

ATOLL RESEARCH BULLETIN

NO. 199.

**OBSERVATIONS ON VEGETATION OF BLUE-FACED
BOOBY COLONIES ON COSMOLEDO ATOLL,
WESTERN INDIAN OCEAN**

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**Issued by
THE SMITHSONIAN INSTITUTION
Washington, D.C., U.S.A.**

February 1977

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Mary E. Gillham¹

Localities occupied by boobies on Wizard and Pagoda Islands

Cosmoledo Atoll lies approximately 960 km east of the Keny coast in latitude 9°40' S. It consists of a circle of islands around a 8 km wide lagoon and spans some 14.5 km by 11 km. Like Aldabra, which is about 160 km nearer to the African mainland, it consists of an old, uplifted coral reef, but it is less rugged, much of the rock surface being hidden under drifts of coral sand. Wizard Island or Grande Ile is one of the half dozen or so larger islands, second in size only to Menai Island where the only settlement is situated. It is 3 km long and forms part of the eastern rim of the atoll, rising some 3.6-4.6 m above sea level.

It was possible to visit only the southern part of this island when the *Manihine* called there in February 1970. Much of this part is scrub covered, so that the ground-nesting Blue-faced or Masked Boobies (*Sula dactylatra*) are uncommon, but nests were scattered along the stragging corridors of low heraceous vegetation between the shrubs.

Some of the coastal bushes were occupied by Red-footed Boobies (*Sula sula*) and some of the inland ones by Lesser Egrets (*Egretta garzetta*) and Cattle Egrets (*Bubulcus ibis*).

Pagoda Island is representative of the many smaller islets occurring on the atoll rim. It is perhaps 0.4 km long and less wide, and, being more exposed to the influence of the sea, supports few shrubs of any size. Many of these lie below the general ground level around the rugged margins of a saline pond sunk in the champignon behind the storm beach on the ocean side, and having only subterranean connections with the sea.

The falling tide leaves curtains of filamentous algae draped about the lagoon walls. Vegetation crowning the storm beach is limited by salty winds to low growths such as the tight wiry rosettes of the sedge,

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(Revised manuscript received September 1974 --Eds.)

Fimbristylis species, in contrast to the tall *Cyperus ligularis* and shrubs of coasts facing in towards the atoll centre.

Bushes on Pagoda Island contained occupied nests of Red-footed Boobies in mid-February 1970; the low vegetation of the remainder of the island was sprinkled throughout with those of Blue-faced Boobies.

This islet is too exposed for mangroves and other trees of large size and the Red-footed Boobies were nesting chiefly on, rather than in, the fringe of low, windtrimmed *Pemphis acidula* bushes of the periphery and the even lower growths around the inland lagoon.

On Wizard Island, where the range of nest sites is larger, they were favouring the white mangrove (*Avicennia marina*), a species which is used little if at all on Aldabra, where it grows in abundance but where *Rhizophora mucronata*, *Bruguiera gymnorrhiza* and *Cerriops tagal* seem to be preferred. Other trees such as the scarlet-flowered *Cordia subcordata* are also used on Wizard Island.

Other localities occupied in this sector of the Indian Ocean

The status of Blue-faced Boobies on the rest of Cosmoledo is not completely known. Bourne (1966) records "A few seen on Cosmoledo and Assumption", giving no details as to which islands. Diamond (in Bayne et al 1970: 48) says "At least 200 pairs of White Booby *S. dactylatra* were occupying clearings in the long grass on the west side of the island (Wizard) or on the dune ridge to the east" in March 1968. Vesey-Fitzgerald (1941) records them as breeding in September-November 1940 on four of the Cosmoledo Islands (West North, East North, Grande Polyte and South) but does not mention Wizard or Pagoda. Piggott (1961) saw large numbers of boobies, species unstated, on Grand Polyte and also bird colonies on Pagoda and South Island.

