11. LAND (INCLUDING SHORE) BIRDS OF ASTOVE

C. W. Benson

Introduction

Much detail concerning the birds of Astove, especially on the systematics of Cisticola cherina and Nectarinia sovimanga, has already been given in the paper on land birds of Cosmoledo (Benson 1970), and need not be repeated. The same acknowledgements and other introductory remarks also apply. Excepting a brief reference by Abbott to a rail (see below), the first mention of birds traced is by Dupont (1907), who drew up a list of species as a whole. Fryer (1911, 428) makes a brief reference, remarking that birds seemed scarce. Vesey-FitzGerald (1940, 486-488) includes Astove in his account of land birds of the Aldabra archipelago, as does Hartman (1958), who spent 9 December 1957 there. H. M. S. Owen called at Astove on 16 March 1964, and a few observations are given by Bourne (1966). I. S. C. Parker collected specimens for the National Museum of Kenya on 7 October 1967, the day after his visit to Menai Island, Cosmoledo. I have had the loan of his specimens, as for Menai. A. W. Diamond, P. Grubb and I were on the western arm of Astove from about 1100 hours until after sunset on 5 March 1968. Their observations, and a few from J. Frazier, have considerably augmented my own. Some further observations were made by M. E. D. Poore and D. R. Stoddart on both the east and west sides of Astove on 15 September 1968.

Resident true land birds

Dryolimnas cuvieri — White-throated Rail

As for Cosmoledo, recorded at second-hand by Abbott (in Ridgway 1895, 529), and listed by Dupont (1907). Fryer (1911, 428, under D. abbotti?) also records it. There is no subsequent record. Due to human activity, it is unlikely that it could still exist there.

Streptopelia picturata — Malagasy Turtledove

This species is listed by Dupont (1907), but no other reference to its occurrence has been traced. As on Cosmoledo (with the possible exception of South Island), it has evidently been extirpated, assuming that it really did formerly occur.

Cisticola cherina — Malagasy Grass-Warbler

Vesey-FitzGerald (1940, 488) found it "abundant", Hartman (1958) "common". Diamond and I also found it common, more so even than the sunbird. Diamond and Stoddart noted the same call as on Cosmoledo.

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As already recorded in the Cosmoledo account, a female collected contained a much enlarged egg. Also, as discussed therein, C. cherina appears to be of recent origin on both Cosmoledo and Astove, and except for some tendency to smaller size on Wizard, is still undifferentiated from the Malagasy parent stock.

Corvus albus — Pied Crow

Listed by Dupont (1907, as C. scapulatus), though Vesey-FitzGerald (1940, 488) thought it was only a visitor. Hartman (1958) saw one pair. I saw one couple and one single bird. As on Cosmoledo, the population is evidently extremely small.

Zosterops maderaspatana — Malagasy White-eye

Vesey-FitzGerald (1940, 488) records it as common, though Hartman (1958) did not see it. Diamond saw 15 in all, and I saw a few others. It would appear to be less common than both the grass-warbler and the sunbird. Diamond noted that the call was the same as on Aldabra, though stronger. This is perhaps to be expected, since Astove birds are larger (Benson 1969). A male collected on 5 March 1968 had testes measuring 6 x 4, 7 x 5 mm, a female the same day had a yolking egg of diameter 6 mm. In order of predominance (numbers of individual specimens in each group), the stomach contents of these specimens were:

Lepidoptera: larvae
Hemiptera: Homoptera
Coleoptera: Curculionidae
Arachnida: small spiders
Psocoptera
Hymenoptera: winged ants

In one specimen there were in addition the apparent remains of a seed and some petals.

Astove birds are considered by Benson (1969) inseparable from those of Z. m. maderaspatana from the moister parts of Malagasy, and lack the yellow tone above of Gloriosa birds. The latter can be matched with material of Z. m. maderaspatana from the drier parts of Malagasy, in the southwest and the extreme north. Aldabra (though not Cosmoledo) birds also tend to be yellowish above.

Nectarinia sovimanga — Souimanga Sunbird

This species is listed by Dupont (1907, as Cinnyris abbotti), while Fryer (1911, 428) noted a Cinnyris. It is also recorded by Vesey-FitzGerald (1940, 488) and by Hartman (1958, as Cinnyris comorensis), the latter giving it as "common". Bourne (1966) records "Anjouan Sunbirds" (sic) as "common". We also found it to be common. As already explained in the Cosmoledo account, the population of Astove is inseparable from N. s. buchenorum. The misconception that it might be referable to N. comorensis, of Anjouan, in the Comoros, arose from the male and female collected by Vesey-FitzGerald (1940) and identified in the British Museum as "near Cinnyris comorensis Peters". These specimens cannot now be found, but are virtually certainly N. s. buchenorum. As explained by

Benson (1967, 86), N. comorensis is a distinct species, albeit derived from sovimanga. No reasonable doubt whatever can now remain but that comorensis is endemic to Anjouan.

Vesey-FitzGerald describes a nest, apparently unoccupied, placed 1.3 m above the ground in a bush of Pemphis acidula. I found a similar old nest in a bush of Suriana maritima. It was collected, and is in the British Museum (Natural History). S. A. Renvoize has pointed out that both these plants are spray-zone species. On Aldabra there are some casualties among sunbirds' nests due to spray. There was certainly some breeding on Astove at the time of our visit, since a female collected contained a yolking egg measuring 7 x 8 mm, while three males had enlarged testes, in one case both measuring 7 x 5 mm. A female collected by Parker also had enlarged gonads. One of two females collected by myself, with wing 49, tail 33, culmen from base 16.5 mm, cannot be fully grown (see measurements in the Cosmoledo account, Benson 1970), and is probably only about six weeks old (from date of hatching). It may thus be presumed to have been from an egg laid in January. The stomach-contents of two males and two females collected by Parker were insect fragments, including Coleoptera. In order of predominance (numbers of individual specimens in each group), those of three males and four females collected by myself were:

Arachnida: small spiders
Hemiptera: Homoptera
Psocoptera
Hymenoptera: ants
Hymenoptera: Parasitica

Diamond heard the same cat-like "miaaw" call as can be heard on Aldabra. Frazier thought that, although the birds were tame, they were less so than on Aldabra. On Astove, in general, they would be more liable to human disturbance.

Possibly resident shore birds

Ardea cinerea — Grey Heron

Listed by Dupont (1907). We saw at least two in the lagoon in March 1968. Adults and young were seen in June 1969 by Diamond and Frazier, so this bird is probably resident.

Egretta garzetta — Little Egret

At least two white and three dark phase birds were seen. Diamond recorded a disused nest in a Bruguiera bush on an island in the entrance to the lagoon. As for Cosmoledo, there is no evidence of the "large flocks" recorded by Dawson (1966, 7).

According to Loustau-Lalanne (1963, 22), "Demiegretta sacra =(asha)" ... "occurs and breeds only on Astove island". On page 13 he also mentions Egretta garzetta as occurring on Astove, stating that it is snow-white. No mention of any colour phase is made, though he states

(page 14) that D. asha is "a dimorphic bird, white or grey in colour". Dawson (1966, 7) goes still further, and apparently considers that there are no fewer than three species of egret on Astove, i.e. E. dimorpha, E. garzetta and D. asha. According to Watson et al. (1963, 101, 106), D. sacra occurs no nearer to Astove than the Cocos-Keeling Islands, and D. asha the Laccadives (merely one record). The latter is placed by Grant and Mackworth-Praed (1933, 194) as a synonym of D. schistacea. This name is a possible source of still further complication. Forbes-Watson (1966) states that he has seen Reef Herons E. schistacea breeding alongside Little Egrets E. garzetta at Tananarive, Malagasy, and gives sight records from the African coast to as far south as Pemba Island. However, White (1965, 25) may be correct in regarding schistacea as a yellow-billed subspecies of E. garzetta, and its breeding range may not extend south of the equator, accordingly excluding any likelihood of it breeding in Malagasy. E. g. schistacea is not mentioned in the comprehensive account of a heronry at Tananarive by Malzy (1967).

Apart from the three species of Ardeidae treated under the headings above and below, there is at present no satisfactory evidence of the occurrence of any species anywhere in the Aldabra archipelago in addition to Egretta garzetta, the subspecies according to Benson (1967, 68) being E. g. dimorpha. Two specimens of this subspecies were recently collected on Cosmoledo. Contrary to Loustau-Lalanne, there are two colour phases. Benson (1967, 96) suggests that E. alba, which breeds in the Comoros, might occasionally occur. But there is still no evidence of this.

Bubulcus ibis — Cattle-Egret

Bourne (1966) records six around the settlement, and six were seen in the settlement itself by Stoddart and Poore in September 1968. Diamond, Frazier and I each saw one bird in March 1968. Frazier's bird was in a coconut tree.

Butorides striatus — Little Green Heron

Listed by Dupont (1907, as B. atricapillus). Diamond saw two in the lagoon, and one in a plantation. On Aldabra, too, this species is not strictly confined to coasts. On Astove as well as on Cosmoledo the subspecies is most likely B. s. crawfordi.

Migrants

Dupont (1907) lists the same eight species from Astove as for Cosmoledo. The only further records are the following, from Diamond, Grubb or myself, from the shore of the lagoon unless otherwise stated (those asterisked are not listed by Dupont): *Squatarola squatarola, three; Charadrius leschenaultii, at least three; Numenius phaeopus, about ten; Arenaria interpres, about 100; *Crocethia alba, two; *Erolia testacea, about 100; Dromas ardeola, at least 30. In addition, Grubb saw what is thought to have been a Charadrius mongolus (Penny, in press).

No true land bird migrants have as yet been recorded from Astove, but as for Cosmoledo there must be occasional occurrences.

Summary

1. An account is given of the land (including shore) birds of Astove.

2. The true land birds are very similar to those of Cosmoledo (Benson 1970), and there is the same paucity of species in comparison to Aldabra. The rail Dryolimnas cuvieri and turtledove Streptopelia picturata, which at one time are said to have occurred, are probably extinct. The warbler Cisticola cherina and sunbird Nectarinia sovimanga, similar to those of Cosmoledo, are plentiful. The white-eye Zosterops maderaspatana, specimens of which are the same as those from the more humid parts of Malagasy, is not so plentiful.

3. Unlike Cosmoledo, there is no evidence that any species has been introduced by man.

4. There are four possibly resident herons or egrets (family Ardeidae), though the status of the Cattle Egret Bubulcus ibis in particular requires further investigation. It has been claimed that the three species Egretta dimorpha, E. garzetta and Demiegretta asha all occur. But probably there is only the one, E. garzetta (subspecies dimorpha), present in a white phase and a dark phase.

5. Of migrants, twelve species of shore birds which breed in the Palaearctic Region have been recorded; also the Crab-Plover Dromas ardeola. No land bird migrants have as yet been recorded.

References

Benson, C. W. 1967. The birds of Aldabra and their status. Atoll Res. Bull. 118: 63-111.

---------- 1969. The white-eye Zosterops maderaspatana (Linn.) of Menai Island, Cosmoledo Atoll. Bull. Brit. Ornithol. Club, 89: 24-27.

---------- 1970. Land (including shore) birds of Cosmoledo. Atoll. Res. Bull. : this issue.

Bourne, W. R. P. 1966. Observations on islands in the Indian Ocean. Sea Swallow, 18: 40-43.

Dawson, P. 1966. A survey of the sea birds of the Seychelles Islands. Ool. Rec. 40: 1-11.

Dupont, R. 1907. Report on a visit of investigation to St Pierre, Astove, Cosmoledo, Assumption and the Aldabra Group. Mahé: Seychelles Government, 1-51.

Forbes-Watson, A. D. 1966. A further note on Reef Herons in East Africa. J. East Afr. Nat. Hist. Soc. 112: 233.

Fryer, J. C. F. 1911. The structure and formation of Aldabra and neighbouring islands--with notes on their flora and fauna. Trans. Linn. Soc. London, ser. 2, Zool., 14: 397-442.

Grant, C. H. B. and Mackworth-Praed, C. W. 1933. On the relationship, status and range of Egretta garzetta, Demigretta gularis, D. schistacea, D. asha and D. dimorpha, a new subspecies, and the correct type-locality of Egretta garzetta. Bull. Brit. Ornithol. Club, 53: 189-196.

Hartman, W. D. 1958. Report on some land birds of Farquhar, St Pierre, Astove, Cosmoledo, Assumption and Aldabra. Seychelles Govt. Bull. 21.

Loustau-Lalanne, P. 1963. Sea and shore birds of the Seychelles. Seychelles Soc. Occas. Pub. 2: 1-26.

Malzy, P. 1967. La héronnière d'Alarobia (Tananarive). Oiseau et Rev. française Ornithol. 37(1-2): 122-142.

Penny, M. J. In press. Migrant waders at Aldabra, September 1967-March 1968. Phil. Trans. Roy. Soc. B.

Ridgway, R. 1895. On birds collected by Doctor W. L. Abbott in the Seychelles, Amirantes, Gloriosa, Assumption, Aldabra, and adjacent islands, with notes on habits, etc., by the collector. Proc. U.S. Nat. Mus. 18: 509-546 (actual date of publication June 24, 1896).

Watson, G. E., Zusi, R. L., and Storer, R. E. 1963. Preliminary field guide to the birds of the Indian Ocean. Washington.

White, C. M. N. 1965. A revised check list of African non-passerine birds. Lusaka.

12. ECOLOGICAL CHANGE AND EFFECTS OF PHOSPHATE MINING ON ASSUMPTION ISLAND

D. R. Stoddart, C. W. Benson, and J. F. Peake

Introduction

Because of their rugged terrain and lack of surface water, elevated reef-limestone islands are often unsuitable for human settlement. As a result of greater environmental diversity and possible greater age than the sand cays of sea-level coral atolls, such islands frequently possess larger and more diverse faunas and floras. Yet because many possess large resources of phosphate derived from bird guano, they have often been subjected to a degree of human interference uncommon on isolated islands before the development of airfields and similar installations. Examples of elevated reef islands where such major modification has taken place include Makatea in the east Pacific, Nauru, Niue and Ocean in the central Pacific, and Christmas in the eastern Indian Ocean.

The results of massive mining disturbance on island ecology are of interest, since they may provide a guide to the results of other kinds of major habitat disturbance, including the construction of airfields and military bases. Such construction work involves the clearing of native vegetation and destruction of habitats, and also the preparation of new habitats for colonisation by introduced plants and animals. We know little of the long-term resilience of indigenous biotas on islands, including those subject to such major interference, except that changes involving extinction are irreversible (Stoddart 1968a, 1968b, MacArthur and Wilson 1967, Mayr 1965).

Assumption Island, 27 km southeast of Aldabra, provides an example of the ecological effects of surface phosphate mining over the last sixty years (Baker 1963). With a fauna and flora similar to those of Aldabra, though smaller, before mining began, it provides data on the capacity of plants and animals to survive vegetation clearance and human settlement, and on the invasions and colonisations which have taken place since settlement began. Assumption was visited by a party from the Royal Society Expedition to Aldabra on 15-16 September 1967, and this paper records the observations made and compares them with previous accounts, mostly from pre-mining times. Familiarity with the fauna and flora of Aldabra meant that maximum advantage could be taken of this short visit.

