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NATURAL HISTORY OF BRAMBLE CAY, TORRES STRAIT

BY

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ABSTRACT

Bramble Cay, a small (3.6 ha) vegetated sand cay, is the most northern island of the Great Barrier Reef and the closest to the mouth of the Fly River. It has both volcanic rock and a reefal sand cay within its lagoon, and phosphatic rock exposures on the cay. The sand cay is the most important location for both seabird and turtle breeding in the Torres Strait and supports an endemic mammal, the rat *Melomys rubicola*. Records indicate that numbers of birds and rats have declined over the last century, possibly due to erosion and loss of vegetated area of the cay. The vegetation of the cay, made up of three herbs, is heavily disturbed by nesting activities. There is, however, a large and diverse drift flora, that is dominated by mangrove propagules exported from the Fly, that has no overlap with the cay's flora. Bramble Cay has a significant human history both from European exploration of the New Guinea coast, and from being the entrance marker to the Great North East Channel through the Torres Strait.

INTRODUCTION

Bramble Cay is the northern extremity of the Great Barrier Reef (GBR) before coral growth becomes limited by the discharge of the Fly, and is the northerly point of Queensland in the Torres Strait (9°08.6 S, 143°52.8 E, Figure 1). It is located 52.8 km SE of Kiwai Island, in the delta of the Fly River, Papua New Guinea (PNG), which carries an annual sediment load of 85 million tons year^{-1} (Harris, et al., 1993) Bramble Cay, however, has clear water and coral reef growth owing to passage of the Fly River plume to the north, tracking directly east along the PNG coastline (Harris, et al., 1993).

Of the island types found in the GBR, Bramble Cay (Plate 1) is within the category of low, vegetated sand cays modified by seabird activites described by Stoddart and Fosberg (1991) at Coombe, Michealmas, Raine, Stapleton and parts of Stainer, Morris and Magra. These are all located between 11-17°S; Bramble Cay is distinguished by its location in the wetter and biogeographically more diverse northern sector of the GBR. These types of islands feature patchy vegetation cover, with uncommon shrubs, and large bare areas resulting from seabird disturbance.

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The closest climate station to Bramble Cay is Daru (74 km to the west), which shows a mean annual rainfall of 2063 mm, and a range of 1163-3972 mm in the period 1894 to 1970 (McAlpine et al., 1983). Most rainfall occurs in the summer period, November to April. Southeasternly trade winds prevail from March to November, tending to send westward currents through the Torres Strait; the Northwest monsoon prevails December to March, tending to send an eastward current through the Strait.

Tides in the Gulf of Papua are semi-diurnal, with a mesotidal range of 2-2.5 m. Circulation in the Gulf of Papua is driven by tidal and wind-induced currents, influences the distribution of sediment load of the Fly along the coastal zone. The Fly has an annual freshwater discharge rate exceeding 235 km^3 (Alongi et al., 1992), carrying 85 million tons of sediment $year^{-1}$ (Harris et al., 1993), of which 47% is discharged from the delta. This sediment is largely carried northeast from the delta and along the coast of the Gulf of Papua, except during the southeast trade wind season, when a small proportion of discharge from the Fly traverses west from the delta and along the southern coastline of PNG (Harris et al., 1993).

GEOLOGY AND GEOMORPHOLOGY

The island rises from water depths of 35 m to an oval reef 1.8 x 0.9 km (Figure 2). It is of volcanic origin, demonstrated by exposures of Pleistocene Maer volcanics in the lagoon (Jardine, 1928; Willmott, et al., 1973). Similar exposures occur at several locations in the NE Torres Strait, at the Murray, Darnley and Stephens Islands, and the Black Rocks 6.5 km to the SW of Bramble Cay. They result from subaqueous emission of basaltic lava, that subsequently was deeply eroded. The largest exposure (about 40 x 40 m) in the Bramble Cay lagoon is shown in Plates 1 and 2.

The sand cay occurs at the western margin of the lagoon, 330 m NW of the large volcanic outcrop, and has a vegetated area of 175 x 76m. It is composed of foraminiferal sand, with some coral and shell fragments (Jardine, 1928), with an exposure of phosphatic rock on the southeast shore (Figure 3, Plate 3) that rises to 1.9 m above HTM. The vegetated area has several raised ridges and lower pools which collect rainwater (Plate 1). Stratigraphy was examined at two locations. Location 1, on a ridge in the southeast of the island, showed 14 cm of organic peat above hard phosphatic rock. Location 2, adjacent to a pool in the center of the island, showed 22 cm of peat above 40 cm of loosely cemented calcareous sand. This is similar to stratigraphy reported from Raine (Stoddart et al., 1981) of moist black peat above calcareous rubble.

In 1862 a mining lease was granted to the Anglo-Australian Guano Company (Crowther, 1939), and occasional boats mined the low grade phosphatic rock (Jardine, 1928). The quality was poor enough to ensure that a base was not established as at Raine (Stoddart et al., 1981), and areas of rock remain today. There is an exposure at the eastern end of the cay (Figure 3, Plate 3). A sample of this rock was analysed, and compared with a surface soil sample from the interior of the cay. Samples were treated with perchloric/ nitric acid

and analysed by ICP-AES. Owing to their high carbonate and phosphatic content, they were diluted for verification. Results are given in Table 1.

Stoddart and Scoffin (1983) reported levels of phosphate of 7.8-35.1% from rock on Raine, demonstrating the lower grade quality of the Bramble Cay rock. This is probably because Bramble Cay receives substantially more rainfall than Raine.

Coal is commonly found on Bramble Cay, both inland on the surface and exposed in wave eroded sand cliffs. Plate 4 shows these as wave-rounded and cobble sized. The source is ships wrecked on the island (Table 2), the most likely being either the *Windhover* (1889) or the *Mutlah* (1915). Both are discussed in the next section.

EARLY HISTORY

The chronology of human visits to the island is given in Table 2.

Customary tenure of Bramble Cay is held by the inhabitants of Darnley Island, 45 km to the southwest. The islanders' legend of Rebes describes how Darnley people, using soil rafted from Darnley, built Bramble Cay to provide turtle eggs and meat in season. Having deposited the soil to form the Cay, the wind veered and strengthened, and four villagers were fixed to form the volcanic rock outcrop, and the rest formed the (phosphatic) stone on the sand cay (Haddon, 1935). Darnley Islanders travel to Bramble Cay to collect turtle and bird eggs during the nesting season, and also grant inhabitants of other islands permission to collect (Johannes and MacFarlane, 1991).

The island was named after the *HMS Bramble* which under the command of Lieutenant C. B. Yule, was engaged in survey work in the Torres Strait and the southern coast of Papua New Guinea in 1843 and succeeding years (Jukes, 1847). Accounts of these early visits provide information about the island's earlier history and ecology. The *Fly* visited Bramble Cay on 6 May, 1844, and Jukes comments:

> The sand-key on one side of the reef was precisely similar in appearance and structure to Raine's Islet, except that it was much smaller. It equally abounded in "spinach" and bird's eggs, and any ship coming in from the Pacific in want of fresh provisions might get enough for some days' consumption by stopping there, taking care to break all the eggs on the island as soon as they arrive, in order to have new-laid ones to carry away with them (Jukes, 1847).

When the *Bramble* returned to Bramble Cay in April 1846, a junior officer remarked that Mr. Yule considered it to be a good anchorage "because it was free from natives of whom he entertained the greatest horror. Here besides a good supply of eggs and spinach we also obtained 5 turtle" (Sweatman, 1977). The anchorage was returned to on 3 June, after a survey of the south coast of New Guinea. The ship remained 5 days to obtain observations for rating the chronometers, and took advantage of the stay to obtain a good supply of eggs (Sweatman, 1977).

During the visit of the *Rattlesnake* 16-19 December 1849, tern and booby eggs were smashed and gathered, and a total of 18 turtles were taken (Huxley, 1935). Huxley comments: "The spinach to my mind is filth; others like it however."
MacGillivray (1852) comments from the same visit:

> In the afternoon I landed for an hour, passing many turtle on the water both going and returning. As usual the island was covered with sea birds, only two species, however, of which were breeding. The Brown Booby (*Sula fusca*) and a large tern (*Thalasseus pelecanoides*) existed in about equal numbers....As the tern eggs were within a short time of being hatched we broke all we saw in order to ensure some newly laid ones in a day or two...
> The Golden Plover was plentiful on the island during our visit, and one afternoon I killed fifteen in about an hour...
> The weed which in the *Fly* we used to call spinach (a species of *Boerhaavia*, actually *B. duffusa*) being in abundance here, was at my suggestion collected in large quantity for the use of the ships company as a vegetable, but it did not seem to be generally liked.

