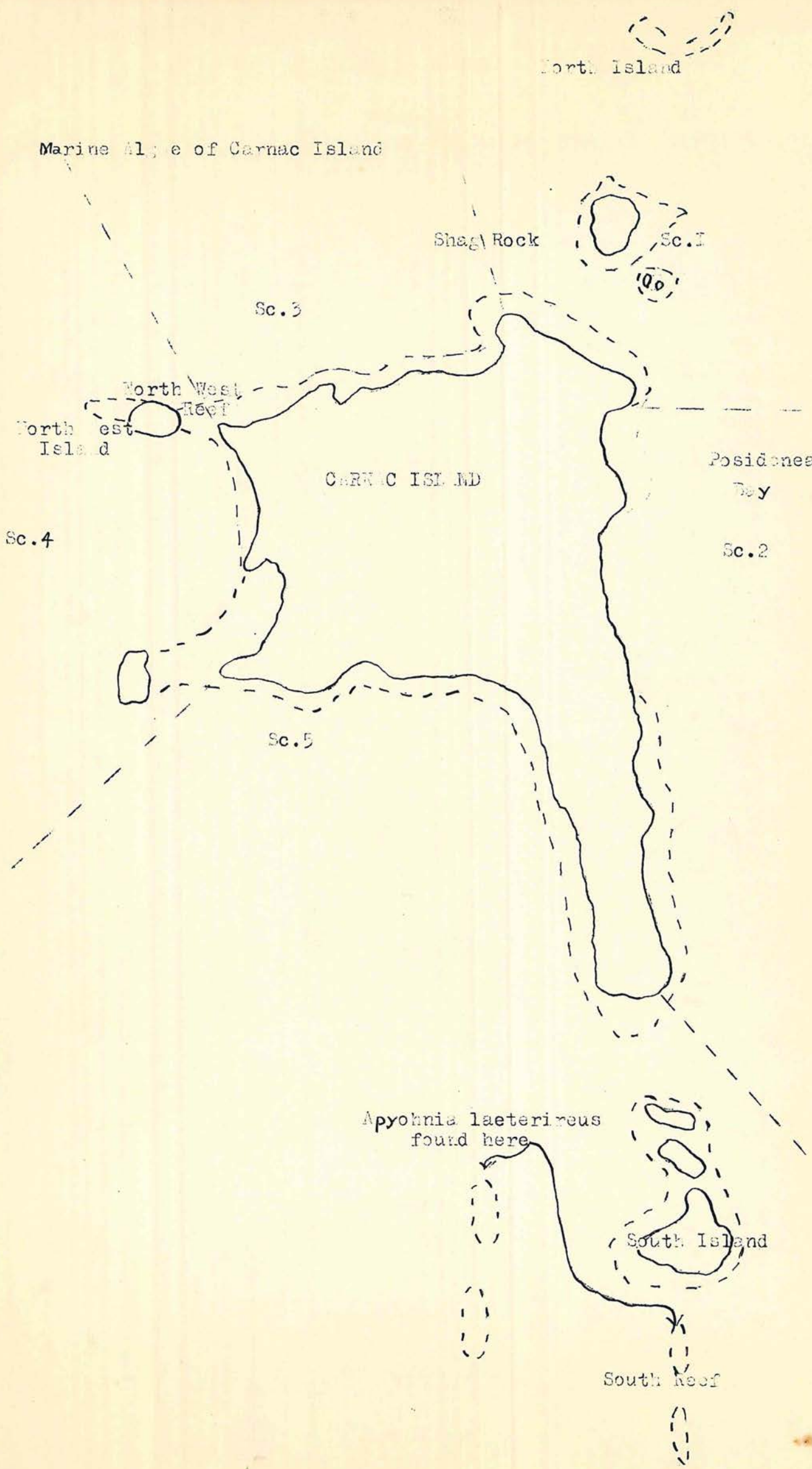
Sc. 4

Sc. 5

Apyohnia laeterimeus
found here

South Island

South Reef



INTERTIDAL ECOLOGY OF THE LIMESTONE REEFS OF
CARNAC ISLAND, WESTERN AUSTRALIA.

By

Loisette M. Marsh and E.P. Hodgkin

INTRODUCTION

A brief visit was made to Carnac Island (28.3.51) during a survey of the intertidal ecology of the limestone reefs of the coast near Fremantle. Within the compass of this small island of $38\frac{1}{2}$ acres there are reefs of varied exposure and width the study of which has helped to elucidate problems of the distribution of the fauna found in other parts of the region. A further visit was made in 1956 (16th-19th January) during which reefs on the north, north-east, south, and west shores of the island were surveyed.

The purpose of the visits was to study the littoral fauna of the rock reefs of a small island with varied exposure and to compare these with the mainland reefs and those of Rottnest and Garden Island.

Weather and tides. During our visit the weather was fine and hot with easterly winds. The tides were of the typical summer pattern, low at about 7 a.m., and ranged from a maximum of 2.6 ft. to a minimum of 1.0 ft. on the Fremantle gauge. A portable recording tide gauge was set up on the reefs studied and their heights relative to Fremantle datum were calculated as described by Hodgkin (1956). Fixed reference points were established on the reefs.

Topography. Carnac island lies south west of Fremantle, three miles north of Garden Island. It is composed of coastal limestone (eolianite) eroded from portion of a line of consolidated sand dunes which ran from Penguin Island in the south, through Point Peron, Garden and Carnac Islands to the Stragglers rocks (Fairbridge, 1948). The shores of the island are somewhat protected by offshore islets and reefs on the southeast, northwest, and north east corners. The degree of exposure to wave action therefore ranges from sheltered on the east coast to moderate exposure on the west and nearly full exposure on the south west corner. The margins of the island are capped by a layer of travertine below which is a cliff of softer rock. At the base of the cliff the rock is again hard and in many places forms the typical features of an overhanging visor, an intertidal undercut, and a reef flat at about mean low water which varies in width from a few yards (north east reef) to about 70 yards (west reef). The eastern shore is sandy with no reefs although there are small patches of rock at the base of the cliff in places. In contrast the eastern shores of the rocky islets north and south of Carnac island have distinct though narrow platforms on their eastern faces. The deepest part of the undercut varies in height from about 1 ft above the reef flat on the north reef to 6-8 ft on the south west island. The outer edge of the reef platforms is in many places deeply undercut and the water is 20-25 ft deep.

FAUNA

The animals and plants of the intertidal reefs show a vertical zonation similar to that observed on rocky coasts in other parts of the world. In addition, however, there is here a horizontal zonation across the width of the reef flat and up to four main zones may be recognised, distinguished by the dominant animals or algae present.

Sketch maps of the reefs were made from the cliff top, the principal measurements being determined on the ground. Levels relative to the fixed points were obtained by horizon levelling and noted on the maps. The principal animal and plant associations were then plotted by observation on the reefs, and traverse line or lines across the reef flat selected for more careful study.

Along each traverse line a number of $1/4$ square yard samples was selected at random in each zone and within each of these all the macroscopic animals were counted and the algal species recorded. The results are here presented in a series of tables. In these the animal populations are shown either as the average number per $1/4$ sq. yd. (figure underlined) followed by the range of variation, (e.g. 2, 0-4), or where the average was less than one per $1/4$ sq. yd. as the total found in all samples examined from the zone. A list of all animal species found alive on the reefs is given in Appendix I.

1. The South Reefs

The southern shore of Carnac Island is mostly rocky and bounded by narrow reefs which extend either from an undercut cliff (at the southern point) or from a deeply pocketed and dissected ramp three to five feet above the reef level on the south west where the traverse was made (1 in fig. 1).

Exposure to wave action is moderate to strong, the reefs being exposed to waves from the south west but protected from the north west.

The reef platforms lie at about 1.5 ft above datum with a narrow raised rim about 0.3 ft higher. A traverse was made across the reef where it faces west-south-west and the fauna is listed in Table I. The distribution of the main associations is shown in fig. 2 and Table II.

The horizontal zonation of the reef flat was not marked, a narrow Jania zone of coralline algae was distinguished in places but the greater part of the platforms were covered with the mutton-fish, Haliotis roei. (Plate 1a). Overlying this species was a mixed algal turf of species of Jania, Pterocladia, Ectocarpus, Laurencia, Hypnea, Dictyota and Cystophora, short and sparse in some places and luxuriant in others. The outer edge of the reef had a dense population of animals on a surface of crumbly lithothamnion, (fig. 2).