Apart from hydrographic surveys in 1823 and 1878, Assumption was first visited by W. L. Abbott, who collected birds, plants and insects

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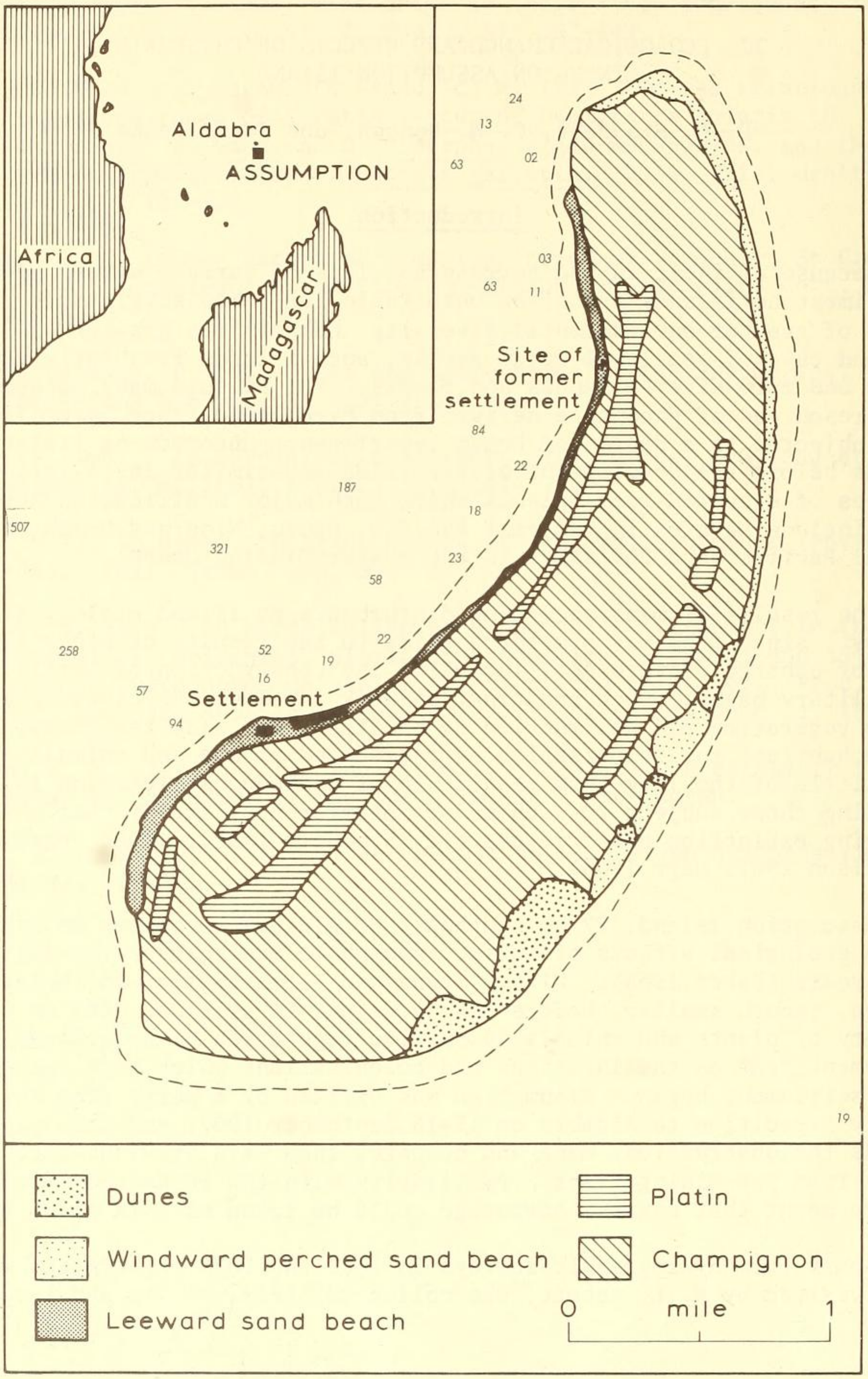


Fig. 6. Assumption

in September 1892. The ornithologist M. J. Nicoll spent 12-13 March there, and was followed by R. Dupont (birds, insects, plants), 19-21 September 1906, and by J. C. F. Fryer (geology, general observations, insects), 6-13 September 1908. The island was uninhabited until June 1908, when a guano-mining settlement was established on the northwest coast: the observations of these earlier workers thus recorded the pre-mining state of the island biota. Table 12 lists these and later

Table 12. Scientific Studies at Assumption Island

Date	Study	Reference
1756 Aug. 15	Nicholas de Morphey, general	Horsburgh (1809)
1823	Richard Owen, hydrographic survey	Adm.Ch.718(1878)
1878	W. J. L. Wharton, hydrographic survey	Adm.Ch.718(1879)
1892 Sept.	W. L. Abbott, birds	Abbott (1893), Ridgway (1895)
1901 Oct. 13	H. A'C. Bergne, general	Bergne (1901)
1906 March 12-13	M. J. Nicoll, birds	Nicoll (1906, 1908)
1906 Sept. 19-21	R. Dupont, birds, insects, plants	Dupont (1907)
1908 Sept. 6-13	J. C. F. Fryer, geology, insects	Fryer (1911)
1910	R. Dupont, insects, plants	
1916	R. Dupont, plants	Hemsley (1919)
1937	L. D. E. F. Vesey-FitzGerald vegetation, birds	Vesey-FitzGerald (1941, 1942)
1956	H. Legrand, Lepidoptera	Legrand (1965)
1956	W. Travis, underwater observations	Travis (1959)
1959	H. Legrand, M. Gerber, Lepidoptera	Legrand (1965)
1960 Oct. 13-16	B. H. Baker (geology) and C. J. Piggott (soils)	Baker (1963), Piggott (1961, 1968)
1964	H.M.S. Owen, Cdr D. W. Haslam: survey, birds	Bourne (1966)
1964	R. E. Honegger, birds, reptiles	Honegger (1966)
1964 Nov. 10	Bristol Seychelles Expedition: M. J. Penny, M. Penny, R. Gaymer and others, birds	This report
1965 Oct. 3	R. Gaymer, birds	This report
1967 March	J. F. G. Lionnet, H. A. Beamish, insects; H. A. Hirth, turtles	
1967 Sept. 15-16	Royal Society party: D. R. Stoddart (geomorphology, plants), C. W. Benson (birds), J. F. Peake (land invertebrates), J. H. Price (marine algae), J. M. Boyd, E. N. Wright (birds)	This report
1967 Oct. 8	M. D. Gwynne, D. Wood, I. S. C. Parker, plants and birds	Fosberg and Renvoize (1970), Parker (1970)
1968 July 31	Royal Society party: J. Frazier R. Hughes, J. Gamble, R. Lowery	

scientific investigations. The Royal Society party in September 1967 consisted of D. R. Stoddart (geomorphology, plants), C. W. Benson (birds), J. F. Peake (land invertebrates), J. H. Price (marine algae), J. Morton Boyd, and E. N. Wright (birds). A further Royal Society party, comprising R. Lowery, J. Gamble, J. Frazier and R. Hughes, made a brief visit on 31 July 1968.

Topography

Assumption (Figure 6) is a raised reef-limestone island, probably similar in origin to Aldabra but without a central lagoon. It is 6 km long, northeast to southwest, and 0.6 to 1.6 km wide, with an area of 10.5 sq km (compare the land area of Aldabra, 155 sq km). The limestone rises to a maximum height of about 6 m above sea-level, and forms cliffs along the northern half of the east coast. As on the south coast of Aldabra, the cliffs are topped by a perched beach up to 1.8 m thick and 18 m wide, which at the head of small coves develops into low dunes 3-4.5 m thick. The perched beach approaches close to the cliff-top along the central part of the coast, but moves inland towards the north, revealing a cliff-top platform of pinnacled limestone. The cliffs are undercut only in coves, and when facing seaward are more ramp-like; they overlook a rock-cut abrasion platform 90-200 m wide (Plates 20 and 21). This platform lacks growing corals, and towards its outer edge has in places mushroom residuals of a surface at least 0.6 m higher (Plate 22). Several high dunes, their steeper slope facing inland, are found along the southeast coast; their heights range from 14-28 m above sea-level. The smaller high dunes have a simple outline, but the larger ones are cut by valleys on their seaward side and may be eroding. Most of the west coast consists of a narrow sand-flat with low dunes, banked against a previously eroded cliff-line. The coast below both the high dunes and the western sand-flat is formed by a wide sand beach.

The main body of the island consists of a deeply-pitted and eroded champignon, with tidal solution holes up to 6 m deep and generally steep-sided. Round the margins of the island there is a higher rim with a less dissected and much smoother surface standing 1.2-1.8 m above the champignon. This surface may be compared to the pavé of Astove, and to the surface of the Aldabra 8 m ridge, where undissected, rather than to typical Aldabra platin. Baker (1963, 101) suggests that the slabby limestone associated with this smoother surface is formed from lithified carbonate sands. Phosphates have accumulated both on the surface, where large quantities have now been scraped away, and in the solution holes, many of which are larger below ground than at the surface. More information on mining activities would be needed before attempting an explanation of the present surface topography on Assumption.

Piggott (1961, 1968) divides the soils of Assumption into three types: phosphatic Desnoeufs Series on the limestones, now largely dug for phosphate; Farquhar Series on the dunes; and variable Shioya Series especially on the leeward sand flat.

Climate

Rainfall records have been maintained at the Settlement since November 1964. The total fall for 1965 was 813 mm, for 1966 920.5 mm, and for 1967 (to 16 September only) 724.1 mm (Table 13). Rainfall is concentrated from December to March, but is rather variable from year to year. September and October are almost rainless. Several heavy falls have occurred during the period of record: 51.3 mm on 15 April 1965, 105.9 mm on 17 January 1966, 102.6 mm on 5 March 1966, 59.2 mm on 29 April 1966, 113.8 mm on 30 April 1966, and 81.3 mm on 14 December 1966. In 1966 the heavy falls on the four days mentioned accounted for 42 per cent of the total annual rainfall. As at Aldabra the period of the Southeast Trades (June-November) is the dry season, that of the north-westerlies and calms (December-May) the wet season. No temperature records have been kept.

Vegetation

The vegetation of Assumption can be described, based on brief reconnaissance only, in terms of eight communities:

1. perched beach community
2. high dune community
3. Pemphis community of the cliffs
4. west coast sand beach community
5. mixed scrub community of the champignon
6. herbs and grasses community of the pavé or platin
7. solution-hole community
8. settlement vegetation

Perched beach community (Plate 23)

The narrow zone of sand perched on top of the seaward cliffs along the east coast closely resembles that on the south coast of Aldabra, except that the cliff-line is more irregular. The beach is subject to constant spray during the Trades and to wave-swash at exceptional tides. As a result areas on the seaward side of the perched beach lack vegetation cover. The vegetation consists of a mosaic of discrete areas of Sporobolus virginicus and Sclerodactylon macrostachyum, bounded sharply inland by a transition to the rock-surface cover of Sarcostemma viminale and Plumbago aphylla. The dominant Sporobolus turf is much denser and longer (up to 230 mm) than at Aldabra, where it is close-cropped by tortoises. Few other plants are present: small patches of Stenotaphrum clavigerum, inconspicuous individuals of Launaea sarmentosa and Sida parvifolia, and infrequent shrubs only where small dunes have developed.

Table 13. Monthly rainfall at Assumption[1]

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
1964											26.67	47.75	
1965	151.64	44.96	92.71	170.94	46.48	60.71	31.50	47.50	3.81	6.35	70.61	86.36	813.56
1966	204.72	59.18	192.28	198.88	32.77	20.07	18.29	9.91	13.46	-	19.81	151.13	920.50
1967	136.40	184.91	93.98	136.91	14.61	11.94	46.74	59.20	1.27[2]				

Source: Settlement Manager, Assumption

1. Figures in mm converted from inches and tenths

2. To 16 September only

High dune community (Plates 24-27)

The high dunes of the southeast coast have a comparatively gentle but irregular seaward slope and a steep landward slope. Vegetation on the seaward slope is variable, some areas being dominated by grasses (Sporobolus virginicus and Sclerodactylon macrostachyum), others with shrubs, but the characteristic features of this community are the large areas of bare and sometimes mobile sand. In the areas dominated by grass species the density of the vegetation is frequently so low that large areas of bare sand are visible. The dominant shrubs are low wind-trimmed Scaevola taccada and bushy Suriana maritima, with occasional Tournefortia argentea. The ground under the shrubs, and the walls and floors of the transverse valleys, are largely bare, with clumps of Fimbristylis cymosa and scattered Euphorbia indica 30-60 cm tall. On the crest and backslope of the dunes, Tournefortia is the dominant shrub, with Fimbristylis and patches of Portulaca sp. and Sida parvifolia. At the foot of the high dunes on the seaward side there is a narrow sand flat with Suriana and Tournefortia, and a ground cover of Ipomoea pes-caprae extending onto the beach. In the sheltered area immediately landward of the high dunes there is a fleshy mat of Portulaca oleracea and a narrow belt of stunted Thespesia populneoides woodland. Some of the shrubs on the dunes are overgrown with Cassytha filiformis, and on isolated lower dunes to the north Tournefortia and Scaevola bushes are so heavily overgrown that they are almost invisible.

Cliffs

Cliffs lacking a perched or sea-level sand beach occur at the northern end of the island, where there is a small clump of Pemphis acidula. Thomasset (in Hemsley 1919) noted Pemphis as "common", but Fryer (1911, 433) found only "a few trees...near the west coast...(which) do not unite to form bush". Dupont (1907) mapped Pemphis near its present position. The present distribution is clearly a small relic of a more extensive cover, though with the absence of suitable habitat probably less extensive than on Aldabra.

West coast sand beach community (Plates 28 and 29)

This has certainly been much altered by man, especially on the sites of the present and former settlements. Shrubs are common along this sand strip, species including Scaevola taccada, Suriana maritima and Tournefortia argentea along the shore, and Clerodendron glabrum 3-5 m tall a short distance inland. Sophora tomentosa is present but not common. In the north, near the old settlement, there are some rather bushy trees of Cordia subcordata, which were in flower in September 1967. The ground cover between the shrubs largely consists of a thick carpet of Cassytha filiformis, with Pennisetum polystachion, Amaranthus viridis and Melanthera biflora. Canavalia rosea is an escape from cultivation near the former settlement. The sand-strip vegetation thus consists of a mixture of native and introduced species.