In 1889 four ship wrecks occurred on the island (see Table 2). The Master of one requested in a letter to *Nautical Magazine* that a lighthouse be located on the cay (Planck, 1889). He stated that the island is at the entrance to the N.E. channel, is difficult to see owing to its low elevation, and because strong and irregular currents occur in the area. The *Windhover* went ashore on the cay in August 1889 while carrying coal, and was abandoned. This wreck could have contributed some of the coal found today on the cay.

A James Nourse steamer, the *Mutlah*, went aground at Bramble Cay on 28/8/1915 on a voyage from Port Kembla to Colombo. It was refloated on 13/9/15 (John Foley. pers. comm), apparently after some thousands of tons of coal had been jettisoned. This coal is referred by Rev. Done, who visited the island on the *Herald* in 1917, and used some of the coal for fuel (Done, 1987).

Done (1987) was not there in the turtle breeding season, so "On this occasion we had to be content with terns' eggs and secured a large quantity.....They were subsequentely used boiled, fried, scrambled or in omelette form, and were not in the least fishy in flavour."

Bramble Cay was heavily exploited in its early history for bird and turtle eggs by both European and Torres Strait Islander visitors. The effects of this exploitation on breeding colonies are discussed in the fauna section below.

Lighthouse History

Bramble Cay, marking the northern entrance to the Great North East Channel through the Torres Strait, is today dominated by a lighthouse (Plate 5). From 1890 it was the boarding ground for pilots to guide sailing vessels through the channel to Thursday

Island (Davenport, 1986). This followed a series of shipwrecks on the cay (Table 2), and requests for a lighthouse (see previous section).

Done records in 1917 that "according to a chart there is a beacon 45 ft high. But that beacon has long been in a recumbent position, and is of no value to mariners. It is whispered that there is some talk of an unattended light being placed there...."

In 1924 (24 October) a 42 ft pyramidal steel tower was erected. Jardine (1928) showed this as located in the central eastern end of the island (Figure 6). There are no remains of this tower today. According to A.M.S.A. records it was razed in 1954 and replaced by the present lighthouse, though Limpus et al. (1983) reported that a temporary scaffold with four wire guys was erected at the southeastern end of the cay in 1958. The remains of this structure can be found on the beach at the southeastern end (Fig. 3, Plate 6), the island having moved to the northwest.

The present lighthouse, a 17 m stainless steel tower, was converted to solar power on 6 January 1987. The lighthouse was never manned, but is maintained by A.M.S.A. vessels every 3-6 months.

MOVEMENT OF THE CAY

Figure 4 shows changes in shape of Bramble Cay between 1978-1979 when it was mapped by Applied Ecology (Parmenter, 1980), and 1994-5 when it was mapped by the author using tape and compass techniques. Other detailed surveys of the island exist that could not be incorporated into this map. Jardine (1928) provided a map of the island from his visit in September 1924 (Figure 6), but the remains of the lighthouse shown on this map could not be located in 1994-5, hence there is no common reference.

In 1924 the area of the cay within the tidal level shown by Jardine (1928) was 395 x 183 m. Limpus et al. (1983) record the dimensions of the island at spring high tide level in December 1977 and 1978 as 340 x 150 m. Parmenter (1980) mapped the island area above high tide as 281 x 128 m in October 1978, and 223 x 112 m in March 1979. In January 1987 the dimensions of the island above high tide were 320 x 130 m (Walker, 1988); in February 1994 it was 272 x 126 m and in February 1995 it was 251 x 104 m. The area of the island in 1995 was 1.72 ha in vegetated area, and 3.62 ha above high tide mark.

Limpus et al. (1983) concluded that the cay was moving towards the northwest, and losing sand over the edge of the reef flat (see Fig. 2). Parmenter (1980) showed that during the south-easterlies (winter) sand is deposited at the northwest shore of the cay, which is eroded during the north-westerlies (summer). Figure 4 shows that the shape of the cay has not substantially changed since the 1970's, the most significant change being reduction in vegetated area.

In 1924 the vegetated area was 295 x 146 m at its widest dimensions (Jardine, 1928); in 1978-79 it was 170 x 97 m (Parmenter, 1980); in January 1987 it was 215 x 100 m (Walker, 1988); and in 1994-5 it was 175 x 76 m. Figure 4 shows that most of the loss has been from the south and north shores. Plate 7 shows how the vegetation margins are limited by the activites of turtle nesting. A former control on turtle nesting would have been cliffs of phosphatic rock, the historic removal of this would make more island area accessible. The main control today is turtle access. Turtle breeding occurs in the summer period, when the island is being eroded from the northwest. Plate 8 shows the sand cliff that develops, which discourages turtles from coming ashore. Many failed attempts were witnessed at night in February 1995. The turtles would move along the shore and successfully cross the beach on the gentler graded south or north shores. The east shore is somewhat protected from turtles by the phosphatic rock outcrop cliffs.

The reliability of Jardine's measurement techniques is demonstrated by his detailed map of the volcanic rocks in the lagoon. Therefore his map of the cay can be used as strong evidence that the island has substantially eroded this century. The area within high tide levels is more variable (Figure 4) with seasonal prevailing wind, but the vegetated area has consistently declined.

WATER

Water collects in pools on Bramble Cay after rainfall and can remain for several days. Water samples were tested in February 1995 from two locations: 1 was the large pool in the NE of the cay (Figure 5, Plate 5), and 2 was the large pool SE of the lighthouse (Figure 5, Plate 7). Results in Table 3 show that surface pools are of fresh water.

VEGETATION AND FLORA

The vegetation of Bramble Cay consists of low herbaceous cover (Plates 1 and 5), greatly disturbed by nesting activities of birds and turtles. Species present in 1994-5 and past records are summarised below. Nomenclature follows Fosberg and Stoddart (1991).

AIZOACEAE

Sesuvium portulacastrum (L.) L.
Limpus et al. (1983) sight.

AMARANTHACEAE

Amaranthus viridus L.

Parmenter, s.n. (January, 1984); Queensland Herbarium s.n. (in Walker, 1988); Walker (1988); Ellison 1002, 1003, 1005.
This erect or decumbent annual with weedy habit was occasional on Bramble Cay in 1994 and 1995.

ARECACEAE (PALMAE)

Cocos nucifera L.
Walker, sight (dead). Drift seeds were present in both 1994 and 1995 (see later section), but none established. Coconuts have been planted on the island by visitors, but have not survived long (Walker, 1988).

CONVULVULACEAE

Ipomoea pes-caprae (L.) R. Br.
Queensland Herbarium s.n. (in Walker 1988).

CYPERACEAE

Cyperaceae indet.
Queensland Herbarium s.n. (in Walker 1988).

NYCTAGINACEAE

Boerhavia tetrandra sensu Walker non Forst. f.
MacGillivray (1852) sight; Queensland Herbarium s.n. (in Walker 1988); Limpus et al. (1983) sight; Parmeter (1980) sight; Ellison 1001, 1004.
The dominant cover on Bramble Cay, as found by all visitors. This is the "spinach" gathered and eaten by early European visitors (MacGillivray, 1852; Sweatman, 1977). Forms a lush and dense cover up to 40 cm in height, especially on raised and better drained areas of the cay.

POACEAE (GRAMINEAE)

Cenchrus echinatis L.
Queensland Herbarium s.n. (in Walker, 1988).

Lepturus repens (Forst. f.) R. Br.
Queensland Herbarium s.n. (in Walker, 1988). Limpus et al. (1983) sight; Parmeter (1980) sight; Ellison, 1006.

Not found by Walker in January 1987, but by February 1995 had reestablished on the north shore of the cay.
Poaceae indet.
Walker, 1988. Unidentified grass found both in January 1984 by C.J. Parmeter and January 1987 by T.A. Walker. Not present in 1994-5.

PORTULACEAE

Portulaca oleracea L.
Parmeter, 1984, sight; Walker, 1987. Not present in 1994-5.

ZYGOPHYLLACEAE

Tribulus cistoides L.
Queensland Herbarium s.n. (in Walker, 1988).