Aldabra in the same latitude and only approximately 760 km from the African mainland, is an important sea bird resting site, but Blue-faced Boobies are not among them. Up to 1966 (Benson, 1966) the only evidence for their occurrence, even as non-breeders, is from Morris (1963), who saw both adult and immature birds. Red-footed Boobies, on the other hand, are abundant in the mangroves, many thousands nesting among the frigate birds (*Fregata minor* and *F. ariel*) on Middle Island. The absence of the ground-nesting species is surprising in view of the open plain and grassed areas which would seem eminently suitable.

Assumption, 40 km to the south of Aldabra, supporting a few breeding Blue-faced Boobies in the late nineteenth century (Ridgeway, 1895; Nicoll, 1906) but as a result of guano-digging activities it is unlikely that any still survive (Stoddart et al 1970).

On a wider scale *Sula dactylatra* has isolated breeding sites along the coast of East Africa from the Red Sea to Tanzania, and on Socotra. Generally these are sited on rocky coasts and cliffs 6-9 m above sea level (Mackworth-Praed and Grant, 1957). Those of Wizard Island and of

Latham Island (65 km off Dar-Es-Salaam and visited by the present author in January, 1970), however, are on quite smooth terrain, uninterrupted by cliffy out-crops and not more than about 3 m above sea level.

Early regeneration phase of vegetation: Wizard Island

The areas occupied by ground-nesting boobies on Wizard Island were limited to patches of open ground seldom more than 20 X 10 m among the overall cover of shrubs. These sites were scattered along the coasts, often to the top of the low coral 'cliffs', but usually separated from the reef by a belt of different vegetation. On and below the jumble of honeycombed champignon rocks of the coastline were thickets of brilliant-flowered *Cordia subcordata* and occasional large white mangroves (*Avicennia marina*) with more spherical bushes of *Xylocarpus granatum* loaded with big green 'cannon-ball' fruits. Where the shore was sandier these were replaced by lower, denser bushes of white-flowered *Pemphis acidula* and yellow-flowered *Suriana maritima*, both self-tolerant species, branching copiously from the base and with characteristically small, sclerophyllous leaves. In areas of mixed rock and sand were silvery-leaved shrubs of *Tournefortia argentia* with speckled orange and white moths massed on their large inflorescences.

Only a small proportion of the guano-impregnated soil of the booby nesting areas was bare in February 1970. Most, sometimes up to 90% was covered by a flattened, straw-coloured mat of dead grass, probably *Dactyloctenium aegyptium*. On this the boobies laid their one or two eggs (usually white, but occasionally pale blue), more sparsely than on Latham Island at the same season. No nesting material was used, but a bare circle of approximately 60 cm diameter was scraped in the dead grass. This was not one of the peak laying periods and tentative plant colonisation had begun between nests in areas which the presence of guano and nest hollows showed to have been recently vacated.

The three pioneer plant species were annuals, growing radially from their points of origin to form neatly circular clumps up to 1 m across but to occasionally near 3 m by 13 February 1970. One of them, the succulent *Portulaca oleracea*, was also the principal species of the blue-faced colony on Latham Island, where vegetation was generally much scantier. The other two Wizard Island pioneers were less succulent and quite prostrate; the minute-leaved, green-flowered creeping spurge (*Euphorbia prostrata*) and the yellow-flowered, pinnate-leaved *Tribulus cistoides*. Fruits of this usually possess 5 carpels, with 2 large, upwardly directed prongs. Close after these 3 species came a creeping ground cover of *Boerhavia repens*, with umbels of tiny white or pink flowers protruding from a continuous carpet of dark, red-tinged leaves. Superimposed in places were the stems of an unidentified cucurbit with yellow flowers 2.5 cm across. The purple-flowered, green-podded herb, *Cleome strigosa* was locally abundant at this stage, principally as seedlings. Mature plants were more or less prostrate, in contrast to an average height of 50 cm in parts of Aldabra unaffected by birds.

Other components of this bird flora were the orange flowered, *Sida parvifolia*; the yellow-flowered *Portulaca* species; the yellow-flowered, trailing Composite, *Launaea sarmentosa*; the mauve-flowered sea Convolvulus (*Ipomoea pes-caprae*) and the grasses, *Dactyloctenium aegyptium*, with radiating flower spike and *Sporobolus virginicus*, with narrow, erect flower spikes.