Mixed scrub community

The mixed scrub on the elevated limestone has clearly been much altered by man, and now presents such a diverse form that any generalisations are difficult to make. Before mining began it was probably comparable to the more open mixed scrub areas of Aldabra. Abbott (1893, 763) noted that the surface was "not so densely covered with scrub as Aldabra", while Nicoll (1908, 107) found it "less thickly covered than Gloriosa. The central part is almost bare of vegetation, the only growth being a few low bushes (hibiscus [Thespesia?]), and a thin wiry grass which springs from the cracks and fissures in the coral". Fryer (1911,433) stated that "the vegetation over the majority of the island consists of a tangled network of Plumbago (P. aphylla sp.?), Astephanus (A. arenarius sp.?) and numerous low bushes not identified. Small trees such as Euphorbia Abbotti, banyan (Ficus sp.?) were not uncommon, while Dracaena (D. reflexa sp.?) occurred in guano-filled pits".

From the floristic records of Dupont (1907) and Hemsley (1919), it appears that the scrub consisted of Thespesia populneoides, Guettarda speciosa, Pisonia grandis, Euphorbia abbottii, Ficus nautarum, Ficus aldabrensis and Dracaena reflexa, with a ground cover of Colubrina asiatica, Lomatophyllum borbonicum, Solanum aldabrense, Capparis cartilaginea, grasses, sedges and herbs. A number of common characteristic trees or shrubs of the Aldabra mixed scrub have, however, not been recorded on Assumption, and were not seen in 1967: these include the trees Grewia salicifolia, Ochna ciliata, Vernonia aldabrensis, Terminalia boivinii, and Tricalysia cuneifolia, and the shrubs Mystroxylon aethiopicum, Sideroxylon inerme, Maytenus senegalensis, Tarenna supra-axillaris, Apodytes dimidiata and Ehretia cymosa. Some may have been present in former times but were not collected and are perhaps now extinct on Assumption.

Guano-mining led to large-scale vegetation clearance. Vesey-FitzGerald reported in 1937 that "the central area ... has been largely cleared of vegetation. ... A thick secondary mat of Plumbago now covers the whole of this country" (Vesey-FitzGerald 1942, 12). There are now very few trees or tall shrubs on the champignon. In the south there are small trees of Euphorbia abbottii, and in holes some bushy Ficus nautarum, but few other shrubs are taller than 2 m, and then only towards the south. Between the settlement and the high dunes the central part of the island is dominated by Gossypium hirsutum with a thick ground cover of Plumbago aphylla and Sarcostemma viminale. Shrubs collected in this sector include Clerodenrum glabrum (1.6 m), Acalypha claoxyloides (1-1.3 m), Abutilon fruticosum (1 m), Secamone fryeri (0.6-1 m), and Capparis cartilaginea. Ficus aldabrensis and Guettarda speciosa, noted by Dupont, were not seen in 1967, and the latter may be extinct on the island; only one almost leafless Pisonia grandis was seen near the northwest coast (Plate 30).

In contrast to the poverty of the shrub layer, the ground vegetation is diverse, but patchy. Apart from Plumbago, Sarcostemma and Cassytha, it includes the grasses Dactyloctenium pilosum, Enteropogon sechellensis and Eriochloa meyeriana, and such weedy plants as Achyranthes aspera, Boerhavia elegans, Euphorbia hirta, Ipomoea tuba, Nesogenes dupontii, Passiflora foetida, Passiflora suberosa, and Tribulus cistoides. Momordica charantia is an escape from cultivation. Solanum aldabrense and the introduced grass Panicum maximum were not seen in 1967, and both Capparis and Lomatophyllum are uncommon. Close to the settlement the mixed scrub is being invaded by such common weeds as Stachytarpheta jamaicensis and Catharanthus roseus. Dried Nostoc commune was taken from bare rock pavement in the centre of the island. In general the vegetation is so low over the southern part of Assumption that visibility is limited more by the irregularity of the ground than by the height of shrubs and trees.

The patchiness of the vegetation needs to be stressed, as a result of the colonisation of workings of different ages. There is a mosaic of plant communities varying in their structure, age and species composition; these differences can possibly be associated with periods of human activity. Shrubs are usually found on the small areas that have escaped such activity, on in areas of older workings.

Pavé or platin community (Plate 31)

The northern part of the island has a much less dissected surface and lacks shrubby growth. Along the seaward side it is covered with a dense mat of Plumbago and Sarcostemma, but further inland and towards the north large areas of ground are bare, except for scattered grasses and sedges (Dactyloctenium, Fimbristylis), weeds such as Achyranthes, and long trailers of orange vine Cassytha filiformis. In crevices and holes it is possible to find a few flowering Hedyotis sp. and Sida parvifolia, characteristic on Aldabra of the most exposed and almost unvegetated champignon of the southeast coast. This area has probably been worked over for phosphate, and the vegetation may be a pioneer one of the bare rock pavement which has resulted.

Solution-hole community

Solution holes in the champignon now contain the largest trees on Assumption, apart from coconuts and Casuarina. In the centre and south of the island Ficus nautarum is characteristic of solution holes, as on Aldabra: Dracaena reflexa, said to occur in holes by Fryer, was not seen by us. No ferns have previously been recorded from Assumption, though Acrostichum aureum is common in shallow holes at the east end of Aldabra. Shrivelled Acrostichum was found in several holes at the north end of Assumption in 1967, together with, in one case, a fern not then recorded but since found on Aldabra, Nephrolepis biserrata (Plate 32).

One hole near the north point also contains several tall trees of Ceriops tagal, though no mangroves have been previously recorded from Assumption and they do not occur on the coast. Local informants stated that this was the only solution hole with mangroves. In Fryer's manuscript journal (Fryer 1908), however, he records several such pits with mature mangroves up to 12 m tall, mostly Bruguiera though in one case with Ceriops. He was unable to understand how mangroves came to colonise such inland holes, at least half a mile from the sea, and thought they were formerly more extensive. Most of these inland mangroves have probably disappeared through being cut for timber since 1908. One hole north of the settlement is now used as a pool for keeping captive turtles.

Settlement vegetation

Before permanent settlement there were "a few casuarina trees, and in one spot on the shore three coconut palms" on the west coast (Nicoll 1908, 107); Sebert Baty in 1895 had found a total of six coconut palms (Bergne 1900). At the site of the first settlement (Plate 33), northern part of the west shore, there is a clump of tall Casuarina, a coconut, two massive trees of Terminalia catappa, a patch of Caesalpinia bonduc, and spreading out over the bare platin behind the beach a conspicuous area of Agave. At the present settlement there is a woodland of mature Casuarina near the manager's house, with, to the south, a coconut plantation of several hundred trees. At the settlement itself there are cultivated trees (Moringa oleifera, Carica papaya) and other plants (Catharanthus roseus, Datura metel, Gossypium hirsutum, Ipomoea batatas, Leonotis nepetifolia, Momordica charantia, Pedilanthus tithymaloides, Solanum lycopersicum and Solanum nigrum), together with weeds (Achyranthes aspera, Boerhavia elegans, Cleome strigosa, Dactyloctenium aegyptium, Enteropogon sechellensis, Hypoestes aldabrensis, Stachytarpheta jamaicensis, Vernonia cinerea). Between the settlement and the sea there is a narrow hedge of Scaevola taccada, with some Tournefortia argentea and Suriana maritima, and a ground cover of Canavalia rosea. Two introductions mentioned by Dupont in 1907 were not seen in 1967: Abrus precatorius and Albizia fastigiata.

Flora

The flora of Assumption has never been properly worked up from the earlier collections, though Dupont (1907) published a list of species in his table of island plants, and Hemsley (1919) included species collected by Fryer, Fox, Dupont and Thomasset in his "Flora of Aldabra". Gwynne and Wood (1969) record 8 species, four of them sight records. A list of plants collected in 1967 is given in a later paper by Fosberg and Renvoize (1970), and the flora is being included in the revision of the Aldabra flora now being undertaken.

The publications of Dupont and Hemsley list about 63 species from Assumption; with the collections made in 1967, this is increased to about 100, or roughly half the number of species found on Aldabra. Among the species conspicuously absent from the earlier records are the mangroves (species of Avicennia, Bruguiera, Rhizophora, Lumnitzera, Sonneratia, Ceriops and Xylocarpus, all found on Aldabra), Pandanus, and the ferns; one mangrove and two ferns have since been collected. Of the additional species collected in 1967, perhaps 16 represent indigenous species present but uncollected at the time of the earlier visits (e.g. species of Acalypha, Acrostichum, Boerhavia, Ceriops, Dactyloctenium, Euphorbia, Ipomoea, Launaea, Nephrolepis, Nostoc, Pennisetum, Portulaca, Sida, Sophora, Sclerodactylon). At least 19 species collected in 1967, or one-fifth of the known flora, represent deliberate introductions or weeds which have probably arrived since settlement began in 1908; six of these have also appeared at Aldabra. These introduced plants include species of Agave, Carica, Catharanthus, Datura, Ipomoea, Leonotis, Momordica, Moringa, Solanum and Terminalia.

Some idea of the contrast between the floras of Aldabra and Assumption, and the greater changes in the latter, can be obtained by comparing the collections made sixty years ago on each with those made in 1966-67 (this comparison includes only Stoddart's collections and not the more extensive collections made on Aldabra by Fosberg and Renvoize):

	Aldabra	Assumption
Per cent total flora recorded by Hemsley and earlier workers	46	28
Per cent recorded by both Hemsley and in present collection	38	35
Per cent recorded only in present collection (new records)	16	36
Total number of species	c.200	c.100

The comparison is only approximate, for the Assumption flora is still to be properly collected and the Aldabra collections of 1966-67 were small and preliminary, but it is clear that considerable changes have taken place in the flora as well as in the vegetation of Assumption since settlement began.

Of the species listed by Hemsley (1919), three have been described as endemic (Panicum assumptionis Stapf, Eriochloa subulifera Stapf, Stenotaphrum clavigerum Stapf), and twenty could be classed as "regional endemics". Since the new records are mainly cosmopolitan weeds and cultivated plants, the flora is changing from one typical of the elevated reef islands of the southwest Indian Ocean to one dominated by common tropical species of no particular regional affinity.

Marine fauna

The Green Turtle Chelonia mydas was formerly abundant on Assumption. Baty (in Bergne 1900) and Nicoll (1908) reported them in great numbers close to the shore, and also nesting. Fryer found them plentiful, but said that it was no longer possible to take up to two hundred in a night as had once been the practice (Fryer 1910, 263). Numbers have declined catastrophically, and though turtle still come ashore at one or two places on the east coast to lay, for several years it has had to be prohibited to take them or their eggs anywhere on Assumption. There has, however, been no means of enforcing this prohibition among the island's labourers. Little else is known of the marine fauna; J. L. B. Smith collected fish at Assumption in 1954, and a few records have appeared in his revisions of the Indian Ocean fish fauna (Smith 1955a, 1955b, 1956a, 1956b).

Land fauna other than birds

The only indigenous mammal at Assumption is an insectivorous bat Taphozous mauritianus collected by Fryer in October 1908 (Scott 1914, 163). The fruit-bat Pteropus, found on Aldabra, is absent. The indigenous land reptiles formerly included the Giant Land Tortoise Geochelone sp., which, however, became extinct before ever being recorded alive, as far as can be ascertained. Fryer found the remains of two in a solution hole in 1908, and Honegger found eggs in a guano pit on 1964. The geckos Phelsuma abbotti abbotti and Hemidactylus mercatorius, and the skink Ablepharus boutonii, are also indigenous (Boulenger 1911); both Hemidactylus and Ablepharus were collected on the high dunes in 1967. All three species are found on Aldabra. The land Crustacea include Birgus latro, very common in 1906 (Nicoll 1908, 112) and still existing. 65 species of insects have been recorded, mainly collected by Fryer and Dupont, and the literature on these earlier collections is keyed in Table 14. There was no opportunity to collect insects in 1967, though members of the Odonata were conspicuous. Blackman and Pinhey (1967) review this group on western Indian Ocean islands, with mention of Assumption.

Land (including shore) birds

Birds form the best known element in the Assumption land fauna, and are also the group apparently most affected by guano mining. In connection with the following account, we are grateful to Professor Charles G. Sibley and Mrs Eleanor H. Stickney for the loan from the Peabody Museum of Natural History, Yale University, of material collected by Hartman in 1957.

Table 14. Insects recorded from Assumption by the Percy Sladen Expedition

Group	Number of species	Reference
Orthoptera	10	Bolivar (1912, 1924)
Dermaptera	1	Burr (1910)
Hemiptera	4	Distant (1913, 1917)
Lepidoptera	22	Fletcher (1910), Fryer (1912), Hampson (1908)
Coleoptera	8	Aurivillius (1922), Champion (1914), Gebien 1922, Scott (1912, 1926)
Hymenoptera	8	Cockerell (1912), Morley (1912), Turner (1911)
Diptera	3	Lamb (1922, 1914), Scott (1914)
Odonata	6	Campion (1913)

Residents

There are five land birds which breed (or did so formerly) on Assumption, with four more which may do so. These are:

Dryolimnas cuvieri	White-throated Rail
Streptopelia picturata	Malagasy Turtledove
Centropus toulou	Malagasy Coucal
Nectarinia sovimanga	Souimanga Sunbird
Corvus albus	Pied Crow

plus

Ardea cinerea	Grey Heron
Egretta garzetta	Little Egret
Bubulcus ibis	Cattle Egret
Butorides striatus	Little Green Heron

All of these species also breed on Aldabra, which has at least seventeen breeding land birds. The following breeding Aldabra land birds have never been recorded on Assumption:

Threskiornis aethiopica	Sacred Ibis
Falco newtoni	Malagasy Kestrel
Alectroenas sganzini	Comoro Blue Pigeon
Caprimulgus madagascariensis	Malagasy Nightjar
Hypsipetes madagascariensis	Malagasy Bulbul
Nesillas aldabranus	Aldabra Tsikirity
Dicrurus aldabranus	Aldabra Drongo
Zosterops maderaspatana	Malagasy White-eye
Foudia eminentissima	Red-headed Forest Fody

Nor has the Barn Owl Tyto alba been recorded from Assumption. It certainly occurred (and probably bred) in the past on Aldabra, but appears no longer to exist there. The Malagasy Cisticola cherina, which Benson found plentiful on Menai and Wizard Islands (Cosmoledo Atoll) and on Astove in March 1968, is unkown on Assumption or Aldabra.

The Assumption subspecies of the White-throated Rail was discovered by Abbott in 1892 and named Dryolimnas abbotti by Ridgway (1894a, 74). Fryer (in MS) in 1908 found "plenty of the Rail D. abbotti which was very tame and very common". Both Abbott in 1892 and Nicoll in 1906 found it abundant. "They were found on all parts of the island, except on the summit of the sandy hill on the windward side" (Nicoll 1908, 109). In spite of the large numbers, Nicoll feared that introduced rats might lead to its extinction by predation of eggs (1908, 111). It did duly become extinct some time between the establishment of the settlement in 1908 and Vesey-FitzGerald's visit in 1937, undoubtedly as a result of catching for food, destruction of habitat, and predation by introduced cats and rats. It was conspecific with Dryolimnas c. cuvieri, of Malagasy, as is the Aldabra form. It appears not to have lost the power of flight so completely as D. c. aldabranus: see the wing-lengths in Benson (1967, 74).