The fauna is typical of a moderately exposed shore, except for area 14 where Balanus nigrescens and Patellanax laticostata occur, species which are typical of exposed shores. Palythoa heideri, a tropical zoanthid common on Rottneest Island formed large colonies on area 10 of this reef and Zoanthus praelongus is also present.

The intertidal undercut showed the zonation typical of reefs in the vicinity of Fremantle (Marsh, 1955). The highest zone was occupied by the littorinids Melaraphe unifasciata and Tectarius rugosus, then a zone of limpets, Notoacmea onychitis and a few Patellanax peroni. Siphonaria spp. were not recorded from this reef. Near the base of the undercut was a band of chitons, Clavarizona hirtosa and Poneroplax costata, then Patelloida alticostata and in sheltered places the anemone Actinia tenebrosa. The large Patellanax laticostata, usually found on the reef edge, invades the undercut in places where the platform is very narrow.

2. South West Island

At the south west corner of Carnac Island is an islet attached by a narrow reef platform which surrounds it and is widest on its seaward end (2, fig. 1). No traverses were made across these reefs but the distribution of the commoner animals and plants was plotted, (fig. 3).

Levels were not taken but most of the reef appears to lie at about 1 ft. above datum with raised areas on the narrow northern reef. There is little differentiation into horizontal zones but a marked change is evident in the animal and plant associations from the exposed western to the sheltered eastern reef flats. On the western side the reef fauna is that typical of the outer edge of a fairly exposed reef: Patellanax laticostata few Haliotis roei, Patelloida alticostata, lithothamnion, few Clavarizona and no Isanemona.

Helicoidaris was abundant over a small area of deeply pocketed reef on the north west side. On the north side which is more sheltered P. laticostata was almost absent and Isanemona and Clavarizona were plentiful. Haliotis was the dominant mollusc. On the moderately sheltered north east and south east sides the animal populations were replaced by algae, mainly Pterocladia capillacea, and on the sheltered eastern side there was a mixed algal turf dominated by Jania fastigiata. Pseudobornellia huterina was abundant on this part of the reef.

The intertidal undercut varies in height around the islet, from about 3 feet on the sheltered side its deepest point is not more than 3 ft above the reef flat while on the exposed side it is 6 or more feet. The animal zones are correspondingly raised. In an exposed place the zones were: a band of filamentous green algae replacing the usual littorinids; a mixed limpet zone of Notoacmea, Patellanax peroni, P. laticostata, Clavarizona, Onithochiton, Poneroplax, and a few Balanus nigrescens; and below this Patelloida, Actinia, Haliotis, and lithothamnion. Where there was more shelter from wave action there were no Onithochiton, Poneroplax, Balanus, P. laticostata or P. peroni.

3. West Reef

This is an extensive reef platform extending westwards from a sandy beach, (3, fig. 1). The reef platform is fairly high, about 2 feet above datum and appears to be moderately exposed to wave action. A traverse was made across the reef flat and the fauna is listed in Table III. The distribution of the associations is shown in fig. 4.

TABLE I

South Reef. Traverse across reef flat. For explanation see page 2.

Yards from notch	0-3	4-12	13-17
Feet above datum	1.8 - 1.5	1.5	1.5 - 1.8
Number of samples	4	17	10
Echiuroidea			
<i>Pseudobonellia biuterina</i>	-	-	1
Coelenterata			
<i>Isanemonia australis</i>	-	2, 0-4	8
Small striped anemone	-	7	6, 5
Amphineura			
<i>Clavarizona hirtosa</i>	-	-	2, 0-14
<i>Onithochiton occidentalis</i>	-	-	2, 0-10
Gastropoda			
<i>Haliotis roei</i>	-	10, 4-20	7, 3-14
<i>Prothallotia lehmani</i>	2	1	-
<i>Patelloida alticostata</i>	-	4, 0-13	7, 0-22
<i>Floraconus anemone</i>	-	1	-
<i>Euplica bidentata</i>	3	-	-
<i>Pyrene</i>	1	-	-
<i>Dicathais aegrota</i>	-	6	1, 0-5
<i>Siphonaria baconi</i>	2	1	-
Echinoidea			
<i>Heliocidaris erythrogramma</i>	-	2, 0-12	3, 0-9
Dominant algae	<i>Jania</i> , <i>Hypnea</i> , <i>Cystophora</i>	<i>Lithothamnion</i> , <i>Ectocarpus</i>	<i>Lithothamnion</i> (crumbly), <i>Pterocladia</i> , <i>Rhodophyceae</i> .

TABLE II

South Reef. Distribution of animal and plant associations.

Area	Algae	Animals	Area	Algae	Animals
1	<i>Jania</i> Rhodophyceae	<i>Heliocidaris</i>	9	<i>Lithothamnion</i> <i>Ectocarpus</i>	<i>Isanemonia</i> <i>Haliotis</i> <i>Patelloida</i>
2	Sargassum on broken reef				<i>Heliocidaris</i>
3	-	<i>Haliotis</i> <i>Heliocidaris</i>	10	Rhodophyceae (small)	<i>Palythoa</i>
4	<i>Pterocladia</i>	<i>Isanemonia</i>	11	-	<i>Cnidopus</i>
5	<i>Laurencia</i> <i>Hypnea</i> <i>Pterocladia</i> <i>Dictyota</i>	<i>Haliotis</i>	12	<i>Pterocladia</i> Sargassum	<i>Haliotis</i> <i>Isanemonia</i> <i>Patelloida</i> <i>Zoanthus</i>
6	<i>Lithothamnion</i> (crumbly)	<i>Haliotis</i> <i>Isanemonia</i> <i>Onithochiton</i> <i>Clavarizona</i> <i>Patelloida</i>	13	<i>Lithothamnion</i>	<i>Haliotis</i> <i>Patelloida</i> <i>Isanemonia</i>
7	<i>Pterocladia</i>	-	14	<i>Lithothamnion</i>	<i>Haliotis</i> <i>Patelloida</i> <i>Isanemonia</i> <i>Clavarizona</i>
8	<i>Jania</i> <i>Hypnea</i> <i>Cystophora</i>	-			<i>Onithochiton</i> <i>Balanus</i> <i>Patellanax latirostrata</i>

At the times of our visits there was a partially exposed beach rock ramp populated with patches of mussels (*Brachydontes erosus*) and *Siphonaria baconi*. From the ramp the platform is horizontally zoned as follows (a) *Jania* zone with much sand; (b) shallow pool; (c) a short turf of coralline algae with some *Sargassum*, *Dictyota*, *Colpomenia* and *Hypnea*; (d) an outer zone of lithothamnion with a fairly dense population of browsing molluscs (*Haliotis roei*, *Patelloida alticostata*, *Patellanax laticostata* (few), *Onithochiton occidentalis* and *Clavarizona hirtosa*) with a few *Isanemonia australis* and *Heliocidaris erythrograna*. (Plate 1b). The chitons are confined to the outer half of the zone.

On parts of the reef lower than the general level *Sargassum* and *Pterocladia* predominate. Occurring on the reef flat, between 43 and 60 yards from the ramp, were these additional species, one specimen of each being found in the traverse: *Cryptonax iredalei*, *Cominella* sp., *Mitra* sp., *Bellastrea* sp., *Notoacmea onychitis*, *Austrocochlea rudis*. *Ravitrona caputserpentis* was found here on the 1951 visit.

TABLE III

West Reef. Traverse across reef flat. For explanation see page 1.
At 7 - 14 yd no macroscopic animals, dominant algae *Sargassum*, *Ecklonia*.