There are records of 11 species of flora from Bramble Cay, but only 3 were found in 1994-5, *Boerhavia tetrandra* , *Amaranthus viridus* and *Lepturus repens* . Limpus and Parmenter found 5 species in 1984, and Walker found 4 species in 1987 (Walker, 1988). The record for *Lepturus repens* indicates that species may be lost from the cay and re-establish, and the later section on drift seeds indicates that there is a plentiful and diverse supply of seeds.

There is intense disturbance of the periphery of the vegetated area of the cay from the nesting activities of turtles, illustrated in Plate 7. Figure 4 shows change in the vegetated area of the cay from 1983 to 1995, indicating that the area has been substantially reduced. This provides an explanation for the reduction in species numbers recorded here.

FAUNA

Coral

The coral communities at Bramble Cay were surveyed by Babcock (1988), who found 117 species, and described coral communities as a mixture of inshore types (of more turbid water), and those more typical of exposed mid and outer shelf reefs of the central GBR. This is due to the combination of proximity to the Fly and exposure of the island to southeasterly swell fom the Coral Sea (see Fig. 1).

Some dead coral seen during the survey was attributed to predation by the crown-of-thorns *Acanthaster planci*, of which 7 were observed.

Birds

Bramble Cay is a major breeding colony for seabirds in the Torres Strait islands (Cameron, et al., 1978), particularly Sooty Terns, Crested Terns, Common Noddies and Brown Boobies. Draffan et al. (1983) show a total of 24 species in a summary table, but only 20 species are named as present on Bramble Cay in the listings by species. Walker (1988) recorded 10 species present in January 1987. On 19 February 1995 there were 11 species present, of which one was a new one for the island (Black-Fronted Dotterel). There have been a total of 23 birds recorded on the island, of which one is almost certainly a mistake (Lesser Noddy).

ALCEDINIDAE

Halcyon sancta Sacred Kingfisher

Recorded by Draffan et al. (1983), a common passage migrant and winter resident in the Strait.

ARDEIDAE

Egretta sacca Eastern Reef Egret

Recorded by Draffan et al. (1983) as breeding during the wet season. Walker (1988) recorded 2 on the volcanic rocks. On 19 February 1995 there was 1 present on the rocks.

Nycticorax caledonicus Rufous Night Heron

Recorded by Draffan et al. (1983), common in the Strait. Walker (1988) recorded 1 on the volcanic rocks. Not recorded on 19 February 1995.

CHARADRIIDAE

Pluvialis dominica Lesser Golden Plover

Recorded by Draffan et al. (1983), common in the Strait. Walker (1988) recorded 20 present. On 19 February 1995 there was one present on the beach, in non-breeding plumage. MacGillivray (1852) records that they were plentiful on the Cay in December 1849, such that he was able to kill 15 in about an hour. Done (1987) notes "half a dozen Plover" present in September 1917.

Charadrius mongolus Mongolian Plover

Recorded by Draffan et al. (1983), common in the Strait. Not recorded by Walker (1988) or in February 1995.

Charadrius melanops Black-Fronted Dotterel

On 19 February 1995 4 were seen feeding in mud areas adjacent to a freshwater pool. This species is previously unrecorded on Bramble Cay.

Subfamily CIRCINAE

Circus assimilis Allied Harrier
MacGillivray (1914) records this present at Bramble Cay on 27 July 1911.

COLUMBIDAE

Ptilinopus superbus Superb Fruit Dove
Recorded by Draffan et al. (1983), nocternal movement across the Strait September to April, not breeding.

FREGATIDAE

Fregata ariel Lesser Frigatebird
MacGillivray (1914) recorded 2 present at Bramble Cay on 27 July 1911. Draffan et al. (1983) recorded presence, but not breeding. Walker (1988) recorded 12 circling overhead or roosting on the volcanic rocks. On 19 February 1995 there were 20 circling overhead or roosting on the volcanic rocks.

Fregata minor Greater Frigatebird
Draffan et al. (1983) recorded presence, but not breeding. Not recorded by Walker (1988) or in February 1995.

LARIDAE

a) Noddies

Anous stolidus Common Noddy
MacGillivray (1914) records these as 'very numerous" at Bramble Cay on 27 July 1911. Draffan et al. (1983) record that more than ten thousand birds breed at Bramble Cay during the wet season. However, in January 1987 Walker (1988) recorded only 30, with 10 unfledged juveniles on the eastern end of the cay, noting that this was not the peak of the breeding season. On 19 February 1995 approximately 3300 were present, with nesting colonies dispersed across the cay (Figure 5). These were in raised and vegetated areas, and occasionally shared the nest of *Sula leucogaster*.

Anous tenuirostris Lesser Noddy
Noted by Draffan et al. (1983) as probably an erroneous record made by Masters (1875), an error for *Anous stolidus*.

b) Terns

Sterna bergii Crested Tern

MacGillivray (1914) records 'great numbers" present at Bramble Cay on 27 July 1911, but not breeding. Draffan et al. (1983) record that over a thousand pairs nest regularly from December to March, despite human predation. Walker (1988) recorded approximately 1800 nests in 4 large colonies on the eastern end of the cay. On 19 February 1995 this was the most common bird present on the cay, with approximately 6400 present in nesting colonies (Figure 5), with the largest colonies at the northwest end and the northeast end surrounding a freshwater pool. The Crested Tern colonies were in lower elevation, unvegetated locations adjacent to areas that flooded after rainfall.

Sterna fuscata Sooty Tern

MacGillivray (1914) records "great numbers" present at Bramble Cay on 27 July 1911, with two small colonies of fledged young. Draffan et al. (1983) recorded this as the most common species at Bramble Cay, with 40,000 breeding in the summer, despite heavy human predation. Walker (1988) recorded 700, with 300 nests containing eggs. On 19 February 1995 there were approximately 1300 present, in four separate colonies on the northwest end of the cay (Figure 5). Like the Crested Terns, the Sooty Terns nested in lower elevation areas.

Sterna hirundo Common Tern

Recorded by Draffan et al. (1983), noted as an uncommon summer visitor to the Torres Strait. They were not recorded by Walker in 1987; on 19 February 1995 there were 10 present.

Sterna anaethetus Brindled Tern

10 pairs are recorded by Draffan et al. (1983) as breeding on Bramble Cay. Not recorded by Walker (1988) or in January 1995.

c) Gulls

Larus novaehollandiae Silver Gull

Recorded by Draffan et al. (1983), who notes that the species breeds on small islands during the winter months. Walker (1988) recorded 24 present. On 19 February 1995 there were 10 present.

PHAETHONTIDAE

Phaeton lepturus White-tailed Tropicbird

Vagrant seen at Bramble Cay November 1989 (Draffan et al., 1983).

PLATALEIDAE

Threskiornis eathiopica Sacred Ibis
Recorded by Draffan et al. (1983), who notes that the species is an irregular visitor to eastern islands.

SCOLOPACIDAE

Arenaria interpres Ruddy Turnstone
Recorded by Draffan et al. (1983), passage migrant found throught the Strait. Walker (1988) recorded 50 present. On 19 February 1995 there were 30 seen on the beach, in breeding plumage.

Tringa brevipes Wandering Tattler
Recorded by Draffan et al. (1983), uncommon migrant.

STURNIDAE

Aplonis metallica Metallic Starling
Recorded by Draffan et al. (1983), nomadic in the Strait.

SULIDAE

Sula leucogaster Brown Booby
MacGillivray (1914) records only two nests present at Bramble Cay on 27 July 1911, but notes that this was just after a major feast by visiting islanders. Draffan et al. (1983) recorded that about 10 pairs breed on Bramble Cay during the wet season, and cites a report of breeding in July. Walker (1988) recorded 70 present. On 19 February 1995 there were 92 present, nesting in raised vegetated areas mostly on the north and east sides of the island (Figure 5).

Patterns in the bird communities

Bird nesting was limited at its outer perimeter by turtle nesting disturbance, which also controlled the outer limit of vegetation, shown in Figure 5. Turtle nesting activities were limited by occurrence of phosphatic rock. Most bird nesting was on the north side of the cay, with virtually no nesting on the south side, as shown in Figure 5. There was microelevational control of nesting patterns, with Terns nesting in lower elevation areas and Noddies and Boobies nesting in areas of raised elevation. The lowest areas were not used because these flood and hold pools of water after rainfall. Sooty Terns only nested on the west end of the cay in 1995, Walker (1988) recorded in 1987 that they only nested on the eastern end.