The turtledove Streptopelia picturata was not definitely recorded by Abbott in 1892 (see Ridgway 1895, 522, under Turtur aldabranus), but was so by Nicoll (1906, 693; 1908, 109, under T. assumptionis). It was "quite common" and "extraordinarily tame" at the time of Nicoll's visit, when it nested in the branches of Hibiscus (?) bushes. It was mentioned by Fryer in 1908, but not by Vesey-FitzGerald in 1937, and has not been seen since. It was probably extirpated by the labourers, again for food. It seems to have only differed from the Aldabra population in being a little larger (Benson 1967, 75-79). This is supported by wing-lengths of recent Aldabra material, four males measuring 166, 167, 169, 170, and six females 155, 157, 158, 160, 160, 163 mm.

The coucal Centropus toulou was collected by Abbott (C. insularis in Ridgway 1895, 522-523), and was noted as common and tame by Nicoll (1906, 494, as C. assumptionis) and by Fryer (in MS). Vesey-FitzGerald (1940, 487) saw one in 1937. But it is not mentioned by Hartman (1958), neither did Gaymer see it in 1964 or 1965, nor Benson in 1967, nor Frazier in 1968. Wright in 1967 thought he saw one but was not sure. It may also be extinct, extirpated by the labourers for food. According to Benson (1967, 80-81), it is (or was) only possibly distinguishable from C. t. insularis of Aldabra by its slightly shorter tail. The following are measurements in mm of further adult Aldabra specimens:

	Wing	Tail
♂♂	149 150	232 243
♀	165	250

The smaller male tail-length indicates an overlap in figures for insularis and assumptionis, and the latter name is really no longer worth maintaining.

The sunbird Nectarinia sovimanga is still relatively flourishing, in no apparent immediate danger of extinction, even though its numbers have probably been greatly reduced by destruction of the original habitat. On the morning of 16 September Benson counted eight males, four females and six unsexed birds on the south-east side of the island, in the mixed scrub community, and in the afternoon 43 males and 26 females in the west coast sand beach community, also a few in Casuarina trees at the site of the old settlement near the northwest corner of the island. Frazier found sunbirds singing in the trees at the present settlement. All males observed appeared to be in full breeding dress. Feeding was noticed at flowers of Agave and Tournefortia argentea. Although Vesey-FitzGerald (1940, 487) reported it as rare, Hartman (1958) found it common, and it is the most plentiful true land bird on Aldabra. It is possible that competition from Nectarinia has excluded the white-eye Zosterops maderaspatana from Assumption, which, unlike Aldabra, may not be large enough for both (Serventy 1951). Nevertheless both have been recorded from other small islands--Gloriosa, Astove, and Menai Island in Cosmoledo. N. s. abbotti is a valid subspecies, endemic to Assumption (Benson 1967, 84-86). This is confirmed by further material from Aldabra, Assumption, Cosmoledo and Astove, the subspecies on both the latter two islands being N. s. buchenorum.

The crow Corvus albus was collected by Abbott in 1892 (Ridgway 1895, 532, under C. scapulatus). Nicoll (1906, 693; 1908, 109) recorded small numbers, and found several empty nests "built at the tops of the tallest trees on the island". He also noted it as "extremely wild". Vesey-FitzGerald (1940, 588), however, considered it was only a visitor. "About 25" were seen in 1964 (Bourne 1966); and Gaymer recorded about "two dozen" in the same year. Benson saw 10 on 15 September 1967 and Morton Boyd a total of 15 on the same day: it was seen at the settlement, in Casuarina trees at the old settlement site, and over the southeast dunes. Frazier saw none in 1968. Probably it does still breed on Assumption, as recently definitely established for Aldabra. Breeding may take place only at infrequent intervals, and so can be easily overlooked.

Of the possibly breeding shore birds, Ardea cinerea and Egretta garzetta, both collected by Nicoll (1906, 695-696, the latter under Demiegretta sacra), have not otherwise been recorded, except that Dupont (1907) lists the former. Possibly they no longer exist on Assumption, though it is unlikely that they have been molested to the same extent (except at possible breeding sites) as the turtledove and coucal discussed above. Bubulcus ibis was seen by Gaymer in 1964, and there was a flock of about 60 inland, just south of the settlement, in 1967. Its status on Assumption is quite uncertain.

Butorides striatus, recorded by Nicoll (1906, 696, under B. crawfordi), and listed by Dupont (1907, under B. atricapillus), was seen by Gaymer in 1964, by Benson on the southeast shore at low water (three adults, one immature) and inland (three adults) in 1967, and by Frazier on the southwest coast in 1968. Assumption is the type-locality of

Nicoll's B. s. crawfordi, only otherwise recorded from Aldabra (Benson (1967, 67). Additional material, now in the British Museum (Natural History), is available from Aldabra, and A. D. Forbes-Watson has kindly donated on behalf of the National Museum of Kenya, Nairobi, a specimen collected by I. S. C. Parker in the Amirante Islands, on the reef between Darros and St Joseph (5°25'S, 53°18'E), on 23 September 1967. Wing-lengths in mm of this material are:

Aldabra	♂♂	159	165	
	♀♀	156	158	162
Amirante Islands	♀	169		

One male and one female from Aldabra have the sides of the neck, chest and abdomen washed with brown, but the other specimens lack this wash. It may be that only the latter are completely adult, the difference thus being due to age rather than sex, contra Benson (1967, 68). It is impossible to separate the Amirante specimen from those from Aldabra on colour, and on present evidence crawfordi must be regarded as extending north to the Amirantes. Possibly Amirante birds are a little larger, see also further figures in Benson (1967). This is also suggested by weights, the Amirante specimen being the heaviest. Those whose wing-lengths were given above weighed respectively 164, 158, 168, 163, 177, 180 g. This recent Aldabra material, collected in 1968, is not markedly paler grey below than in any specimen of B. s. rhizophorae, whether collected a decade or a century ago, and the two subspecies may only be distinguishable on size. It would seem that the type of crawfordi and the adult male from Aldabra examined by Benson (1967, 67), so pale grey below, are exceptional individuals.

Migrants

The following are recorded from Assumption:

Ardeola idae

One seen by Benson to fly onto the island, from the direction of Aldabra, at 0800 hours on 16 September 1967. It was thought to be this species, now known to occur on Aldabra, whereas A. ralloides is not.

Squatarola squatarola

Two seen on the southeast coast in 1967.

Charadrius leschenaultii

Listed by Dupont (1907, under Aegialitis geoffroyi); three seen in 1967.

Numenius phaeopus

Listed by Dupont (1907); two seen in 1967.

Numenius arquata

Listed by Dupont (1907).

Tringa nebularia

Listed by Dupont (1907, under Totanus glottis); two seen in 1967.

Actitis hypoleucos

Listed by Dupont (1907).

Arenaria interpres

Listed by Dupont (1907); 100 seen in March 1964 (Bourne 1966); five seen in 1967.

Crocethia alba

One seen in 1967.

Erolia minuta

Listed by Dupont (1907).

Dromas ardeola

Listed by Dupont (1907); 40 seen in March 1964 (Bourne 1966); one seen on the southeast shore in 1967.

Hirundo rustica

On 13 December 1957 Hartman (1958) saw "an unidentified swallow, black above, white below, and with a long, forked tail", "in flight over the sand dunes". It was very probably this species, for which Benson (1967, 95) quotes one sighting for Malagasy in January, while a number were seen on Aldabra in March 1968.

Other migrants must occur occasionally on Assumption. Thus among shore birds, Erolia testacea is plentiful on Aldabra, and some 14 species of palaearctic true land birds have by now been found there.

Sea birds

Sea birds were not common in 1967, and have certainly greatly decreased in numbers during the last sixty years. It is probable that few now nest on Assumption. The following species have been recorded:

Phaethon rubricauda

Collected by Abbott (Ridgway 1895, 522), who found it breeding in dense thickets or under a bush, and by Nicoll (1906, 693). Not seen in 1967. Loustau-Lalanne (1963, 21, 23) considers it confined to Assumption, but this is not correct. Thus Benson (1967, 99) quotes records from Aldabra, where it breeds. P. lepturus has never been recorded from Assumption.

Sula abbotti

Collected by Abbott (Ridgway 1893, 599; 1895, 520-522), who stated that "a few" breed. According to Fryer (1911, 433) it "inhabits the large dune, never descending to low parts of the island." It has not been recorded since, and Vesey-FitzGerald (1941, 52) says it was extirpated in 1926; the species now only breeds on Christmas Island (Indian Ocean). Gibson-Hill (1950) has very fully discussed uncertainties in the earlier records. The two specimens collected by Fryer on Assumption, and examined by Gibson-Hill, are still extant in the University Museum of Zoology, Cambridge. The statement by Loustau-Lalanne (1963, 23) in regard to the Red-footed Booby Sula sula is presumed to be really intended to apply to S. abbotti, though unfortunately it is more than "very near extinction" on Assumption.

Sula dactylatra (syn. S. cyanops)

Noted by Abbott (Ridgway 1895, 520) to breed on bare ground on the sand dunes; collected by Nicoll (1906, 697). Probably no longer breeding in 1937 (Vesey-FitzGerald 1941, 521) but "a few" seen in 1964

(Bourne 1966). Not seen in 1967. Sebert Baty in 1895 found a "camp of boobies", species not specified, on guano 600 yards northeast of the big dune, and boobies in trees (Sula sula ?) all over the island (Bergne 1900).

Sula sula

Recorded breeding by Nicoll (1906, 697). Four seen in 1967.

Fregata minor (syn. F. aquila)

Recorded by Nicoll (1906, 692) and listed by Dupont (1907). Not seen in 1967, but R. Hughes saw a female in March 1968.

Fregata ariel

A group of four males and seven females, all apparently adult, seen soaring over the southeast coast in 1967.

Sterna fuscata

15-20 seen by J. Frazier off the west coast in March 1968.

Sterna albifrons

Listed by Dupont (1907, under both S. minuta and S. balaenarum). About thirty probably this species seen in March 1964 (Bourne 1966).

Sterna sumatrana

Three recorded in March 1964 (Bourne 1966), and one flock of ten, another of four, on the southeast coast in 1967.

Thalasseus bergii

Listed by Dupont (1907, under both "Sterna Bersteini" and "Sterna Bergi").

Anous stolidus

Listed by Dupont (1907).

Gygis alba

Collected by Nicoll (1906, 696), listed by Dupont (1907). One seen in March 1964 (Bourne 1966). On 16 September 1967 Benson saw one lot of ten, four each of two, and one single bird, and E. Wright a total of about 20. J. F. Peake found three probably breeding in a solution hole. Frazier saw 4-5 off the west coast on 31 July 1968.

Introduced animals

Rats were abundant by the time of Nicoll's visit (before settlement began), and were already destroying birds' eggs. Goats were introduced "many years" before Abbott's visit in 1893, according to him from Europa Island in the Mozambique Channel (Abbott 1893, 763). According to Bergne (1901) goats were introduced by H.M.S. Wasp, Captain Bidenfield, in 1867, a crew member on that occasion living on Astove when Bergne visited it in 1901. Sebert Baty gave the number of goats as 300-400 in 1895 (Bergne 1900). Dupont (1907, 12) gave the date of introduction as c. 1887 and the number in 1906 as "several thousands". Nicoll (1908, 112) found twenty, very wild, near the foot of the dunes. Vesey-FitzGerald (1942) did not mention them and Gaymer thought they were extinct in 1964. We saw none in 1967, though we were told that some still existed in the north. Dupont was so impressed by the goats as a food resource that he suggested the introduction of rabbits and hares (Dupont 1907, 13). Dogs, cats and chickens were seen in 1967.

Settlement and Exploitation

Settlement began in June 1908, and by Fryer's arrival in September tracks had been cut through the bush in several directions. The first settlement was in the northern part of the west bay, and large rainwater tanks were constructed there in 1910. Both contained excellent water in 1967. At a date unknown the settlement was transferred to the south end of the bay, where there is now a manager's house and garden, and a line of labourers' huts (Plate 34). There is a short jetty, a boat house, and to the north a small cemetery. On the east coast there are two small fishing shacks on the dunes.

Between 1926 and 1945, 161,000 tons of guano were exported, together with an unknown amount before 1926. After 1945 the lease lapsed and exploitation ceased in 1948; but with the renewal of the lease in 1955 mining began again. A mechanical crusher and light railway (Plate 35) have been installed. Baker (1963) estimated reserves at 160,000 tons following his survey in 1960, mostly in solution holes. Because of the sharp decline in the price of guano, production was at a standstill in 1967, and mounds of guano stood at the settlement unable to be shipped. Assumption is leased jointly with Aldabra and Cosmoledo by Mr H. Savy of Mahé, for thirty years from 1955 (Stoddart and Wright 1967, 48-50). Unlike Aldabra, it still forms part of the Colony of Seychelles, and has not been incorporated in the British Indian Ocean Territory.

Summary and Conclusions

After sixty years of intensive exploitation and a previous century of more casual interference, Assumption has now lost many of the faunal and floral elements which formerly characterised the elevated reef islands of the southwest Indian Ocean. There is no doubt that at the time of settlement in 1908 a number of irreversible changes had taken place, particularly the disappearance of the Giant Land Tortoise. The Tortoise population on so small an island must clearly have been more vulnerable to cropping for food during the late eighteenth and early nineteenth centuries than on the much larger island of Aldabra. The presence of introduced goats must have initiated vegetation changes, and early reports mention the wide distribution of Plumbago.

Major vegetation and floristic changes, however, followed the beginning of phosphate mining, in which vegetation was removed and the phosphate scraped from the surface of the ground, leaving a sterile rock surface for new colonisation. Many of the species common in Mixed Scrub on Aldabra and possibly formerly present on Assumption appear now to be absent on the latter, and their place has been taken by weeds such as Plumbago, Sarcostemma and Cassytha, and escapes such as Gossypium. All of these species are rare on Aldabra except close to the settlement where man has actively interfered with indigenous vegetation. The only areas apparently unaffected by these changes on Assumption are the high

dunes and the windward perched beach, with their typical vegetation of Sporobolus, Sclerodactylon, Scaevola, Suriana and Tournefortia, all characteristic of similar habitats on Aldabra. Lack of active disturbance and the extreme environmental conditions have probably restricted invasions in these habitats. In the flora as a whole, indigenous elements are possibly being replaced by common weeds, many of pan-tropical distribution, and cultivated plants, but further data on these processes are required.