Yards from beach	6-6	15-23	24-51	52-58
Feet above datum	2.3	2.1	2.2	1.9-2.4
Number of samples	3		8	17
Echiuroidea				
<i>Pseudobonellia biuterina</i>	-	-	2	5
Coelenterata				
<i>Isanemonia australis</i>	-	-	4	+
Amphineura				
<i>Clavarizona hirtosa</i>	-	-	-	3, 0-16
<i>Onithochiton occidentalis</i>	-	-	-	4, 0-25
Gastropoda				
<i>Haliotis roei</i>	-	-	-	6, 0-21
<i>Gemma auricula</i>	-	-	-	11
<i>Prothallotia pulcherrimus</i>	-	-	4	3, 0-22
<i>Notogibbula preissiana</i>	-	-	-	3
<i>Ninella whitleyi</i>	-	-	1	1, 0-4
<i>Patellanax laticostata</i>	-	-	-	1
<i>Patelloida alticostata</i>	-	-	7	34, 0-95
<i>Floraconus anemone</i>	-	-	2	2
<i>Euplica bidentata</i>	-	-	7, 0-22	7, 0-27
<i>Pyrene</i>	-	-	2	7
<i>Dicathais aegrota</i>	-	-	1	9
<i>Siphonaria baconi</i>	11, 0-20	-	-	-
Pelecypoda				
<i>Brachydontes erosus</i>	800-1000	-	3	2
Echinoidea				
<i>Heliocidaris erythrograna</i>	-	-	11	2
Asteroidea				
<i>Patiriella gunnii</i>	-	-	8	6
Dominant algae	No macroscopic algae	<i>Jania</i> , <i>Sargassum</i> , <i>Rhodophyceae</i>	<i>Rhodophyceae</i>	Lithothamnion, <i>Ulva</i> , <i>Pterocladia</i> , <i>Laurencia</i> , <i>Jania</i> , <i>Sargassum</i>

4. North Reef

The reef flat is about 40 yards wide but is dissected by several deep pools (4, fig. 1). It extends from an intertidal undercut which is low with a wide overhang. The reef is fairly sheltered in aspect.

No traverses were made but the distribution of the animal and plant associations were plotted (fig. 5). The reef is horizontally zoned into: (a) an inner Jania zone of coralline turf with some Sargassum and sand, at about 1.5 ft above datum, Patiriella gunni was abundant in this zone; and (b) red-brown zone of Sargassum with Pterocladia, Hypnea, Laurencia, Ulva, Jania, and patches of Cymodocea, this was deeply pocketed and at a relatively low level (1.0-1.3 ft above datum) Pyura pachydermatina occurred here; (c) at the reef edge a narrow raised rim, at about 1.5 ft, on which a modified Haliotis-lithothamnion association was present (fig. 5).

The intertidal undercut: the deepest part of the undercut was about 1 ft above the reef flat and the animal population was sparse. In the Littorinid zone were few Melaraphe and Tectarius. The limpet zone was dominated by Notoacmea onychitis with Siphonaria luzonica and a few Patellanax peroni. Lower down were Patelloida alticostata with a few Poneroplax and Balanus. The alga Gelidium occurs at the base of the undercut and in places a tube-building Polychaete of the family Sabellariidae was plentiful.

5. North East Reef

On the north east corner of the island are narrow dissected reefs, ten yards wide or less (5, fig. 1). They are sheltered from wave action and provide a contrast to the more exposed reefs of the other shores of the island.

We were not able to examine this reef but a survey was kindly made by J.A.L. Watson. The reef was covered by a coralline turf and sand. The outer edge lacked the dense animal populations of the exposed reefs and was covered with Sargassum and Pterocladia with little lithothamnion. Patelloida was the only animal species living on the rock surface, the others being browsers on the algae, predators, detrital and plankton feeders.

The distribution of the animals is shown in Table IV.

TABLE IV

North East Reef. Traverse across the reef flat. Survey by J.A.L. Watson

Yards from notch	0-1	1-3	3-5	5-7
Polychaeta	-	-	-	-
Fam. Sabellariidae	-	-	-	+
Echiuroidea				
<u>Pseudobonellia biuterina</u>	-	-	-	+
Coelenterata				
<u>Isanemonia australis</u>	-	+	+	-
Small green anemone	-	+	-	-
Small striped anemone	-	-	+	-
Amphineura				
<u>Clavarizona hirtosa</u>	+	-	-	-
Gastropoda				
<u>Patelloida alticostata</u>	+	++	+	+
<u>Floraconus anemone</u>	-	-	-	+
<u>Euplica bidentata</u>	-	-	+	+
<u>Gena auricula</u>	-	-	+	+
<u>Dicathais aegrotata</u>	-	-	-	+
<u>Ninella whitleyi</u>	+	-	+	++
<u>Austrocochlea rudis</u>	+	+	-	-
<u>Siphonaria baconi</u>	+	-	-	-
<u>S. luzonica</u>	+	-	-	-
Pelecypoda				
<u>Brachyodontes erosus</u>	-	+	+	+
Echinoidea				
<u>Helicoidaris erythrogramma</u>	-	-	-	+

DISCUSSION

On this small island with its irregular shape there is considerable difference in exposure to wave action on the various reefs. The distribution of the fauna is related to this factor and to platform width and level. On the moderately exposed South Reef the Haliotis roei association extends from the outer edge almost to the intertidal undercut where the reef is narrow; where it is wider and more exposed Patellanax laticostata and Balanus nigrescens also occur. More exposed conditions were found on the outer face of the South West Island where P. laticostata and B. nigrescens were dominant. Haliotis roei was dominant on the moderately exposed areas and algae dominated the sheltered side. On the moderately exposed West Reef the H. roei association was dominant in a wide zone on the outer parts while on the more sheltered North Reef this association was confined to a very narrow band along the outer edge. The lower parts of both these reefs and the inshore areas were dominated by algae. On the narrow North East Reef algae extended to the reef edge with a few Patelloida alticostata.

These observations confirm those made elsewhere that the pattern of zonation is related to the distance from the reef edge and to the exposure to wave action. The height of the intertidal undercut is also related to the exposure. On the outer face of the South West Island the deepest part is about 6 ft above the reef flat while on its inner face it is not more than 3 ft, and on the North Reef it is even lower, 1-2 ft above the reef flat. The animal zones of the undercut vary correspondingly.

The fauna of the Carnac Island reefs is similar to that found on Garden Island and Ft. Peron in that most of the species have a southern or warm temperate distribution. Tropical species, namely, Zoanthus praelongus, Palythoa heideri and Ravitrona caputserpentis which was uncommon. In the sublittoral several species of corals, not yet identified, formed large colonies.

ACKNOWLEDGEMENTS

The authors wish to express their thanks to the State Fisheries Department of Western Australia for generously providing transport to the island, and to members of the Naturalists' Club for assistance with the field work.

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Dominant algae	Bare rock	Coralline algae	Corallines, Sargassum in pools.	<u>Sargassum</u> , <u>ulva</u> , <u>Pterocladia</u> , <u>Lithothamnion</u>
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(Table IV - continued from previous page)

APPENDIX I

List of species found alive on the intertidal reefs Carnac Island,
January 1956.

Coelenterata

Actiniaria

Actinia tenebrosa Farquhar
Isanemonia australis Carlgren
Smallstriped anemone
Cnidopus verater (Drayton)

Zoanthidea

Zoanthus praelongus Carlgren 1954
Palythoa heideri Carlgren 1954

Amelida

Polychaeta

Fam. Sabellariidae, Gen. et sp. indet.

Echiuroidea

Pseudobonellia biuterina Johnston &
Tiegs

Arthropoda

Cirripedia

Balanus nigrescens Lamarck
Tetraclita purpurascens (Wood)

Echinodermata

Echinoidea

Heliocidaris erythrogramma (Valenciennes)

Asteroidea

Patiriella gunnii (Gray)
Petricia obesa H.L. Clark

Chordata

Tunicata

Pyura pachydermatina Herdman
var. *gibbosa*
Herdman

Mollusca

Amphineura

Clavarizona hirtosa Blainville
Poneroplax costata Blainville
Onithochiton occidentalis Ashby
Cryptoplax sp.

Gastropoda

Haliotis roei (Gray)
Gena auricula (Lamarck)
Patelloida alticostata (Angas)
Notoacmea onychitis (Menke)
Patellanax peroni Blainville
Patellanax laticostata (Blainville)
Prothallotia pulcherrimus (Wood)
Prothallotia lehmani (Menke)
Austrocochlea rudis (Gray)
Notogibbula preissiana (Philippi)
Ninella whitleyi Iredale
Bellastrea Sp.
Melaraphe unifasciata (Gray)
Tectarius rugosus (Menke)
Melanerita melanotragus (Smith)
Euplica bidentata Menke
Pyrene spp.

Dicathais aegrota (Reeve)

Mitra sp.

Cominella sp.

Floraconus anemone (Lamarck)

Ravitrona caputserpentis (Linne)

Siphonaria baconi Reeve

Siphonaria luzonica Reeve

Pelecypoda

Brachyodontes erosus Lamarck























EXPLANATION OF PLATE & FIGURES

Plate I

- a. Haliotis roei, Patelloida alticostata and algae on South Reef.
 b. Haliotis roei, Patelloida alticostata, Isanemonia australis,
Clavarizona hirtosa and Lithothamnion on West Reef.