Walker (1988) comments on the impact of human predation on bird numbers, particularly on Brown Boobies which have a longer incubation and fledgeling period. Early ships visiting the island commonly smashed all eggs in order to gather fresh ones the next day (Jukes, 1847; Huxley, 1935; Sweatman, 1977). Johannes and MacFarlane (1991) describe the traditional harvesting of Boobies, Terns and Noddies, and their eggs by Darnley Islanders on Bramble Cay. Thousands of eggs could be collected on one trip by Darnley islanders, and frequently 14 or 15 turtles are brought back in addition. Walker (1988) witnessed thousands of eggs removed by people who arrived in speedboats from Stephens Island. The Booby numbers recorded in February 1995 were higher than other recent records (Draffan et al., 1983; Walker, 1988), but far less than the records of early ships visiting the cay. MacGillivray (1852) from a visit in December 1849 records Boobies nesting in equal numbers to Terns.

Turtles

Bramble Cay is one of Australia's larger green turtle (*Chelonia mydas*), rookeries (Limpus, 1981), though numbers recorded are variable. The nesting season in the Torres Strait is approximately October to February (Kowarsky, 1978).

In the early 1970's a federally-funded project by Applied Ecology Pty. Ltd. attempted to establish turtle farming in the Torres Strait islands. A research team spent 3 seasons (Oct-March) on Bramble Cay studying breeding habits (Onions, 1979), and turtle eggs from Bramble Cay and other islands were gathered to establish commercial turtle farms on inhabited islands (Kowarsky, 1977; Johannes and MacFarlane, 1991). Applied Ecology built a house on the southwestern end of the island, the foundations of which were still there in 1995 (Figure 3). The project had failed by 1980 owing to insufficient research and economic inviability (Johannes and MacFarlane, 1991).

Over their two years research Applied Ecology found a maximum nightly count of 60 turtles nesting. Numbers were generally lower: Kowarsky (1978) recorded 1 turtle nesting on 7 November 1975, and 9, 4 and 5 nesting on the nights 3-5 January 1976. The maximum count was Walker (1988) in January 1987, who recorded a minimum of 290 nesting. From 17-19 February 1995, 20 and 24 turtles nested each night, which was relatively low numbers.

As well as harvesting of bird eggs, early ships (see Table 1) visiting Bramble Cay commonly took turtles (MacGillivray , 1852; Sweatman, 1977; Done, 1987). Limpus (1980) noted that with all the taking of green turtles in the GBR area since European colonisation, Bramble Cay is the only island with evidence of a major decline in nesting populations. Parmenter (1980) commented that in the early 1970's government social programmes permitted dinghy/ outboard ownership beyond Thursday Island to allow easier turtle harvest in the Bramble Cay area of the Torres Strait.

Rats

Sweatman in April 1845 describes a number of large rats that ran from under dead turtle shells. This is *Melomys rubicola*, an endemic rodent that is only recorded on Bramble Cay, first described by Thomas (1924) from a specimen collected by MacGillivray in May 1845.

In 1977 and 1978 Limpus et al. (1983) describe several hundred rats as present, foraging in the vegetation at night. They found no evidence of the rat preying on eggs or young birds on the island. Walker (1988) found only one mother with two young near the lighthouse, though he did not visit after dark, when the rats are active.

In February 1995 rat tracks were seen around a small cave entrance beneath the phosphate rock on the southeast shore of the island, close to the 1958 lighthouse base. Tracks could be seen leading into fresh turtle nests, suggesting that the rats may not be vegetarian as was previously thought (Limpus et al., 1983; Walker, 1988). Nests with rat tracks approaching had uncovered and broken turtle eggs. On the night of 16/2/96 the *R/V Harry Messel*'s engineer reported seeing rats feeding on turtle eggs (Craig Rawson, pers. comm.). Despite a search for two nights with torches, this was the only individual seen during the visit, suggesting that numbers are much reduced from the 1970's.

DRIFT DISSEMENULES

The diversity of species occurring on Bramble Cay as drift seeds was considerably more than that of the island's flora, with no common species. All seeds stranded during low tide on 6 Febraury 1994 and 17 February 1996 were collected and identified. Results are given in Table 4.

In 1994 (6 February) the shoreline length was 886 m, and there were a total of 647 drift seeds, of which 79% were mangrove. This gave a seedling density of 0.73 seeds/m. In 1995 (17 February) the shoreline length was 809 m, and there were a total of 3206 drift seeds, of which 81% were mangrove. This gave a seed density of 3.96 seeds/ m.

In addition to seeds, there was a diversity of other debris along the strand-line, including whole *Nypa* trees, other large tree trunks, old turtle eggs, pumice, *Sargassum* seaweed, cuttlefish and coal. There were mangrove plant parts such as *Bruguiera* buds, *Sonneratia* and *Bruguiera* flowers, and *Rhizophora* leaves.

The domination of Bramble Cay's drift flora by mangroves, particularly *Nypa,* suggests a source from the Fly River. Sedimentation studies by Harriss et al. (1988) showed that the vast majority of discharge of the Fly is carried northeast from the delta and along the coast of the Gulf of Papua. During the southeast trade wind season, a small proportion of discharge from the Fly traverses west from the delta and along the southern coastline of PNG. Both drift seed counts here were from February, when prevailing Northerlies should keep Fly discharge from affecting Bramble Cay. The drift species and quanitity,

however, suggest that large amounts of debris from the Fly are caught in eddies away from the main direction of the plume, to deposit material on Bramble Cay.

During the author's visits to Bramble Cay the Australian Institute of Marine Science cored several large *Porites* colonies. Data shows complex interactions between river plumes and coral crowth band fluorescence, as well as stable isotope and trace element variations thought to be associated with sea surface temperature (Gregg Brunskill, pers. comm. 8/98). This confirms the drift seed record that Fly discharge influences Bramble Cay.

CONCLUSION

This review has established that for its small size (3.62 ha), Bramble Cay has particular interest in its location and geomorphology, flora and fauna, and human history. It is both the most northern island of the Great Barrier Reef and the closest to the mouth of the Fly River. It has both volcanic rock and a reefal sand cay within its lagoon, and phosphatic rock exposures on the cay.

Records show 23 species of seabirds on the sand cay, and it is a major breeding location for Crested and Sooty Terns, Common Noddies and Brown Boobies. It is one of Australia's most important green turtle rookeries, and also has an endemic mammal, the rat *Melomys rubicola*. Records indicate that numbers of birds and rats have declined over the last century, possibly due to erosion and loss of vegetated area of the cay. The vegetation of the cay is heavily disturbed by nesting activities, and is limited to three herbs, though there are records of eleven in total over time. There is, however, a large and diverse drift flora, dominated by mangrove propagules exported from the Fly, that has no overlap with the cay's flora.

Bramble Cay has a significant human history both as a site of European exploration of the New Guinea coast, and as the entrance marker to the Great North East Channel through the Torres Strait. It has records of five shipwrecks that have resulted in significant deposits of coal on the cay. and a history of four lighthouses which are lost over time due to movement of the cay.

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Plate 1. Bramble Cay, showing low herbaceous vegetation, tern rookeries adjacent to water pools, and volcanic rock offshore in the lagoon.

Plate 2. Pleistocene volcanic exposure in the Bramble Cay lagoon.