With major vegetation changes and probable continuous predation, the bird fauna has changed considerably since 1908. The endemic rail Dryolimnas cuvieri abbotti has certainly become extinct, the local population of the turtledove Streptopelia picturata possibly so too. Of the shore birds, Ardea cinerea and Egretta garzetta may no longer occur. Changes in the sea bird population have been considerable. Though a few Sula sula and S. dactylatra have been seen in recent years, the booby breeding colonies over the northern half of the island have disappeared. Abbott's Booby Sula abbotti is now extinct on Assumption, and breeds only on faraway Christmas Island. None of the other eight recorded species of sea bird is now definitely known to breed, though Gygis alba probably does so. On the other hand, the endemic sunbird Nectarinia sovimanga abbotti, the crow Corvus albus, and migrants generally, are probably little affected by changes on the island.

Since settlement began the large breeding grounds on Assumption of the Green Turtle have been largely abandoned, and though this decline appears to be common throughout the southwest Indian Ocean it has been especially catastrophic on Assumption.

Assumption thus provides an extreme example of ecological change brought about by human settlement and exploitation. Since exploitation depends on the maintenance of an economic price for phosphate, it is possible that the venture will become uneconomic and the settlement could be abandoned. If this occurs it will be useful to observe the progress of ecological change in the future, as part of the Royal Society's continuing programme at Aldabra.

References

Abbott, W. L. 1893. Notes on the natural history of Aldabra, Assumption and Gloriosa Islands, Indian Ocean. Proc. U.S. Nat. Mus. 16: 759-764.

Aurivillius, C. 1922. Coleoptera (Cerambycidae) from the Seychelles Islands, Aldabra, and Rodriguez. Ann. Mag. Nat. Hist., ser. 9, 10: 421-443.

Baker, B. H. 1963. Geology and mineral resources of the Seychelles archipelago. Geol. Surv. Kenya Mem. 3: 1-140.

Benson, C. W. 1967. The birds of Aldabra and their status. Atoll Res. Bull. 118: 63-111.

Benson, C. W. and Penny, M. J. 1968. A new species of warbler from the Aldabra Atoll. Bull. Brit. Ornith. Club, 88: 102-108.

---------- In preparation. The land birds of Aldabra. Phil. Trans. Roy. Soc. B.

Bergne, H. A'C. 1900. Fair record of islands in the Indian Ocean. Manuscript.

---------- 1901. Rough notes of a voyage to the Aldabra group. Manuscript.

Blackman, R. A. A. and Pinhey, E. C. G. 1967. Odonata of the Seychelles and other Indian Ocean islands groups, based primarily on the Bristol University Expedition of 1964-1965. Arnoldia, 3(12): 1-38.

Bolivar, I. 1912. Orthoptera: Acrydiidae, Phasgonuridae, Gryllidae. Trans. Linn. Soc. London, ser. 2, Zool., 15: 263-292.

---------- 1924. Orthoptera Dictyoptera (Blattidae and Mantidae), and supplement to Gryllidae, of the Seychelles and adjacent islands. Ann. Mag. Nat. Hist., ser. 9, 13: 313-359.

Boulenger, G. A. 1911. List of the Batrachians and Reptiles obtained by Prof. Stanley Gardiner on his second expedition to the Seychelles and Aldabra. Trans. Linn. Soc. London, ser. 2, Zool., 14: 375-378.

Bourne, W. R. P. 1966. Observations on islands in the Indian Ocean. Sea Swallow, 18: 40-43.

Burr, M. 1910. Dermaptera. Trans. Linn. Soc. London, ser. 2, Zool., 14: 123-133.

Campion, H. 1913. Odonata. Trans. Linn. Soc. London, ser. 2, Zool., 15: 435-446.

Champion, G. C. 1914. Coleoptera, Curculionidae. Trans. Linn. Soc. London, ser. 2., Zool., 16: 393-497.

Cockerell, T. D. A. 1912. Hymenoptera, Apoidea. Trans. Linn. Soc. London, ser. 2, Zool., 15: 29-41.

Distant, W. L. 1913. Rhynchota. Part I: suborder Heteroptera. Trans. Linn. Soc. London, ser. 2, Zool., 16: 139-190.

---------- 1917. Rhynchota. Part II: suborder Homoptera. Trans. Linn. Soc. London, ser. 2, Zool., 17: 273-322.

Dupont, R. P. 1907. Report on a visit of investigation to St Pierre, Astove, Cosmoledo, Assumption and the Aldabra group. Mahé: Government Printing Office, 1-51.

Fletcher, T. B. 1910. Lepidoptera, exclusive of the Tortricidae and Tineidae, with some remarks on their distribution and means of dispersal amongst the islands of the Indian Ocean. Trans. Linn. Soc. London, ser. 2, Zool., 13: 265-323.

Fosberg, F. R. and Renvoize, S. A. 1970. Plants of Assumption Island. Atoll Res. Bull., this issue.

Fryer, J. C. F. 1908. Diary. Manuscript.

---------- 1910. The South-west Indian Ocean (being an account of Aldabra and certain neighbouring islands, which were not explored by Prof. J. Stanley Gardiner in H.M.S. "Sealark"). Geog. J. 37: 249-268.

---------- 1911. The structure and formation of Aldabra and neighbouring islands--with notes on their fauna and flora. Trans. Linn. Soc. London, ser. 2, Zool., 14: 397-442.

---------- 1912. The Lepidoptera of Seychelles and Aldabra, exclusive of the Orneodidae and Pterophoridae and of the Tortricina and Tineina. Trans. Linn. Soc. London, ser. 2, Zool., 15: 1-28.

Gebien, H. 1922. Coleoptera, Heteromera: Tenebrionidae. Trans. Linn. Soc. London, ser. 2, Zool., 18: 261-324.

Gibson-Hill, C. A. 1950. Notes on Abbott's Booby. Bull. Raffles Mus. 23: 65-76.

Gwynne, M. D. and Wood, D. 1969. Plants collected on islands in the western Indian Ocean during a cruise of the M.F.R.V. "Manihine", Sept.-Oct. 1967. Atoll Res. Bull. 134: 1-15.

Hampson, G. F. 1908. On the moths collected during the cruise of the "Valhalla" during the winter 1905-6 by Mr E. G. B. Meade-Waldo. Ann. Mag. Nat. Hist. ser. 8, 1: 474-492.

Hartman, W. D. 1958. Report on some land birds of Farquhar, St Pierre, Astove, Cosmoledo, Assumption and Aldabra. Seychelles Govt. Bull. 21.

Hemsley, W. B. 1919. Flora of Aldabra: with notes on the flora of the neighbouring islands. Bull. Misc. Inform. Roy. Botanic Gards. Kew, 1919: 108-153.

Honegger, R. 1966. Beobachtungen an der Herpetofauna der Seychellen. Salamandra, Zeitschr. f. Herpetol. u. Terrarienkunde, 2(1-2): 20-36.

---------- Unpublished. Some notes and observations on Giant Tortoises Testudo gigantea Schweigger living and extinct of the Indian Ocean islands. World Wildlife Fund Project No. 28. Typescript.

Horsburgh, J. 1809. Directions for sailing to and from the East Indies, China, New Holland, Cape of Good Hope, and the interjacent points. Part first. London: Black, Parry and Kingsbury, 1-397.

Lamb, C. G. 1914. Diptera: Heteroneuridae, Ortalidae, Trypetidae, Sepsidae, Micropezidae, Drosophilidae, Geomyzidae, Milichidae. Trans. Linn. Soc. London, ser. 2, Zool., 16: 307-372.

---------- 1922. Diptera: Asilidae, Scenopinidae, Dolichopodidae, Pipunculidae, Syrphidae. Trans. Linn. Soc. London, ser. 2, Zool., 18: 361-416.

Legrand, H. 1965. Lépidoptères des îles Seychelles et d'Aldabra. Mém. Mus. Nat. Hist. Natur. A, Zool., 37: 1-210.

Loustau-Lalanne, P. 1963. Sea and shore birds of the Seychelles. Seychelles Soc. Occas. Papers, 2: 1-26.

MacArthur, R. H. and Wilson, E. O. 1967. The theory of island biogeography. Princeton: University Press, 1-203.

Mamet, R. 1943. A revised list of the Coccoidea of the islands of the western Indian Ocean, south of the equator. Mauritius Inst. Bull. 2: 137-170.

Mayr, E. 1965. Avifauna: turnover in islands. Science, 150: 1587-1588.

Morley, C. 1912. Hymenoptera, Ichneumonidae. Trans. Linn. Soc. London, ser. 2, Zool., 15: 169-179.

Nicoll, M. J. 1906. On the birds collected and observed during the voyage of the "Valhalla", R.Y.S., from November 1905 to May 1906. Ibis, ser. 8, 6: 666-712.

---------- 1908. Three voyages of a naturalist, being an account of many little-known islands in three oceans visited by the "Valhalla", R.Y.S. London: Witherby, 1-246.

Parker, I. S. C. 1970. Some ornithological observations from the western Indian Ocean. Atoll Res. Bull., this issue.

Piggott, C. J. 1961. A report on a visit to the Outer Islands between October and November 1960. Directorate of Overseas Surveys, Land Resources Division, typescript, 1-71.

Piggott, C. J. 1968. A soil survey of Seychelles. Directorate of Overseas Surveys, Land Resources Division, Tech. Bull. 2: 1-89.

Regan, C. T. 1912. New fishes from Aldabra and Assumption, collected by Mr J. C. F. Fryer. Trans. Linn. Soc. London, ser. 2, Zool., 15: 301-302.

Ridgway, R. 1893. Descriptions of some new birds collected on the islands of Aldabra and Assumption, northwest of Madagascar, by Dr W. L. Abbott. Proc. U.S. Nat. Mus. 16: 597-600.

---------- 1894a. Note on Rougetius aldabranus. Auk, 11: 74.

---------- 1894b. Descriptions of some new birds from Aldabra, Assumption and Gloriosa Islands, collected by Dr W. L. Abbott. Proc. U.S. Nat. Mus. 17: 371-373.

---------- 1895. On birds collected by Doctor W. L. Abbott on the Seychelles, Amirantes, Gloriosa, Assumption, Aldabra and adjacent islands, with notes on habits, etc., by the collector. Proc. U.S. Nat. Mus. 18: 509-546 (actual date of publication June 24, 1896).

Scott, H. 1912. Coleoptera, Lamellicornia and Adephaga. Trans. Linn. Soc. London, ser. 2, Zool., 15: 215-262.

---------- 1914. Mallophaga, Aphaniptera, and Diptera Pupipara. Trans. Linn. Soc. London, ser. 2, Zool., 17: 161-167.

---------- 1926. Coleoptera from the Seychelles and adjacent islands: Carabidae (supplement), Cryptophagidae (supplement), Dermestidae, Lymexylonidae, Rhipiceridae, Sphindidae, Throscidae, Brenthidae. Ann. Mag. Nat. Hist. ser. 9, 18: 50-76.

Serventy, D. L. 1951. Interspecific competition on small islands. Western Austr. Nat. 3(3): 59-60.

Smith, J. L. B. 1955a. The fishes of the family Anthiidae of the western Indian Ocean. Ann. Mag. Nat. Hist., ser. 12, 8: 337-350.

---------- 1955b. The fishes of the family Pomacanthidae in the western Indian Ocean. Ann. Mag. Nat. Hist., ser. 12, 8: 337-384.

---------- 1956a. The fishes of Aldabra, Part V. Ann. Mag. Nat. Hist. ser. 12, 9: 721-729.

---------- 1956b. The fishes of Aldabra, Part VI. Ann. Mag. Nat. Hist. ser. 12, 9: 817-829.

Stoddart, D. R. editor. 1967. Ecology of Aldabra Atoll, Indian Ocean. Atoll Res. Bull. 118: 1-141.

Stoddart, D. R. 1968a. Catastrophic human interference with coral atoll ecosystems. Geography, 53: 25-40.

---------- 1968b. Isolated island communities. Science J. 4(4): 32-38.

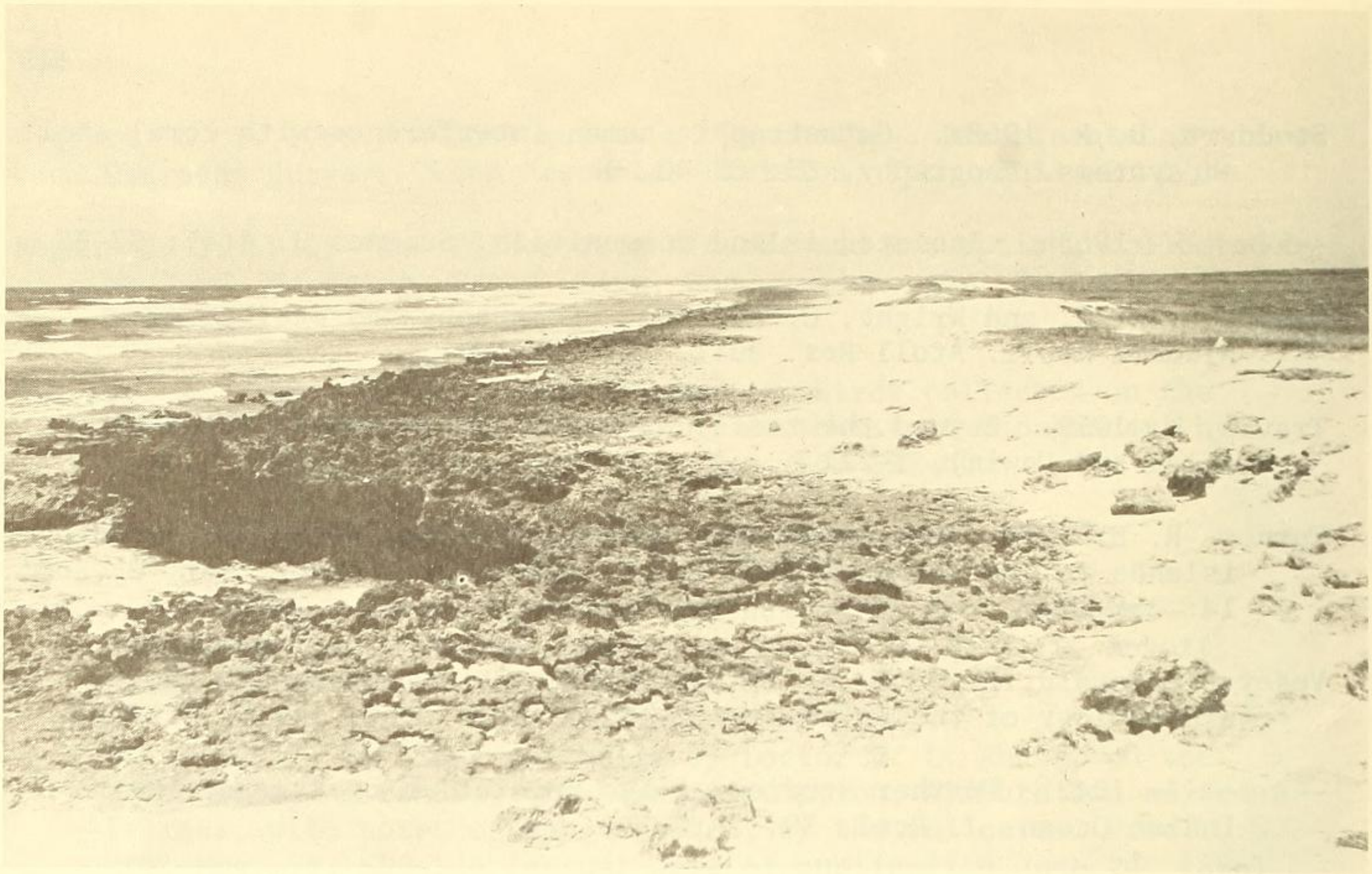
Stoddart, D. R. and Wright, C. A. 1967. Geography and ecology of Aldabra Atoll. Atoll Res. Bull. 118: 11-52.