Figures 1 to 4 Key to symbols used

ANIMALS

	Isanemonia australis		Ulva lactuca
	Onidopus verater		Jania fastigiata
	Palythoa heideri		Hypnea spp.
	Zoanthus praelongus		Pterocladia capillac
	Onithochiton occidentalis		Laurencia spp.
	Clavarizona hirtosa		Lithothamnion
	Patelloida alticostata		Sargassum spp.
	Patellanax laticostata		Cystophora uvifera
	Haliotis roei		Ecklonia radiata
	Brachydontes erosus		
	Balanus nigrescens		
	Patiriella gunnii		
	Heliocidaris erythrogramma		

12

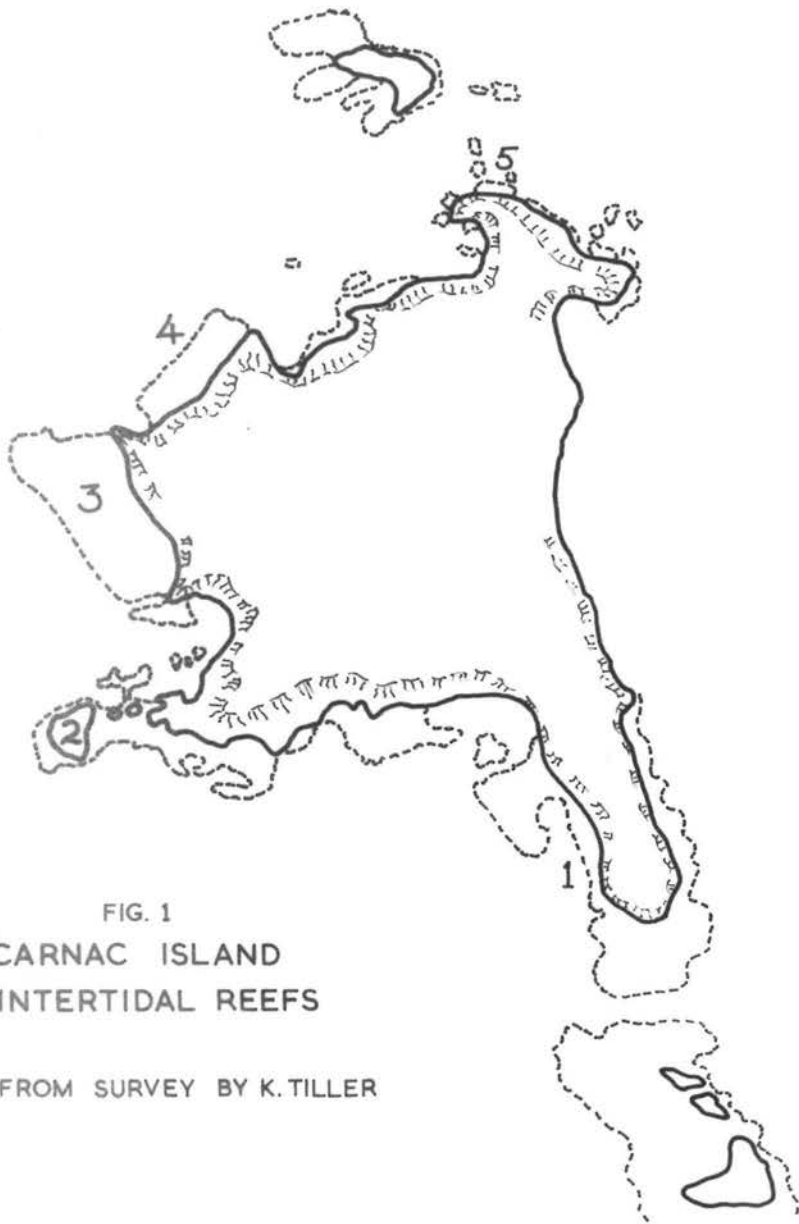


FIG. 1
CARNAC ISLAND
INTERTIDAL REEFS

FROM SURVEY BY K. TILLER

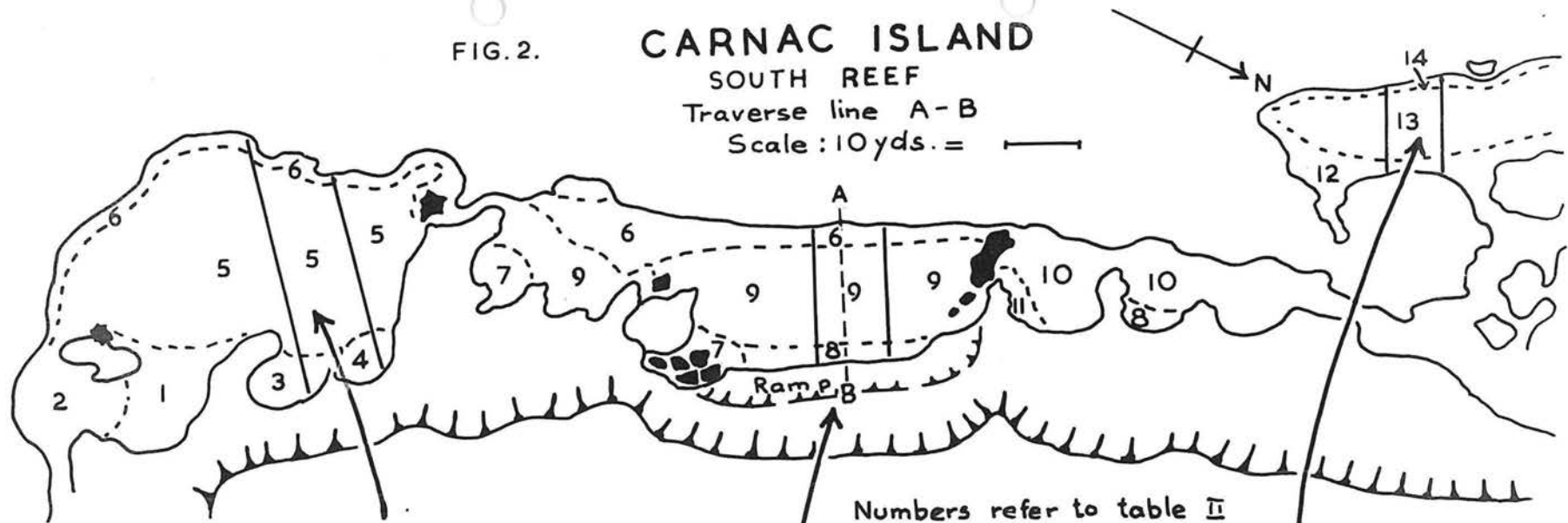
FIG. 2.

CARNAC ISLAND

SOUTH REEF

Traverse line A-B

Scale: 10yds. = 



Numbers refer to table II
in the text.

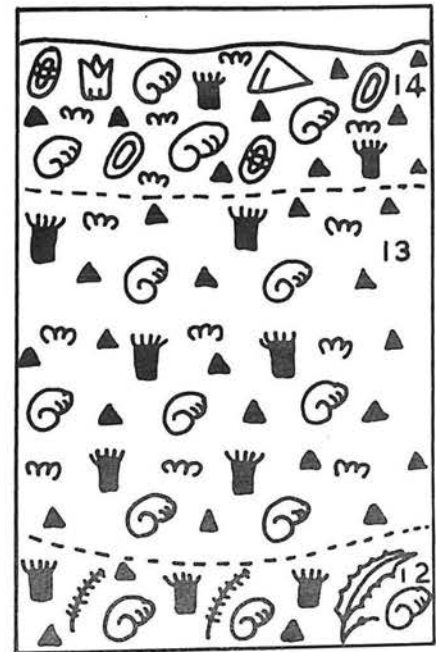
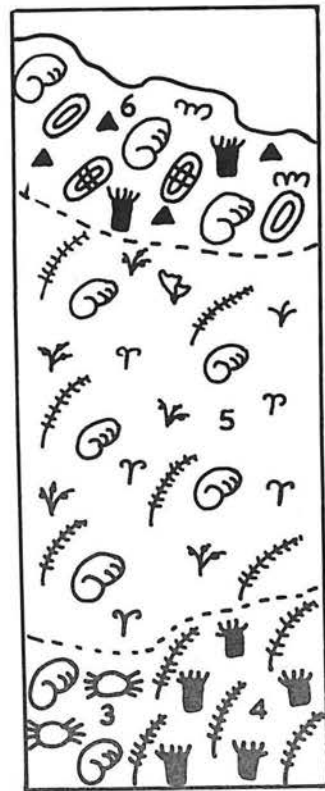
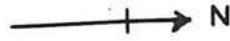