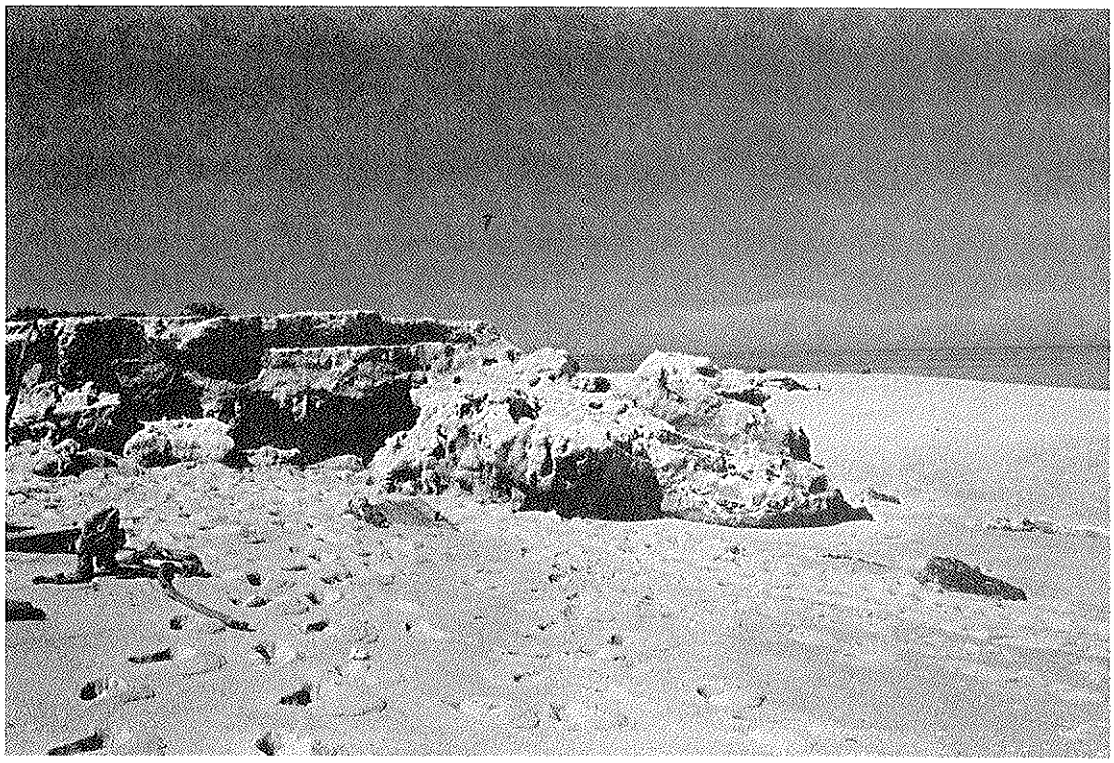

Plate 3. Phosphatic rock exposure (to 1.9 m above HTM) on the SE shore.

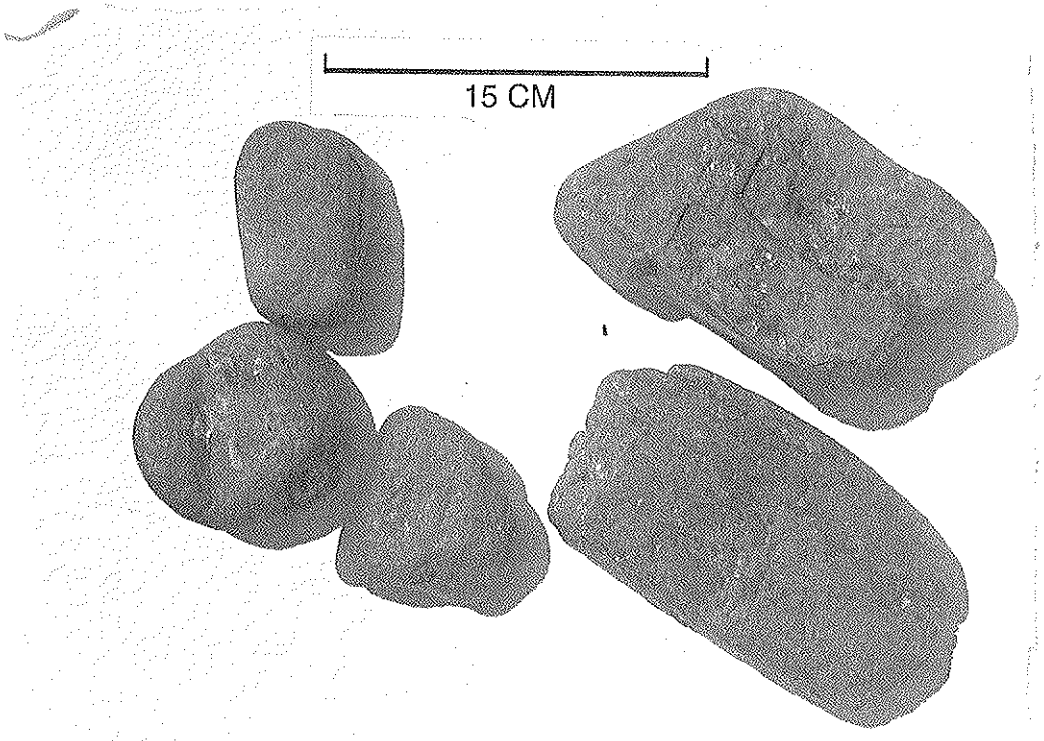

Plate 4. Coal collected from wave cut sand exposures, Bramble Cay.

Plate 5. Inland of Bramble Cay, showing Boobies nesting on higher ground in the foreground, crested terns nesting on lower ground adjacent to water pools, and the lighthouse.

Plate 6. Remains of the 1958 lighthouse.

Plate 7. Illustration of how turtle nest craters limit the vegetated area, this from the southern margin of the cay.

Plate 8. Eroded south shore of Bramble Cay, February 1995.

Table 1. Major element analysis of rock and soil from Bramble Cay.

		Phosphatic rock	Soil surface
Fe	%	0.04	0.04
Mg	%	1.10	0.34
Al	%	0.05	0.03
Ca	%	32.8	18.6
Cu	ppm	3	34
P	%	4.77	14.8
Na	%	0.72	0.24

Table 2. Chronological record of human visitors to Bramble Cay

DATE	VESSEL	VISITORS	NOTES	REFERENCES
Ongoing		Darnley Islanders	collect turtles, birds, eggs	Johannes & MacFarlane, 1991
1791 (25 Aug)	*Pandora*	Capt. E. Edwards	passed island	Haddon, 1935
1845 (April)	*Midge*	Blackwood Jukes	noted igneous rock in center of coral ring	Sweatman 1977
1845 (6-7 May)	*Fly*	Blackwood Jukes	on way to N.G. coast	Jukes 1847
1845 28-29 May	*Fly & Prince George*	Jukes Blackwood	while surveying N.G. coast	Logan Jack, 1921
1846 4-9 April	*Bramble*	Yule Sweatman	collected eggs, spinach 5 turtle taken	Sweatman 1977
1846 3-8 June	*Bramble*	Yule Sweatman	collected eggs	Sweatman 1977
1849 (28-29 Sept)	*Bramble Rattlesnake*	Yule	en route N.G. to Cp York to get supplies	Logan Jack, 1921 Huxley, 1935
1849 (16-19 Dec)	*Rattlesnake*	Capt. Stanley MacGillivray	collected turtle/ bird eggs noted many boobies	MacGillivray, 1852 Huxley, 1935
1873 (?April)	*Basilisk*	Rev. A.W. Murray	trading paddlesteamer	
1875	*Chevert*	G. Masters J. Brazier	Ornithology Shells, molluscs	Masters, 1875 Brazier, 1876, 1877a,b
1889 (24.3)	*Janbaas*		shipwrecked on cay	Loney, 1982
1889 (July)	*Kenilworth*		shipwrecked NW of cay	Loney, 1982
1889 (20.8)	*Windhover*		wrecked on cay carrying coal	Loney, 1982
1889 (Sept.)	*Rosie Welt*		shipwrecked near cay	Loney, 1982
1915 (28.8-13.9)	*Mutlah*		ran aground, unloaded thousands of tons of coal	Done 1987 J. Foley. pers. comm.
1911 (27 July)	?.	W.MacGillivray	Ornithology	MacGillivray 1914
1917 (Sept)	*Herald*	Rev. J J E Done	used some coal for fuel took turtle, eggs	Done 1987

Table 2. Continued.

DATE	VESSEL	VISITORS	NOTES	REFERENCES
1924 (Sept)	?	C. Hedley F. Jardine	collection of corals water quality geomorphology	Nathan, 1924 Hedley, 1925 Jardine, 1928
1927-1934		M Murray	visits with Darnley Islanders	Johannes & MacFarlane, 1991
1950's ongoing	*Trader Horn* others	B. Whittaker	mackeral fishing	Anon, 1955
1954-1987	AMSA vessels		acteylene replacement lighthouse maintenance	AMSA records
1975 (7 Nov) 1976 (3-5/1)	Dinghy from York Island	Applied Ecology	Turtle nesting count	Kowarsky, 1978
1978-79 Oct-March	(resident)	Applied Ecology	Turtle research, Island mapping	Onions, 1979 Parmenter 1980
1987 (Dec)	(dinghy)	C. J. Limpus		Limpus, et al., 1983
1988 (Dec)	(dinghy)	C. J. Limpus		Limpus, et al., 1983
1984	(dinghy)	C.J. Parmeter		Walker, 1988
1987 (4-6 Jan)	*M.V. Lumen*	T. A. Walker A.M.S.A.	Island survey LH conversion to solar	Walker, 1988
1988 (July)	*Western Venturer*	OK Tedi R.C. Babcock	Coral survey	Babcock 1988
1994 5-7 Feb	*R/V Lady Basten*	A.I.M.S.	Coral coring Island survey	Brunskill, in prep. This study
1995 17-19 Feb	*R/V Harry Messel*	A.I.M.S.	Coral coring Island survey	Brunskill, in prep. This study

Table 3. Properties of water pooled on Bramble Cay.