Travis, W. 1959. Beyond the reefs. New York: E. P. Dutton (London: Allen and Unwin), 1-221.

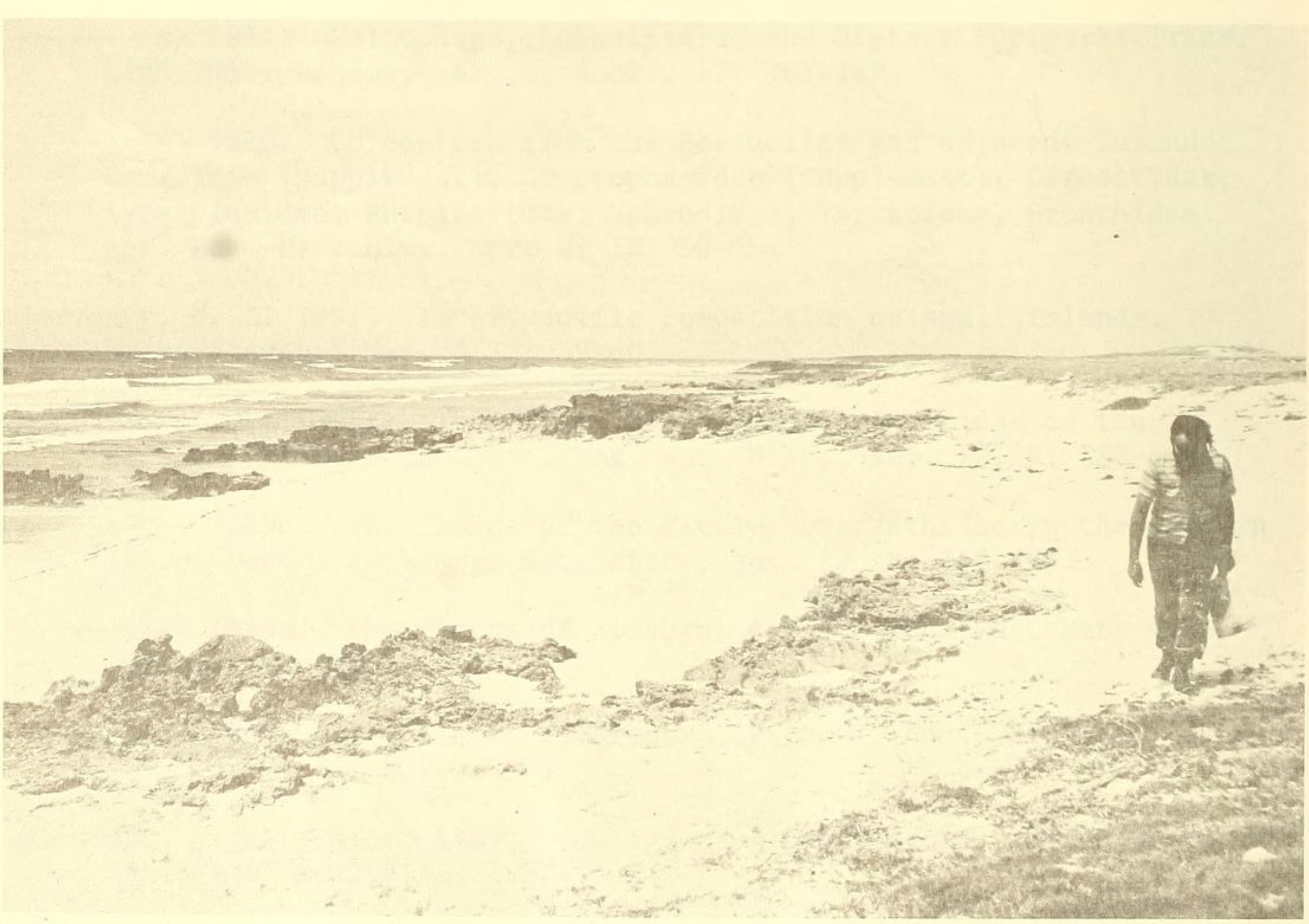
Turner, R. E. 1911. Fossorial Hymenoptera from the Seychelles and other islands in the Indian Ocean. Trans. Linn. Soc. London, ser. 2, Zool., 14: 367-374.

Vesey-FitzGerald, L. D. E. F. 1941. Further contributions to the ornithology of the Seychelles Islands. Ibis, ser. 14, 5: 518-521.

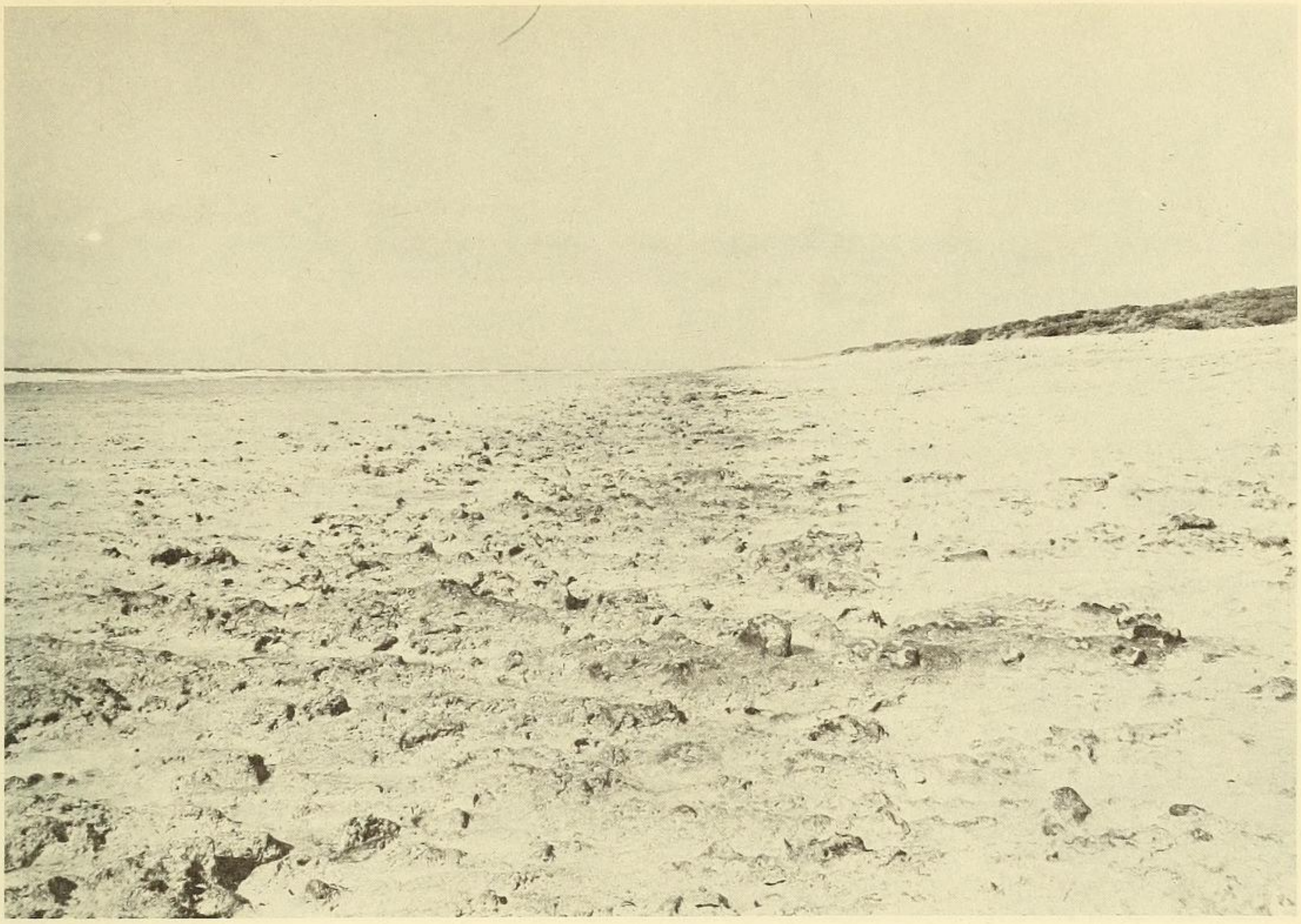
---------- 1942. Further studies of the vegetation on islands in the Indian Ocean. J. Ecol. 30: 1-16.



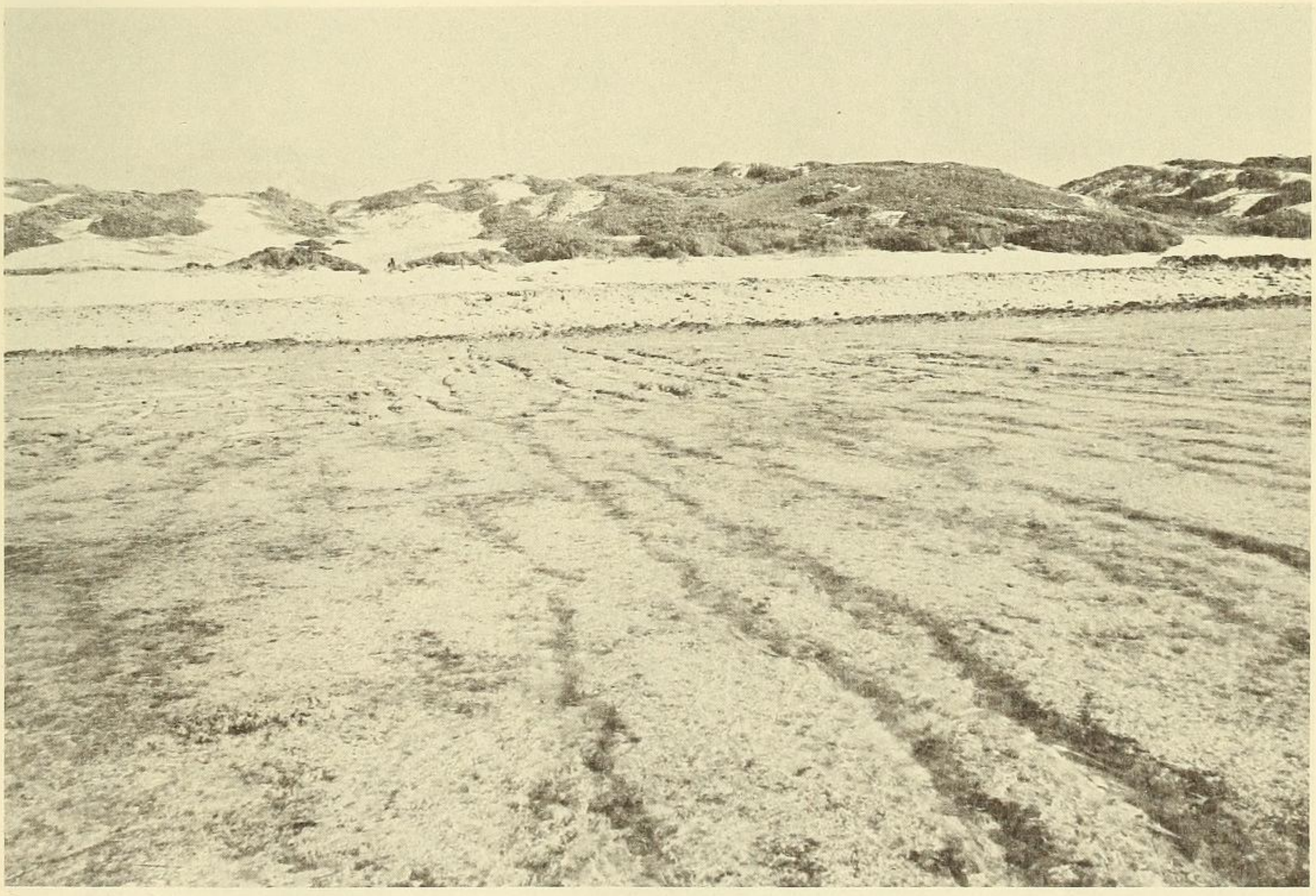
18. Low champignon cliffs and perched beach, east coast, view towards the south



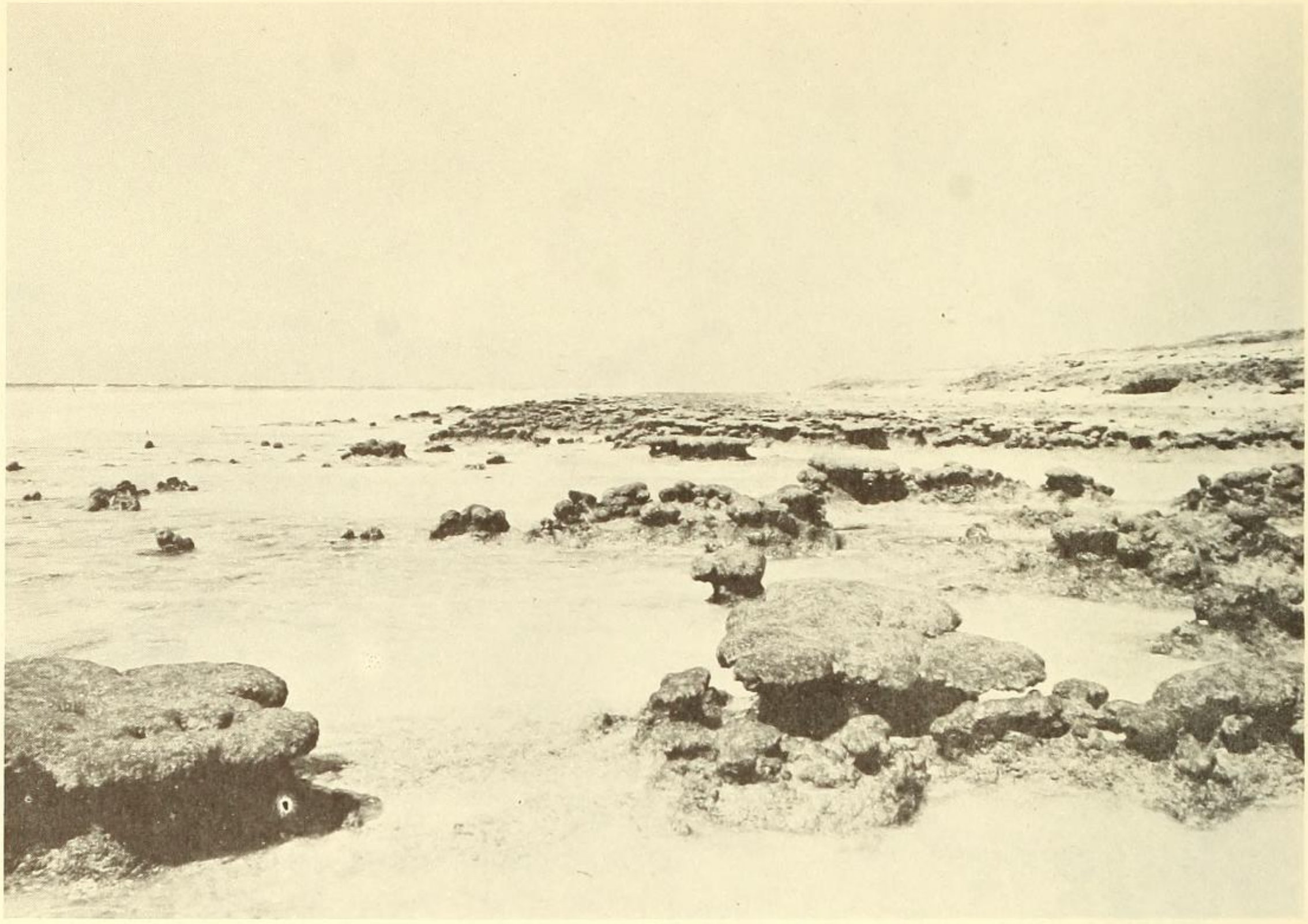
19. Pocket beach in the champignon cliffs, continuous with the higher perched beach; north of the high dunes, east coast