FIG. 3.
CARNAC ISLAND
SOUTH-WEST ISLAND



Scale : 10 yds. =

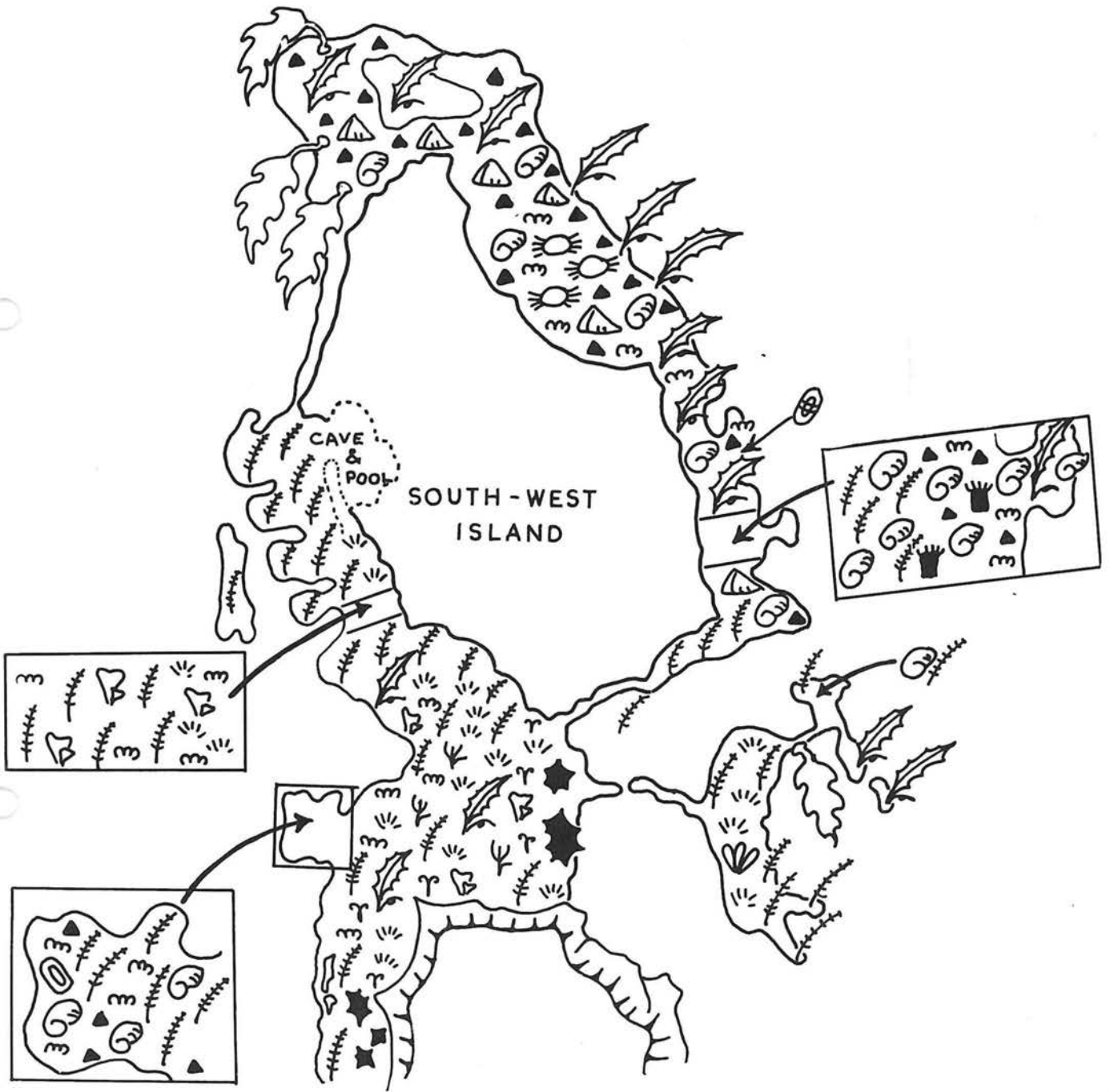


FIG. 4.
CARNAC ISLAND
WEST REEF

Traverse line A-B

Scale : 10 yds. = 

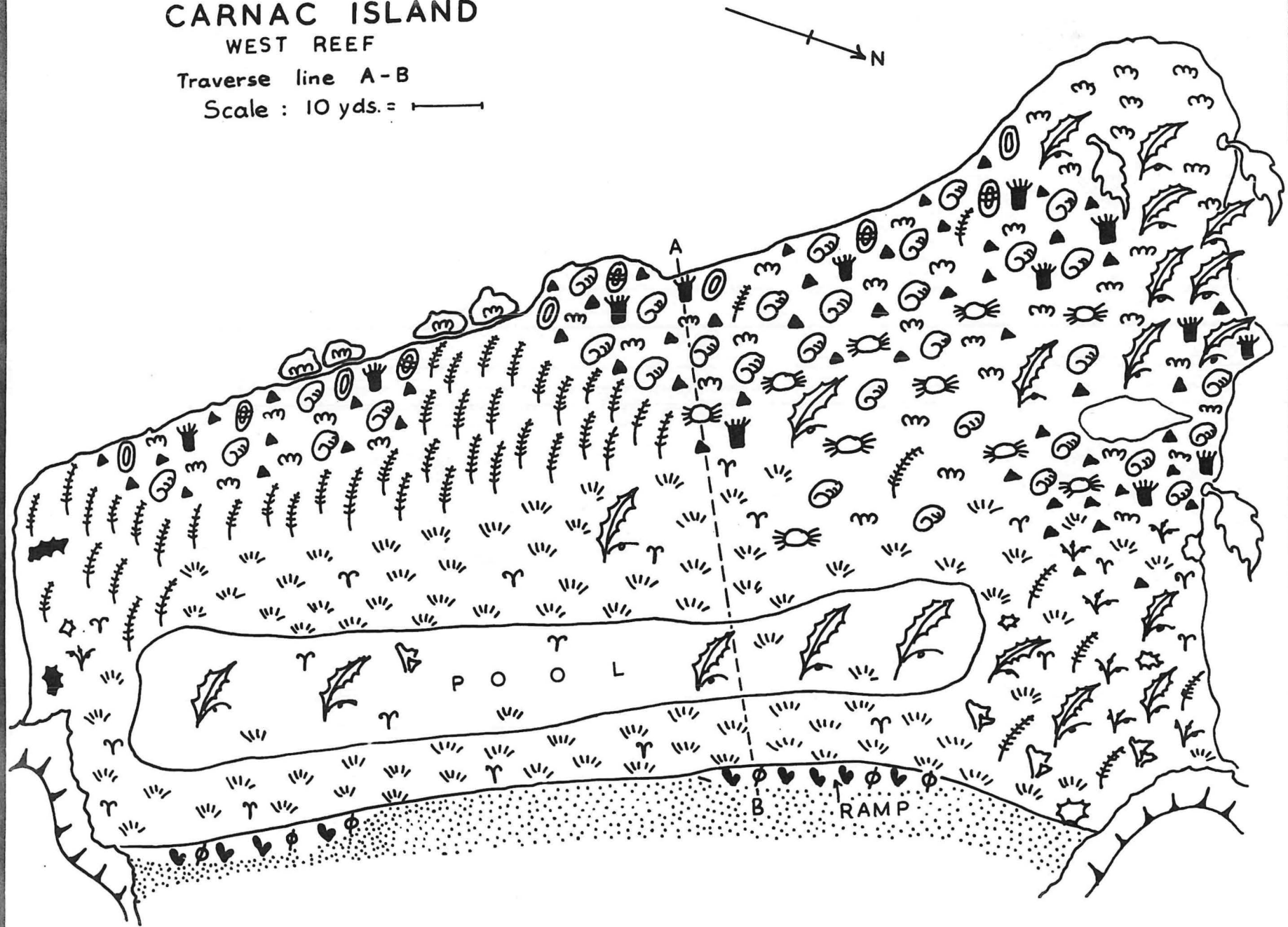

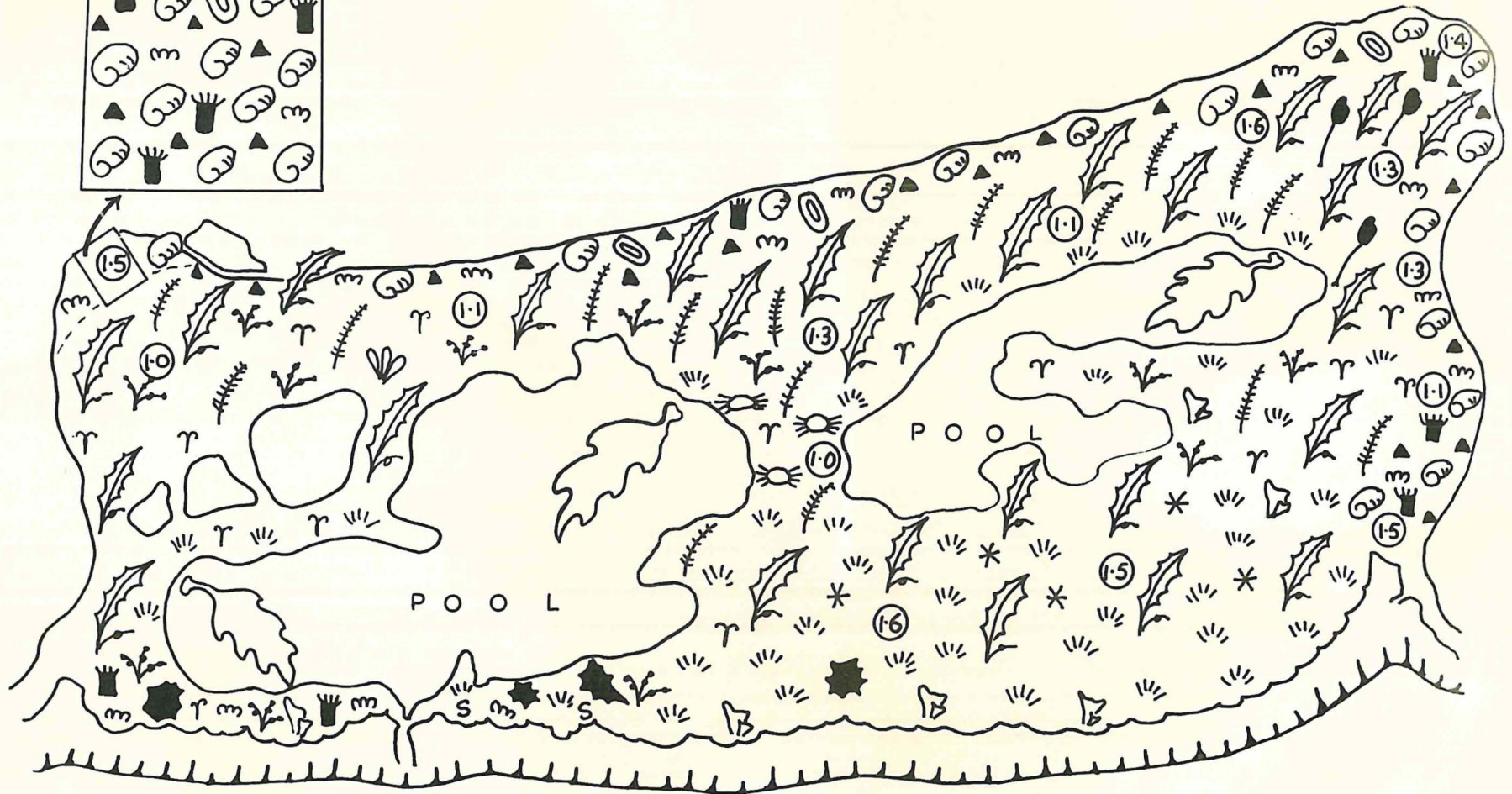
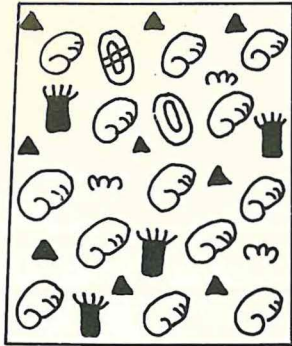
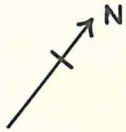


FIG. 5.
CARNAC ISLAND

NORTH REEF

Height above datum thus (1-3)

Scale : 10 yds. = 



THE SUB-LITTORAL MOLLUSCA OF CARNAC ISLAND

Report on collections made during December, 1955.

By D.L.Cook.

In the following list of species, general habitat is given, e.g. sandy bottom, reef etc., as well as any additional useful information. For general distribution, reference should be made to the detailed map of the island, showing topography of the adjacent ocean floor.

This report deals only with living animals, observed in their natural habitats and is by no means complete as was evident from the abundant dead material in the ocean floor and washed up on the surrounding beaches.

GASTROPODA

Sabia conica (Cap Limpet) All the specimens collected were found attached on the external surface of other larger molluscs e.g.

Megalotractus aruanus; Dicathais aegrotata; the Red Whelk, Charonia rubicunda
Megalotractus aruanus (False Trumpet shell). The two specimens found, were associated with the sea grass Posidonia. Both wore a heavy growth of alga on the forsal surface of the shell.

Melo miltonis (Southern Bailer). Two specimens 12" in length and one juvenile 4" in length - all associated with banks of Posidonia.

Charonia rubicunda (Red Whelk). A sub-littoral, reef form, associated with Ecklonia radiata in sand pockets on the reef flat.

Scutus antipodes (Elephant Snail). Littoral to sub-littoral - under detached limestone boulders or in crevices in the reef.

Quibulla botanica (Bubble Shell). All specimens found, were beneath limestone boulders on the reef flat, east side of the island.

Campanile symbolicum (Giant Creeper). In sandy areas away from reefs or in the larger sand pockets of limestone reefs. All specimens very eroded. Dead shells occupied by a species of Pagurid.