Location	Time	Temperature °C	Salinity	Conductivity
1	1440	39.7	0.8	9.0
2	1500	42.2	2.8	4.7

Table 4. Drift dissemenules on Bramble Cay

Species	1994	1995
Mangrove		
Avicennia marina	12	128
Bruguiera existata	10	75
Bruguiera gymnorrhiza	10	50
Bruguiera parviflora	1	1
Ceriops australis	4	11
Ceriops decandra	3	16
Ceriops tagal	3	7
Cynometra iripa		2
Heritiera littoralis	33	660
Nypa fruticans	302	374
Rhizophora apiculata	81	163
Rhizophora mucronata		45
Rhizophora stylosa	27	87
Xylocarpus granatum		845
Xylocarpus moluccensis		123
Xylocarpus sp.	27	
SUB-TOTAL	513	2587
Non-mangrove		
Aleurites moluccana	2	14
Barringtonia asiatica	3	15
Barringtonia racemosa		1
Caesalpina bonduc	1	6
Calophyllum inophyllum	1	
Canavalia sp.	2	
Cerbera manghas		17
Cerbera odollam	12	11
Cocos nucifera	12	10
Dalbergia canadensis	2	
Dendrodium sp.	1	
Entada phaseolus	3	16
Euphorbiaceae	30	102
Guettarda speciosa		7
Inocarpus fagifer	25	0
Ipomoea sp.		2
Leguminosae	32	333
Mangifera indica	1	5
Pandanus sp.	4	14
Pongomia pinnata	1	55
Pterocarpus sp.	2	
Terminalia sp.		11
SUB-TOTAL	134	619
TOTAL	**647**	**3206**

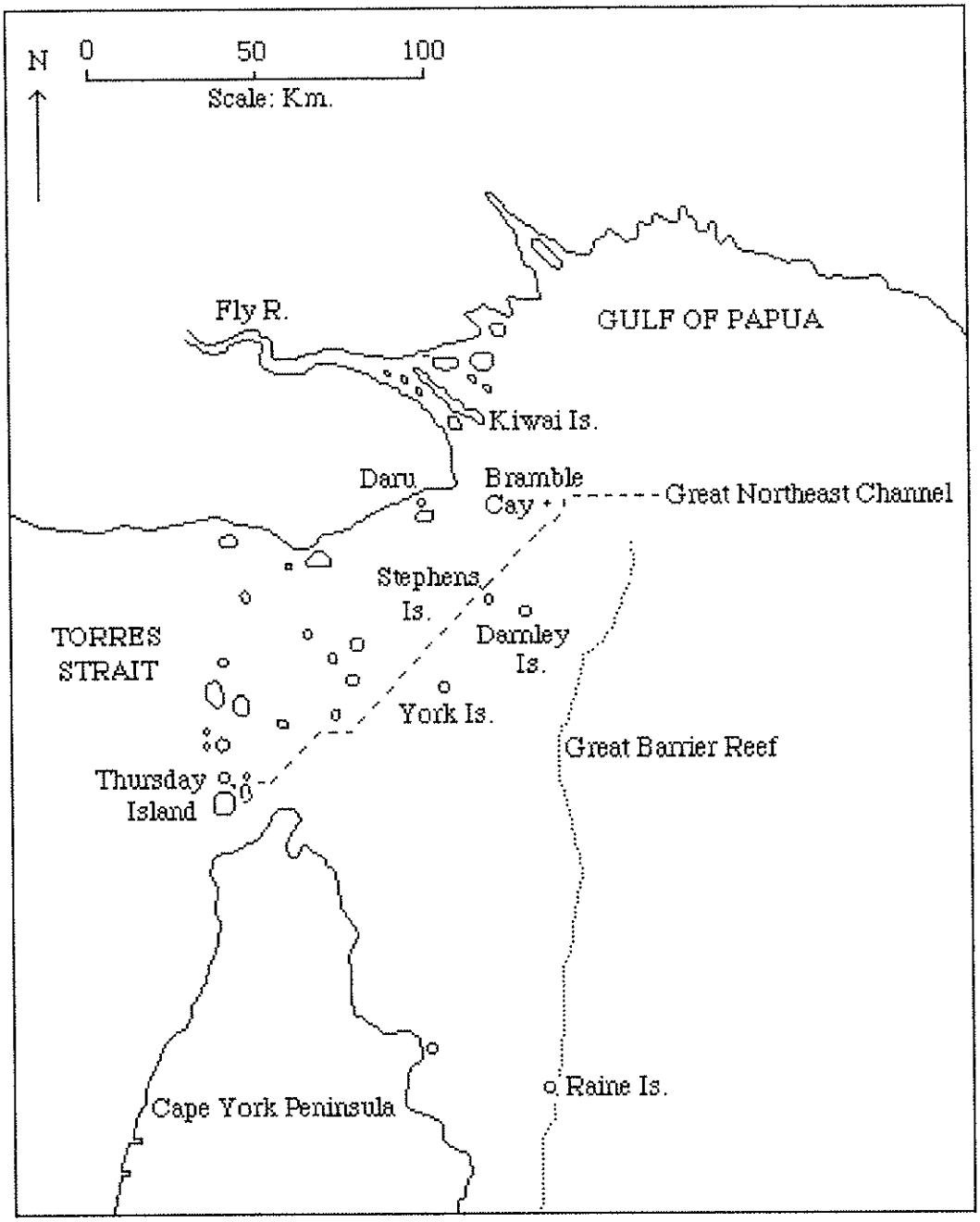

Figure 1. Location of Bramble Cay in the Torres Strait.