20. Eroded inner edge of the reef flat where it passes beneath the beach at the foot of the high dunes, east coast



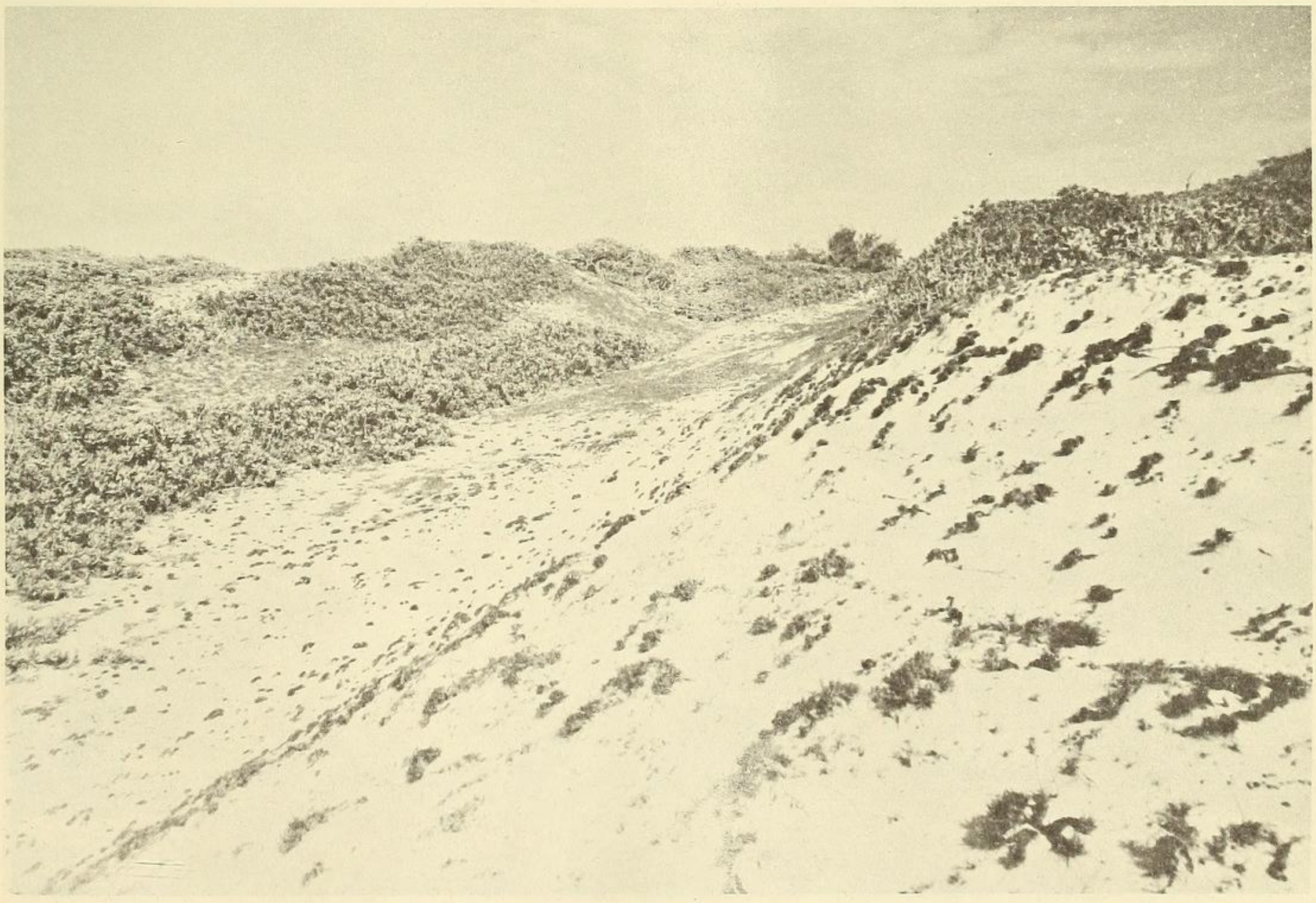
21. Transverse erosional grooves in the reef flat, backed by a rocky erosion ramp, beach, and high dunes; east coast



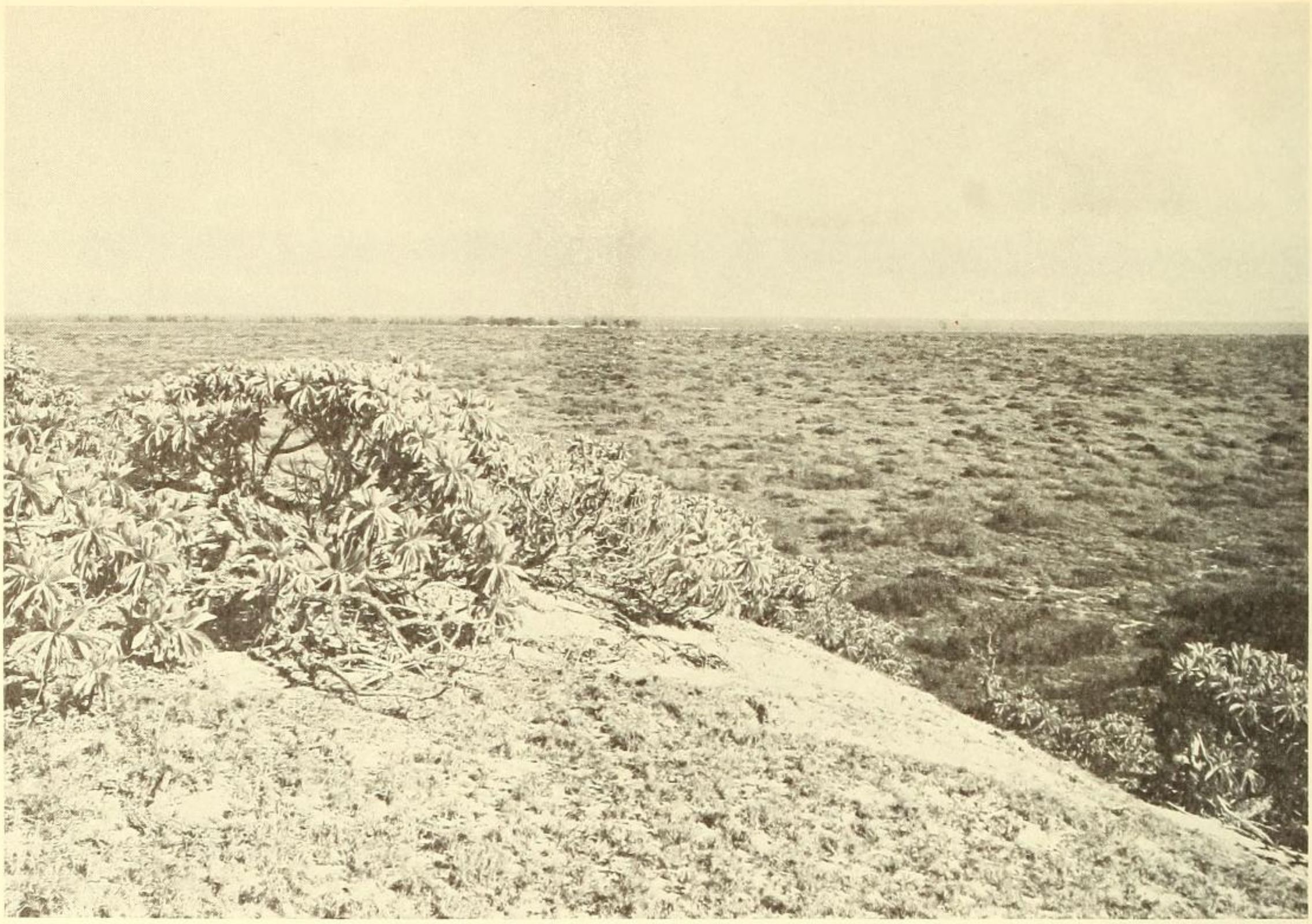
22. Outer edge of the reef flat near the high dunes, east coast

23. Small dunes on the perched beach, which is densely covered with grasses; east coast, looking north

24. Clumps of Suriana maritima and scattered Fimbristylis on the eroding seaward face of the highest dune



25. Scaevola and Fimbristylis on the high dunes

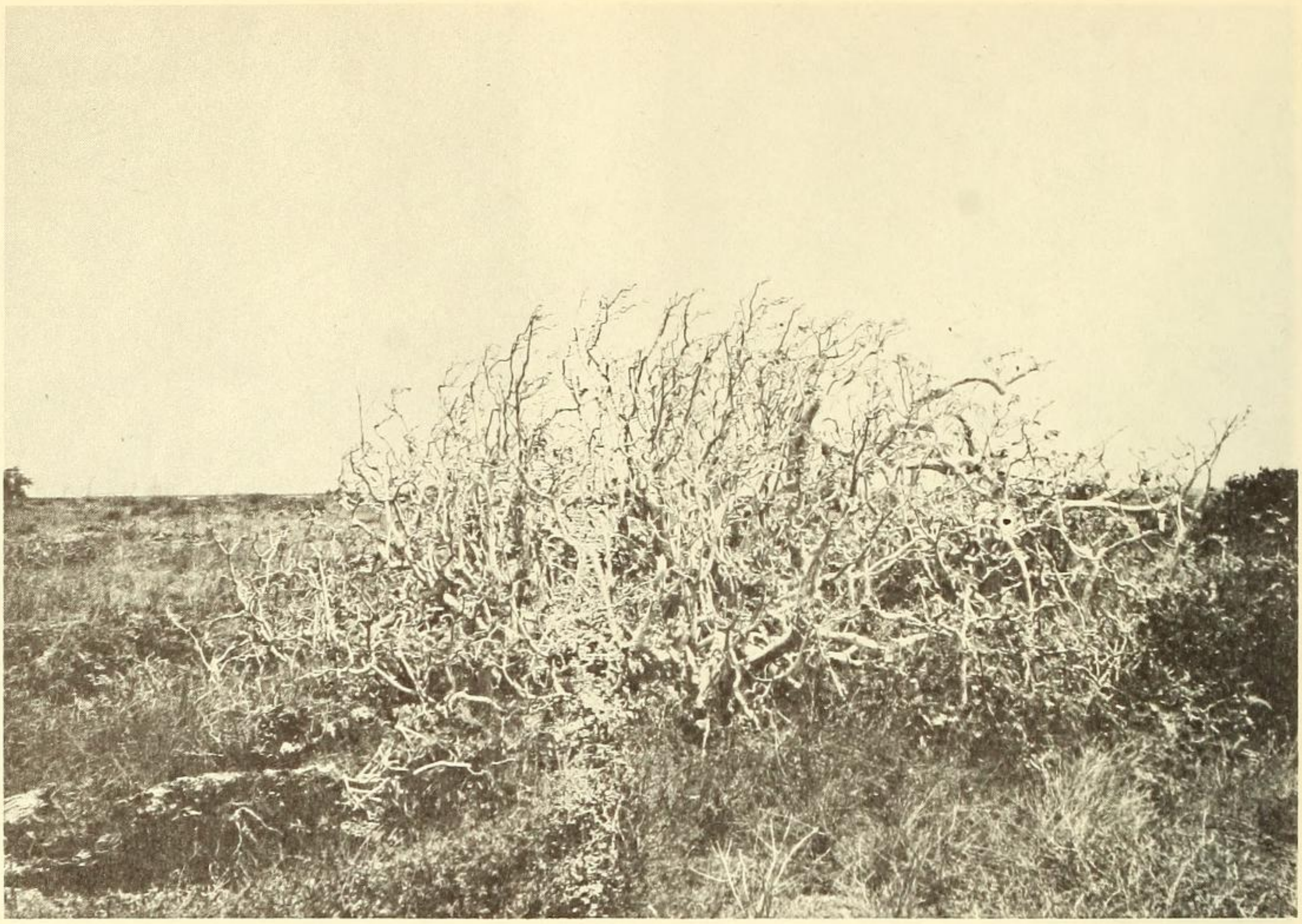


26. View from the summit of the highest dune, with Tournefortia scrub, across the low mixed scrub of the centre of Assumption. The line of Casuarina trees on the west shore marks the Settlement