Stomatella imbricata. All specimens found, were beneath boulders on the reef flat; east side of the island.

Bellastraea kesteveni. Not common. Found on Posidonia fronds. Dead shells found in water, contained Pagurids.

Bellastraea sp. In rock hollows from mid-tide levels and deeper.

Cacozeliana granarium (Bittium). Common beneath limestone boulders on reef-flats. Dead shells frequently contained Pagurids.

Sophismalepas nigrita (Key-hole Limpet). Common beneath boulders on the reef-flat.

Haliotis elegans. The only specimen, with the animal intact, was one found taken by an Octopus (Octopus vulgaris) in 10 ft. of water on the west side of the island.

Gena auricula. (False Ear Shell). All specimens found were beneath limestone boulders on the reef-flat.

Josepha tasmanica (Whelk). Sub-littoral, under rocks.

Thalotia conica. On Pospidonia leaves.

Clanculus consorbrinus. Beneath limestone boulders on intertidal platform.

Gibbula priessiana. Beneath limestone boulders on intertidal platform.
Glossodoris westraliensis. Numerous specimens found, crawling on weed
 or limestone surfaces.

Aplysia angasi. Crawling amongst Posidonia.

ALPHINEURA:

Heteroyona cariosa and Autochiton virgatus. Common on shell tests
 and living Pinna dolabrata.

Cryptoplax iredalei; Autochiton torri, Notoplax striata westraliensis,
Ischnochiton contractus.

All found beneath limestone boulders on intertidal platform.

Autochiton virgatus. A small species (3-4 mm) found on shell tests and
 living on pinna dolabrata associated with Posidonia.

CERIALOPODA

Octopus vulgaris. Common in littoral and sub-littoral. Burrows or
 permanent nests have only been observed in the sub-littoral.

Sepia sp. One specimen collected in crayfish pot in deep water
 (40 ft) off North side of island.

PELECYPODA

Venerupis exotica (Venus Shell). A number of specimens found beneath
 limestone boulders on reef flat.

Cardita crassicosta. Specimens collected beneath boulders on inter-
 tidal platform.

Barbatia pistachia. Firmly attached in and on limestone boulders on
 reef-flat. Common.

Mytilus planulatus (Mussel). On piles of old tide gauge.

Chama ruderalis. Fused by one valve to base of limestone boulder on
 reef flat.