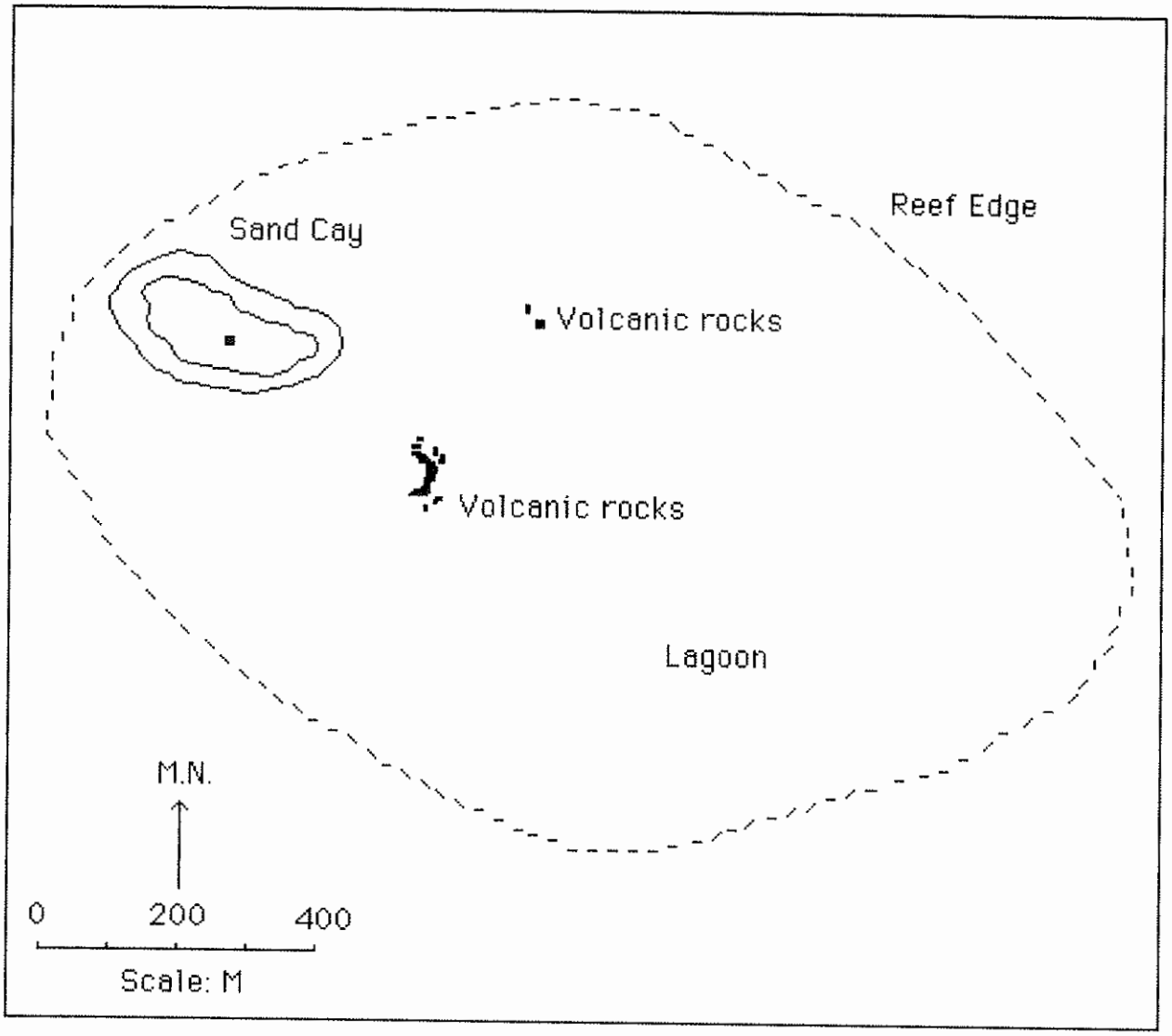

Figure 2. Map of the Bramble Cay Lagoon

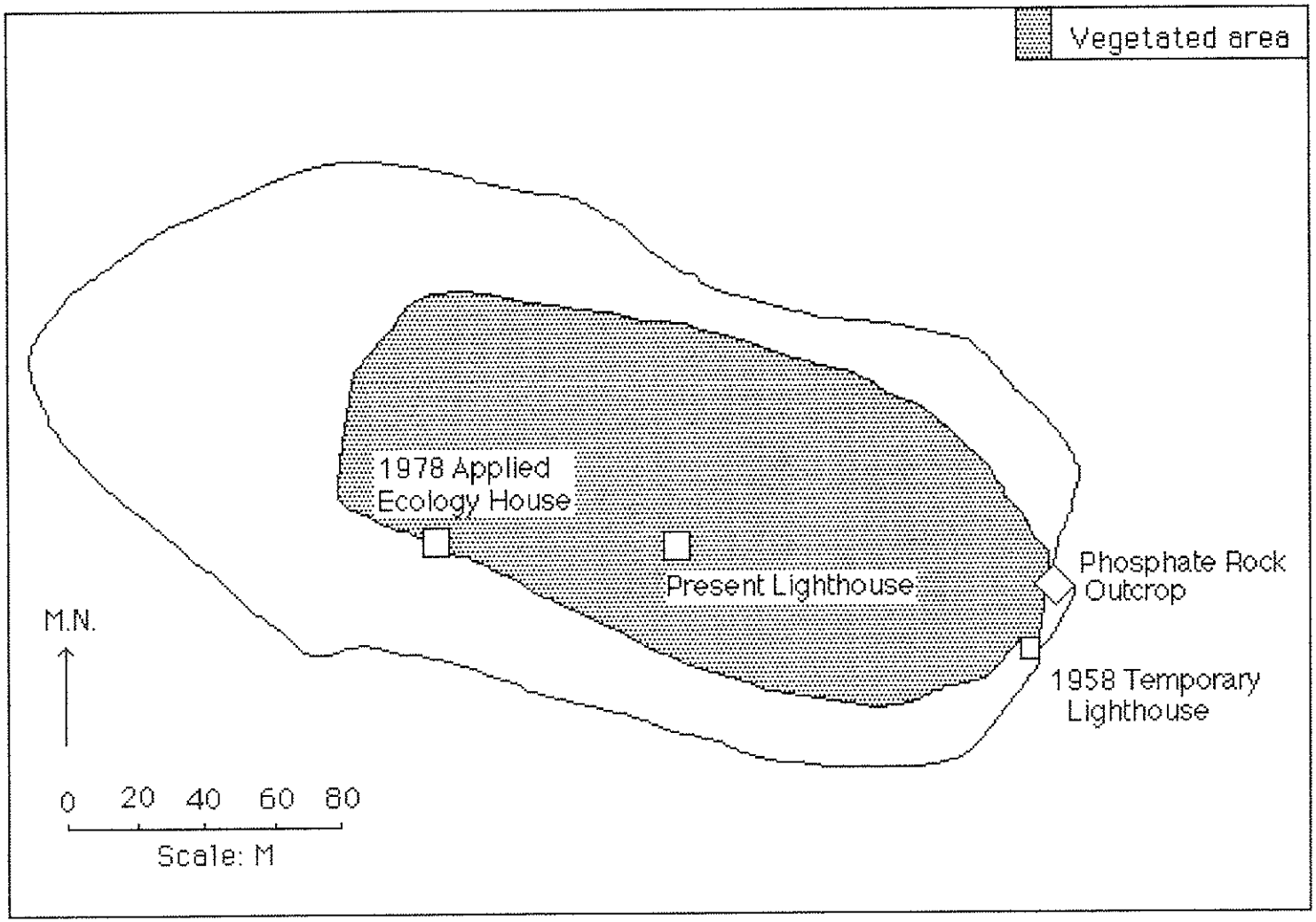

Figure 3. Map of Bramble Cay in February 1995, showing man made structures

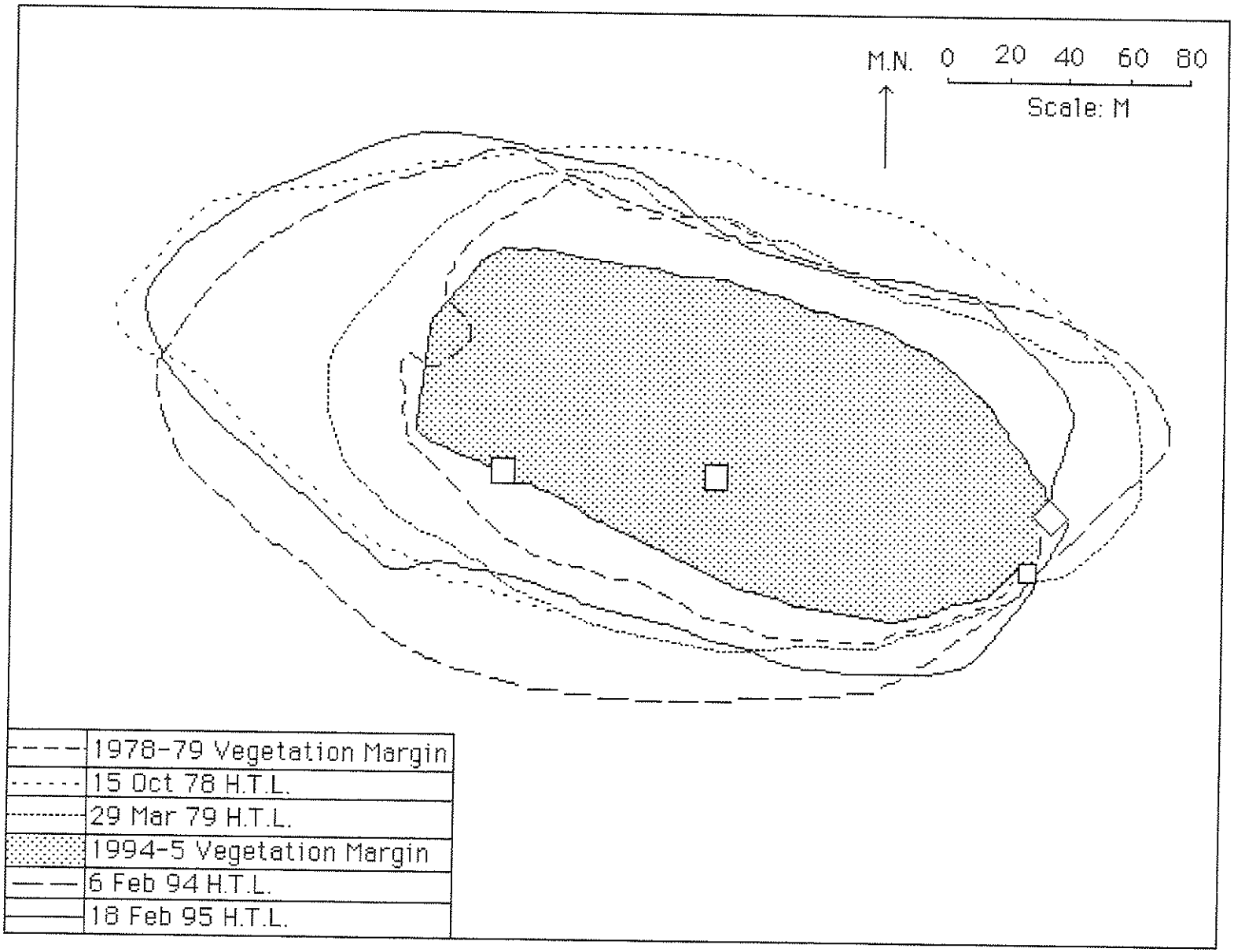