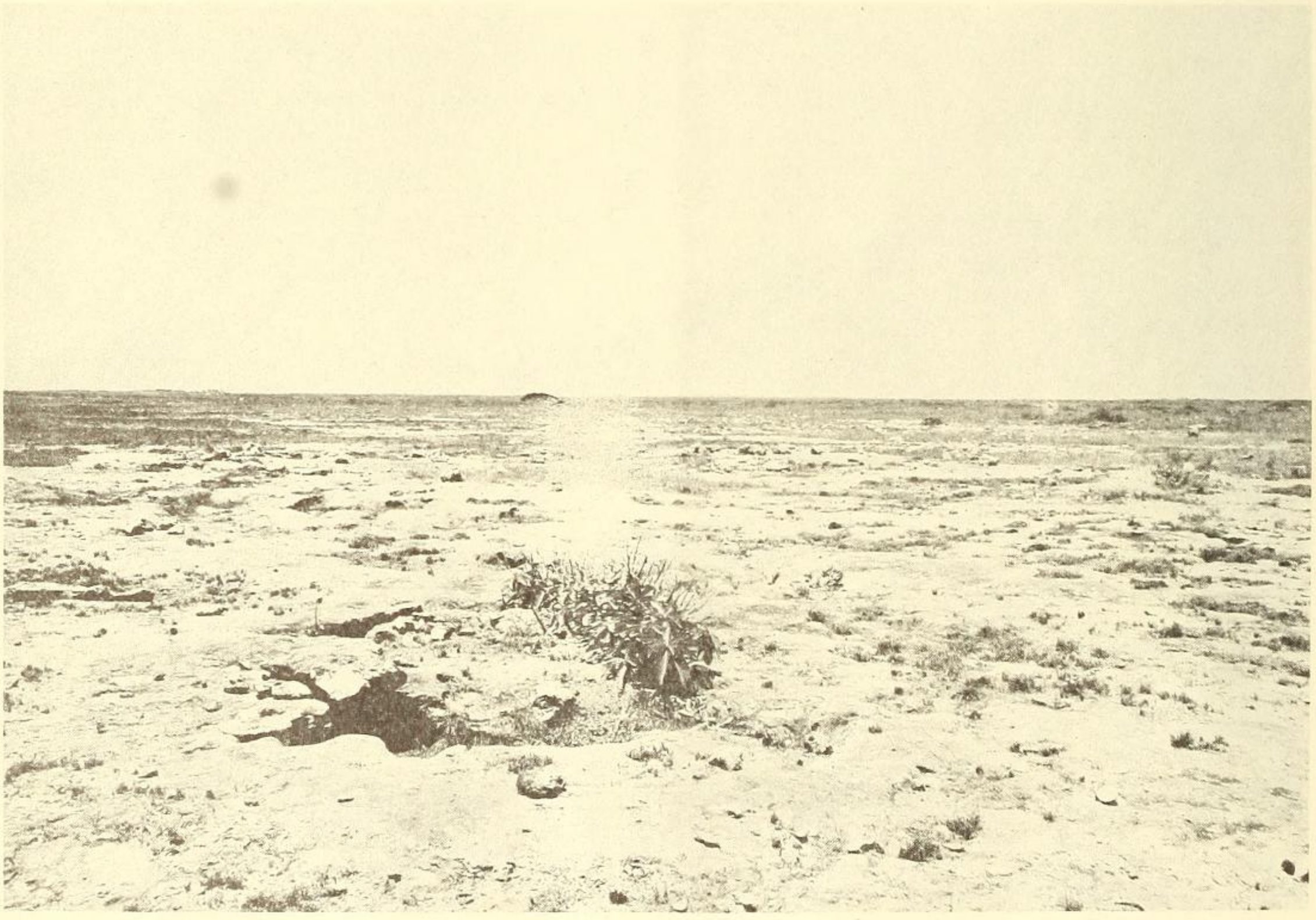
27. The lee slope of the highest dune, with Tournefortia and Scaevola

28. Tournefortia and Suriana forming the littoral hedge on the prograding west coast, view north from Settlement

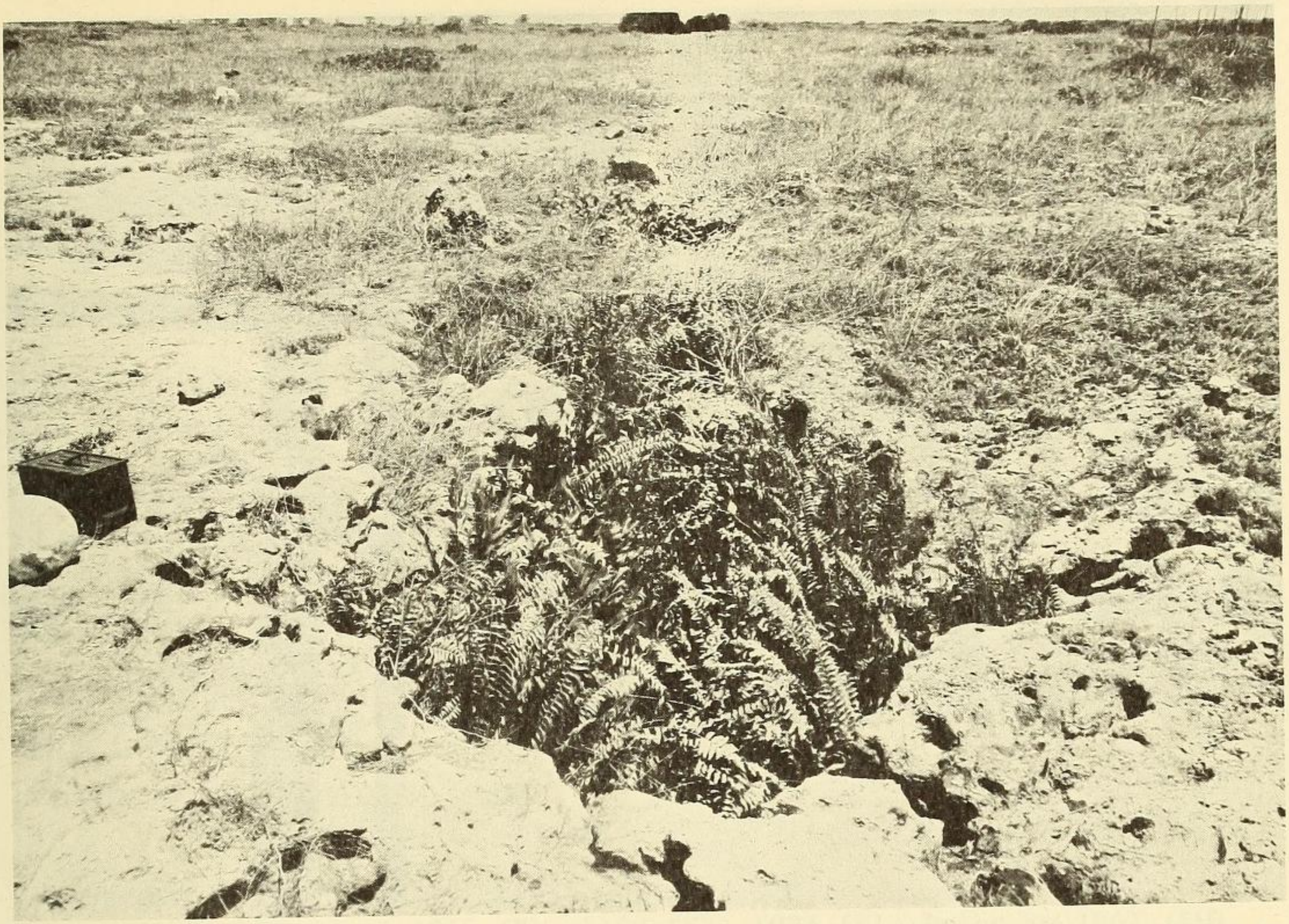
29. Suriana and Pemphis forming the littoral hedge near the northern end of the west coast



30. Leafless Pisonia in the low mixed scrub in the centre of the island

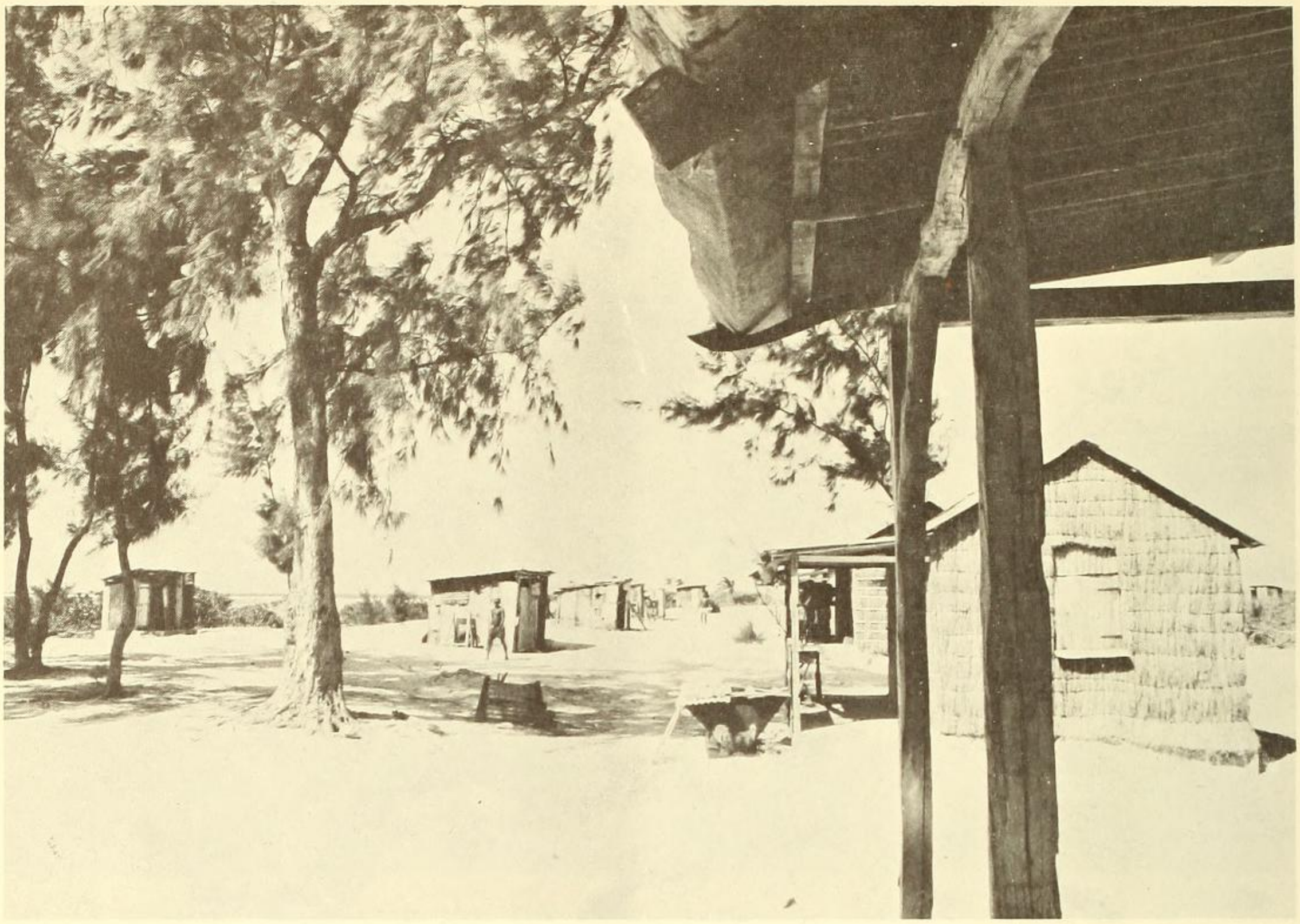


31. Flat platin almost devoid of soil and vegetation, northern end of the island; Ficus in the foreground

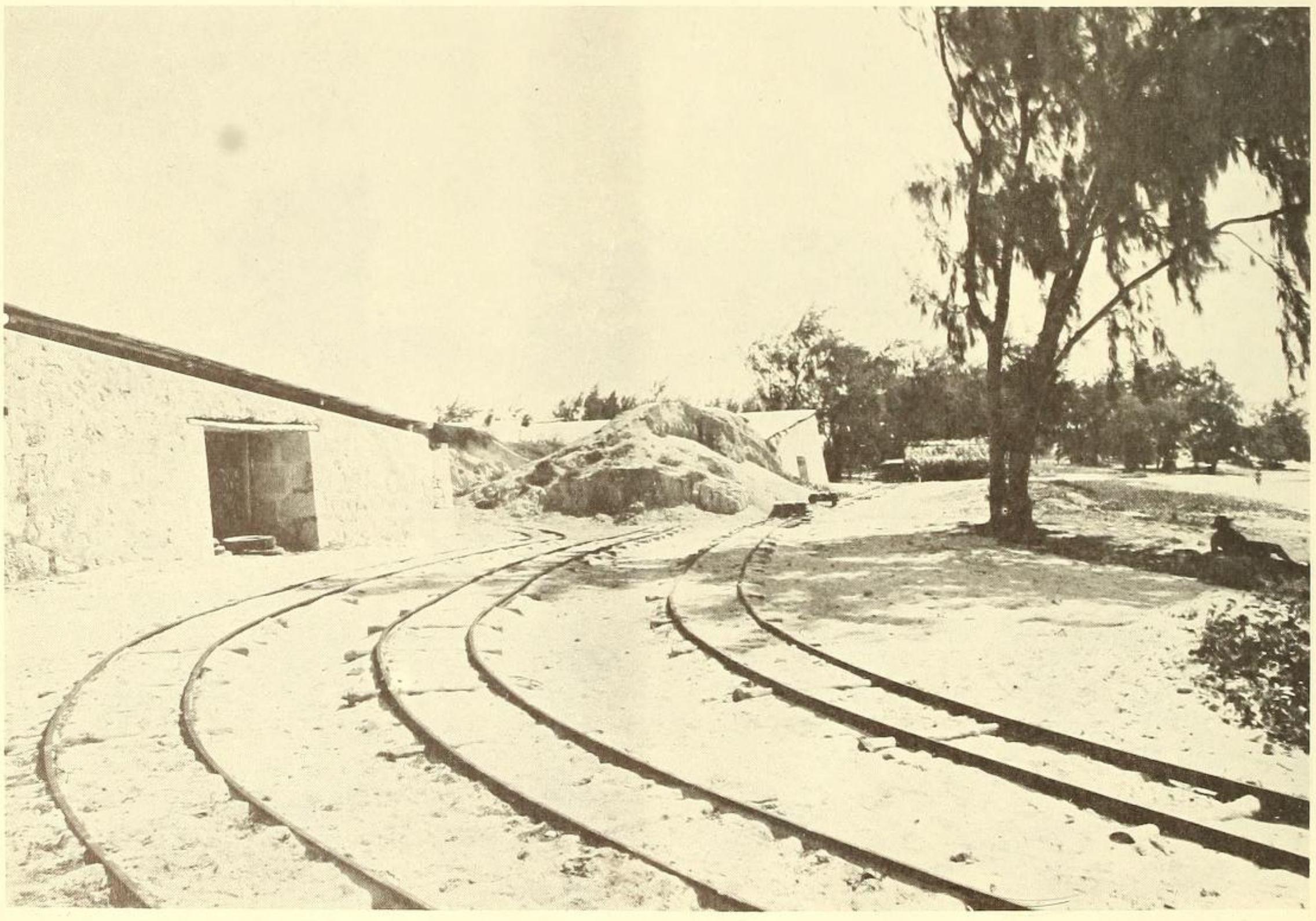


32. Nephrolepis biserrata in a solution hole, north end

33. Agave, massive Terminalia, and Cocos at the site of the old settlement; note the water tank behind the coconut



34. Labourers' huts at Settlement; compare with the illustration given of similar quarters in Fryer (1910)



35. Guano railway and sheds at Settlement