Ostrea sp. Attached to umbilical wall of living Megalotractus.

Pinna dolabrata. Common in sand, adjacent to Posidonia banks.

THE ECHINODERM FAUNA OF CARNAC

ISLAND

by D.L. Cook and L.M. Marsh

Introduction

The present collection of echinoderms was made in connection with a survey of the fauna of Cockburn Sound and as an addition to the survey of Carnac Island made by the W.A. Naturalist Club during the summer of 1955-56.

A brief visit was made to the island on 29th-30th March 1958 by the same group during which time one of the authors (D.L.C.) was able to collect and observe the echinoderm fauna of the island. The short coastline, about 1.5 miles long, enabled samples to be collected from a number of different habitats on the North, West and East sides of the island using self-contained breathing apparatus to permit thorough observation and collection from otherwise inaccessible habitats such as the sublittoral undercuts.

The physiography of the island and the fauna of the intertidal limestone reefs are described elsewhere in these reports. The information relevant to the species collected is tabulated overleaf. The specimens have been donated to the W.A. Museum.

Discussion and Conclusions.

The majority of the species collected are common in the vicinity of Fremantle and the offshore islands with the exception of Austrofromia polypora of which only seven specimens were previously known (H.L.Clark, 1946). Plectaster decanus is listed by Clark as an uncommon species ranging from Port Jackson to the Bight. The present record extends the range of this species westwards.

Few specimens of Patiriella gunnii were found in March 1958 whereas it was very abundant on the north ~~east~~ reef (area H in fig. I.) in January 1956. Patiriella brevispina in contrast to the previous species occurs in calm water on piles, rocks or Posidonia beds; while not common at Carnac it is very abundant on the Eastern side of Cockburn Sound.

The echinoderms listed are predominantly Flindersian species. Of the fourteen species positively identified ten are Flindersian and six of these extend eastwards into the Peronian province. Of the remainder, two species are endemic to South Western Australia and two have a wider distribution; one of these is almost circum-Australian except for the North East portion and the other is widely distributed in the Southern Hemisphere from Natal through Southern Australia to New Zealand.

No primarily Dampierian species appear in this collection. Four species have not been identified.

Acknowledgments

We wish to acknowledge the valuable help given by the State Fisheries Department in providing transport to the island.

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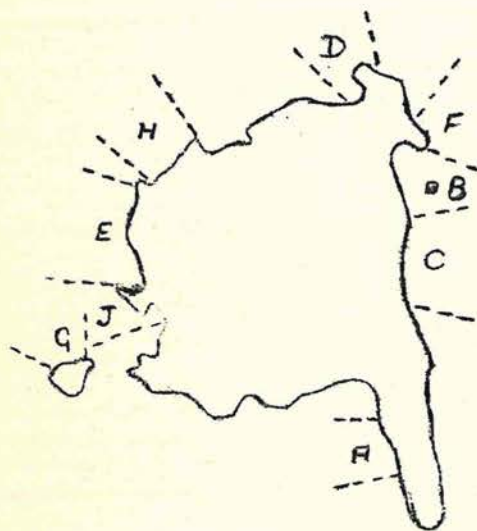
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Key to table:

Area of collection - indicated by letters in table are shown on map.

Key to habitats (indicated by numbers in the table).

1. Flat weed beds. Dominant plants Posidonia australis and Zostera sp.
2. Intertidal reef platform.
3. Sub-littoral undercut. Diffuse lighting; little or no plant life; much animal life.
4. Beneath sub-littoral boulders at 1.5 fathoms.
5. Low limestone outcrop in Posidonia weed bed. Depth 1.5 fathoms.
6. Tide gauge piles.
7. Beneath boulders in pool in intertidal cave. Diffuse lighting; no plant life; little animal life.



Carnac Island - showing areas collected.

Species	Habitat & area	Relative abundance	Further distribution
ASTEROIDEA			
<u>Austrofromia polypora</u> H.L.Clark	6B, 1C	Common at 6B	Flindersian
<u>Coscinasterias calamaria</u> (Gray)	4D, E	3 specimens	Natal, Southern Aust. to N.Z.
<u>Parasterina occidentalis</u> H.L.Clark	3A, F	2 specimens	Endemic near Fremantle
<u>Patiriella gunnii</u> (Gray)	2E, F, H	Not common	+ Flindersian +
<u>Patiriella brevispina</u> H.L.Clark	6B	2 specimens	Flindersian
<u>Patiriella</u> sp.	4D	1 specimen	-
<u>Petricia osea</u> H.L.Clark	3A, D, F	Very common	Abrothhos to Cape Naturaliste
<u>Pentagonaster dubeni</u> Gray	3A, E	Very common	cf. <u>P. vernicina</u> (S.A. & N.S.)
<u>Plectaster decanus</u> (M & T)	3D	1 specimen	+ Flindersian +
cf. W.A.M. 95.32	1C	1 specimen	Flindersian
ECHINOIDEA			
<u>Heliocidaris erythrogramma</u> (Valenciennes)	2A, E, G, F 3D, F, J, 5C	Very common	+ Flindersian +
<u>Phyllacanthus irregularis</u> Mortenson	3E, F	2 specimens	Flindersian
Holothuroidea			
<u>Leptosynapta dolabrifera</u> (Stimpson)	4D	3 specimens	Flind., Peronian, Western
Large brown holothurian	3C, Sand at base of 3J	2 specimens	Dampierian & Lord Howe Is.
CRINOIDEA Comasteridae			
? <u>Genolia trichoptera</u> (J.Müller)	3D, 7F	Common at 7F	+ Flindersian +
OPHIUROIDEA			
<u>Ophiocoma canaliculata</u> Lütken	4D	3 specimens	+ Flindersian +
<u>Ophionereis schayeri</u> (Müller & Troschel)	4D	4 specimens	+ Flindersian +

Footnote: Flindersian = Victoria, S.A. and W.A. not east of Bass Str. or north of Geraldton. + Flind. + = Flindersian with extensions into N.S.W. and north of Geraldton. Peronian = Eastern Vic. to South Qld. Dampierian = Geraldton to Cape York. (After Bennett & Pope 1953).

Addendum.

Peronella lesueurii

1C

collected -
Jan 1956.

East Indian & North Aust.
Cosmopolitan.

Echinocardium cordatum.

1C.

PRELIMINARY LIST OF THE FISH POPULATION FOUND IN
THE WATERS IMMEDIATELY SURROUNDING CARNAC IS.

ERIC J. CAR.

Due to the limited time available for us to work on the fish population, this list is to be regarded only as a basis for future work which it is hoped we will be able to carry out in the near future.

The period during which this survey was taken extended from:- the 29th December, 1954, to 3rd January, 1955 and the 30th March, 1958 to the 2nd April, 1958.

To obtain a complete picture of the area, we first swam round the island. We subsequently selected 3 areas in which a more complete survey was carried out.

The three areas worked on were:-

- (a) the Possidonia bay on the Eastern shore.
- (b) the Northern shore.
- (c) the Northern most bay on the Western shore.

Rather than itemise the fish found in each area, I propose to list all the fish recorded and to indicate by the use of the prefix (a), (b) or (c) the area in which they were found.

For the purpose of this list I have omitted the Cartilaginous fish (sharks, rays, etc.), as none were collected and their identification would be uncertain from specimens seen.

A LIST OF FISH FOUND ON CARNAC ISLAND.

SUB PHYLUM PISCES.

CLASS ACTINOPTERI.

Family: Clupeidae.

Sardinops neopilchardus. (Stein) Pilchard. (a)

Family: Plotosidae.

Cnidoglanis macrocephalus (C&V) Cobbler. (a)

Family: Muraenidae.

Gymnothorax woodwardi (McCull) Woodward's Reef Eel. (bc)

Family: Gadidae.

Lotella callarias (Gnth.) Beardie. (b)

Family: Atherinidae.

Hepsetia pinguis (Lacepede) Hardy Head. (a)

Family: Mugilidae.

Aldichetta forsteri (C&V) Yellow Eyed Mullet. (a)

Family: Epinephelidae.

Acanthistius serratus (C&V) Wirrah. (c)
Epinephelus homosinensis. Whitley. (c)

Family: Hypoplectrodidae.

Epinephelides armatus (Cast.) Tiger Cod. (b)
Othos dent (C&V) Harlequin Fish. (b)

Family: Therapontidae.

Therapon humeralis (Ogilby) Trumpeter. (a)
Helotes sexlineatus (Q&G)

Family: Plesiopidae.