Figure 4. Change in shape of Bramble Cay 1978-1995

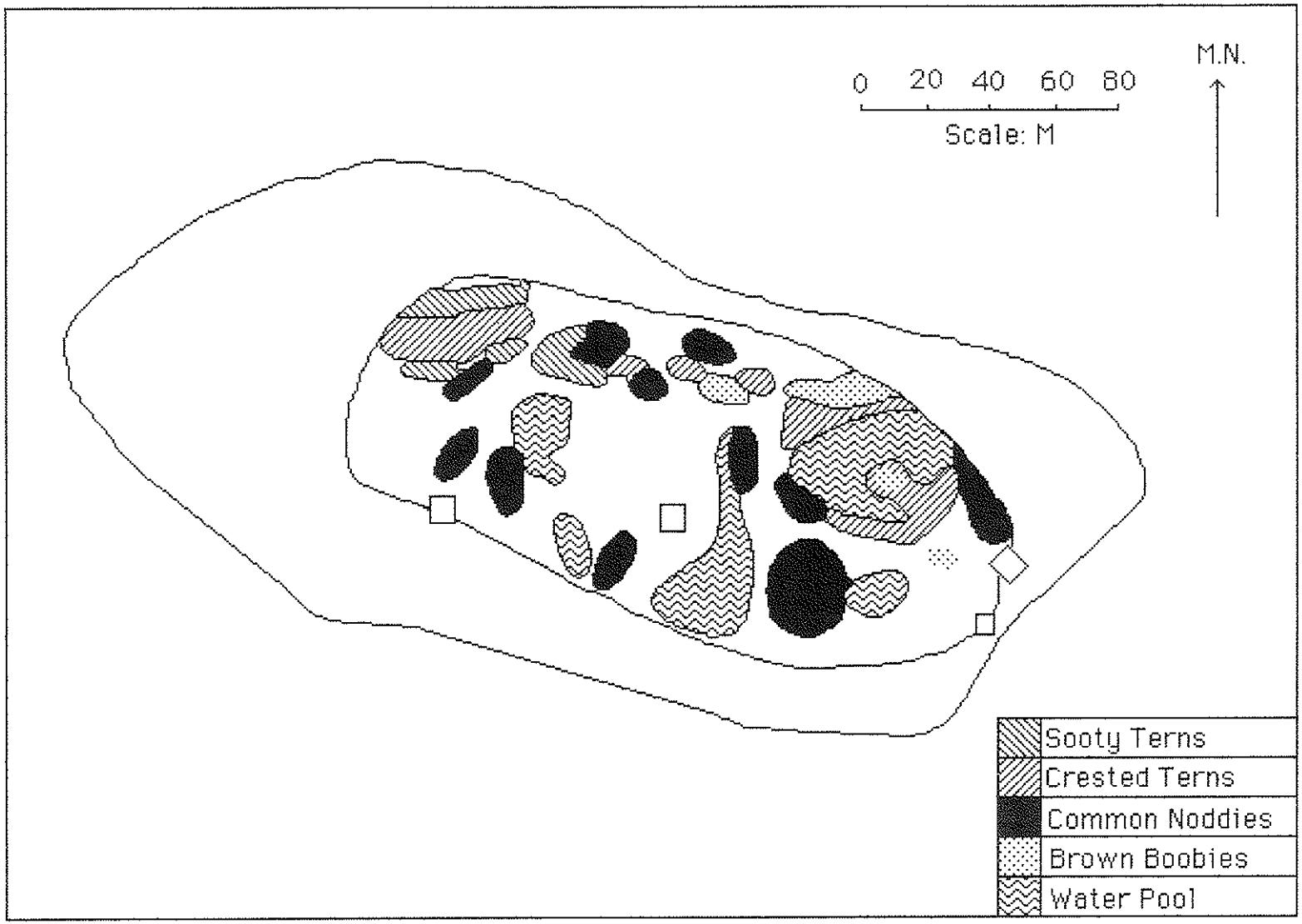

Figure 5. Bird nesting colonies on Bramble Cay, February 1995

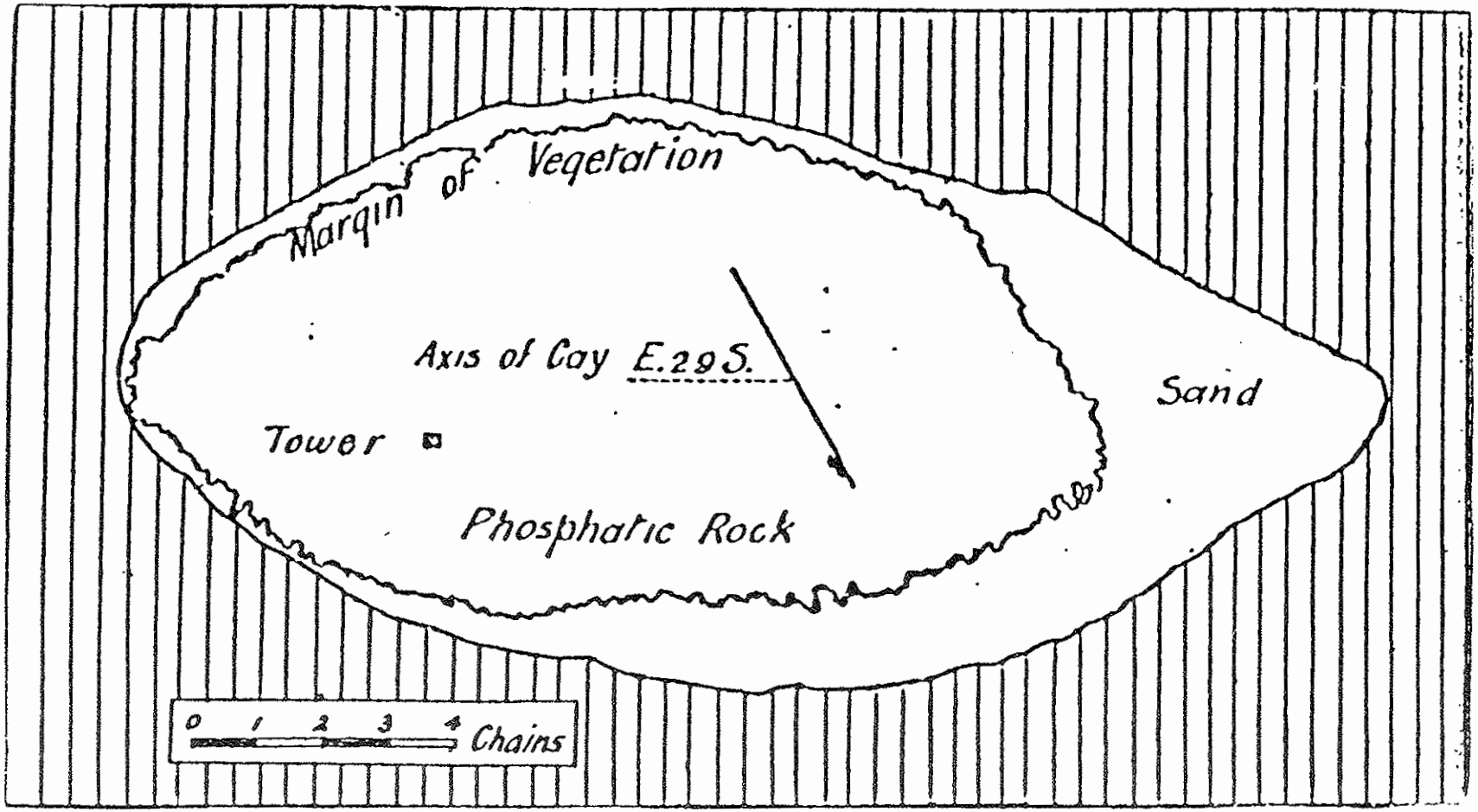

Figure 6. Map of Bramble Cay in September 1924 from Jardine (1928).
Scale: 4 chains = 80.48 m.