Paraplesiops meleagris (Peter) Blue Devil. (b)

Family: Apogonidae.

Ostorhinchus ruppellii (Gunther) Gobble Guts. (a)
Lovamia fasciata. Stripped Gobble Guts. (c)

Family: Sillaginidae.

Sillaginodes punctatus (C&V) King Geo. Whiting. (a)

Family: Carangidae.

Caranx georgianus (G&V) Trevally. (b)

Family: Glaucosomidae.

Glaucosoma hebraicum. Richardson. Jew Fish. (c)

Family: Arripidae.

Arripis georgianus (C&V) Ruff. (abc)

Family: Pomatomidae.

Pomatomus saltator (Linn). Tailor. (b)

Family: Gerridae.

Gerres ovatus (Gnth) Silver Belly. (c)

Family: Mullidae.

Upenichthys porosus (C&V) Goat Fish. (a)
Upenus tragulus (Rich) " " (b)

Family: Sparidae.

Rhabdosargus sarba (Forse), Silver Bream. (b)

Family: Pempheridae.

Pempheris klunzingeri. McCull. Bulls Eye. (bc)

Family: Scorpidae.

Scorpius georgianus (C&V) Banded Sweep. (bc)
Scorpius aequipinnis Rich. Sea Sweep.

Family Girellidae.

Tephraeops tephraeops. (Rich) (bc)
Melambaphes zebra. (Rich) Zebra Fish. (bc)

Family: Chaetodontidae.

Chelmonops truncatus (Kner) (bc)
Microcanthus stribatus (C&V) Footballer. (abc)
Vinculum sexifasciatum (Rich) Moonlighter. (bc)

Family: Chironemidae.

Threpterus maculosus Rich Silver Spot Fish. (b).

Family: Cheilodactylidae.

Cheilodactylus spectabilis (Hutton) Brown Banded Morwong. (bc)
Goniistius gibbosus (Rich) Magpie Morwong. (b)
Dactyopagrus nigricans. (Rich) Dusky Morwong. (a)

Family: Pomacentridae.

Parma McCullochi (Whit) Puller. (bc)

Family Coridae.

Coris Auricularis (C&V) (a)
Pseudolabrus terticus (Rich) (b)
Pseudolabrus parilius (Rich) (bc)
Pseudolabrus punctulatus (Gnth) (bc)
Ophthalmolepis lineolatus (C&V) (bc)

Family Bociandiae.

Achoerodus gouldii (Rich) Blue Groper. (b)

Family: Parapercidae.

Paraperca haackei (Stein) Grub Fish. (ab)

Family Blenniidae.

Blennius tasmanien sis. (Rich.) Blenny. (bc)
Graviceps alexanderi. whit. Snake Blenny. (a)

Family: Brotulidae.

Diplus caecus waite. (b)

Family Gobridae.

Callogobius mucosus (Guth) (a)

Family. Platycephalidae.

Platicephalus bassensis (C&V) Flathead. (a)

Family: Ostraciontidae.

Anoplocapros lenticularis (Rich) Box Fish. (a)
Aracana aurita (Shaw) Horned Box Fish. (ab)

Family: Tetraodontidae.

Speroides pleurogramma (Regan) Blowie. (abc)
Contusus richei. (Fremin ville) Horseshoe Blowie. (b)

Family: Diodontidae.

Atopomycterus nictemerus. (C&V) Porcupine Fish. (a)

Plates 1-8.

Plate 1. Eastern shore of the island.

- (a) Looking North. Shearwater nesting sites under travertine cap on headland.
- (b) Looking South. Seal found resting at base of cliff at this point.
- (c) General view of the Eastern shore looking North. Tide gauge, right centre.

Plate 2. (a) Tumbled block on Northern Edge; typical erosive feature.

- (b) Travertine cap at the top of cliffs on Northern side. Solution pipes present.

Plate 3. Vegetation.

- (a) Central portion, annual grasses. Orabanche observed in this region.
- (b) View of West coast, typical sand dune vegetation present: Scirpus nodosus, Salsola kali, Olearia axillaris.
- (c) View of cliff edge, Carpobrotus sp., Scaevola crassifolia.

Plate 4. (a) South East corner of island looking towards south island. Garden Island in right background.

- (b) View West-East across island, mainland in distance.
- (c) Shag rock off the North East corner of Carnac. Little Carnac in foreground.

Plate 5. (a) Silvereye, photographed at soak.

- (b) Nest collected from top of dead acacia. See text.

Plate 6. (a) Shearwater under travertine cap. North East corner.

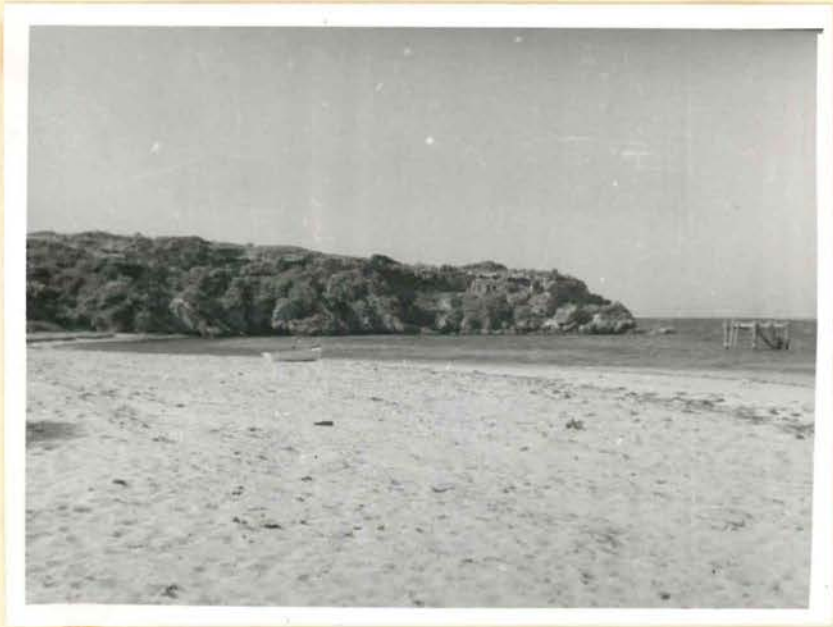
- (b) White capped hair seal (Neophoca cinerea) sleeping on Posidonia layer on beach.
- (c) North Reef, looking east. (See fig. 5, Report on Intertidal Ecology.)

Plate 7. (a) Western shore, looking south. West Reef on right. (See fig. 4, Report on Intertidal Ecology.)

- (b) Southern shore, looking East.
- (c) Southern Shore, looking West. Part of South Reef at left. (See fig. 2, Report on Intertidal Ecology.)

Plate 8. (a) South Reef. Pocketed surface with Haliotis roei and Patelloida alticostata. Sargassum sp. lower left. Coralline turf between pockets.

- (b) West Reef. Haliotis roei, Patelloida alticostata, Clavariopsis hirtosa and Isanemonia australis (lower centre). Lithothamnion on ridges between pockets. (See Report on Intertidal Ecology.)



No 1
a



b



c



No 2

a



b



a No 3



b



c



a No. 4



b



c



No 5

a



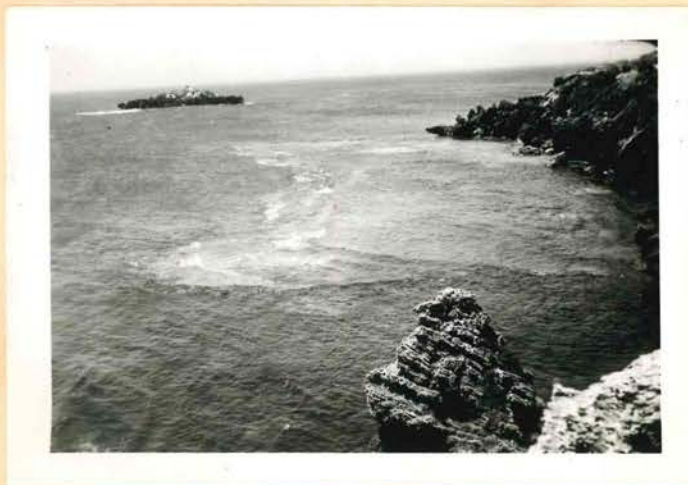
b



a No. 6



b



c



No 7
a



b



c



No 8
a



b