Peripheral to these, on less recently disturbed ground, were low undershrubs of *Achyranthes aspera* with 30 cm long spikes of mauve flowers ripening from the bottom upwards and falling to leave reflexed bract scales. Seedlings of another small bush, *Acalypha claoxyloides*, sprouted between them, their soft, balsam-like leaves veined with yellow among lax catkins of minute yellow-green flowers.

This low and easily negotiable community of undershrubs alternated with the booby colonies, to form with them a coastal belt 7-10 m wide. There is every probability that this belt represented areas occupied at some time or other by boobies and showing an intermediate successional phase between a fully occupied herbaceous sward and an unoccupied scrub. Both species, *Achyranthes* and *Acalypha*, grew to 2 m in the main inland scrub, where, along with many other shrubs, such as the small-flowered, round-leaved *Pleurosteima cernuum* of the milkweed family (Asclepiadaceae), they became generously festooned with creepers. Chief of the lianas was the white-flowered morning glory (*Ipomoea macrantha*) and there was also a small, green-flowered passion fruit (*Passiflora suberosa*). The tall brown-headed sedge, (*Cyperus ligularis*) occupied sandy hollows.

Later regeneration phase of vegetation: Pagoda Island

Blue-faced Boobies, as indicated, occupied almost the entire area of Pagoda Island, but spacing of the nests was as wide as on Wizard (although it was difficult to be certain of this because many of the well-grown chicks were tucked under bushes and not visible unless flushed). The ground was of coral gravel further whitened by guano and with little sand. Not much was bare and there was little grass, the area being divided between a prostrate herb flora dominated by *Boerhavia repens* and a sapling shrub flora dominated by *Achyranthes aspera*.

On the open area the *Boerhavia* carpet formed a ground cover of about 60%; *Euphorbia prostrata* covered another 20%, whilst 10% was bare. The remaining 10% was occupied by two forms of *Tribulus*, principally a robust one with larger flowers and fruits than any seen on Wizard. With it were *Sida parvifolia*, *Portulaca oleracea*, *P. australis*, *Sesuvium portulacastrum* and a little *Launaea sarmentosa*.

Throughout this sward seedlings of *Achyranthes aspera* and *Acalypha claoxyloides* were growing, especially the former. The *Achyranthes* dominating the main part of the island obviously represented the same community in a more advanced successional phase, the herbaceous sward which persisted between the 30-100 cm high bushes diminishing until

these finally coalesced.

Apparently not involved in this 'booby succession' were the thick stands of *Plumbago aphylla* backing the rocky beaches and land-locked pond. Most of its grey-green stems were bare, but some patches retained the ephemeral circular leaves produced during the rains (December to March), and considerable stands on the ocean side bore massed white flowers -- the plants reminiscent of a less succulent version of *Sarcostemma viminalis*. *Cyperus* was associated with the *Plumbago* in places.

The greater state of advancement of the booby plant succession on Pagoda is of particular interest when considered in relation to the more retarded climatic succession of this smaller, more wind-swept and spray-drenched island. Few bushes exceeded 1 m in height, there were no mangroves and no *Cordia* trees around the fringes and little variety of species in the main body of the island. Only one *Tournefortia argentia* bush was seen, its main trunk prostrate, living branching to only 60 cm and dead ones overtopping these by another 60 cm. *Pemphis acidula*, the only abundant shrub around the edge of the *Boerhavia-Achyranthes* succession, was generally gnarled and mis-shaped by the wind.

The greater growth of the post-booby vegetation could have been the result of either a sparser total population of boobies on an annual basis or an earlier start to nesting. Most chicks were 4-5 months ahead of those on Wizard Island and it is probable that, with this low bird density, vegetation grew up alongside them, affording useful cover as their parents left them unattended for longer periods. This cover may be of greater importance in giving protection from the sun's heat than from predators, midday temperatures in February reaching to 110 F on the Aldabra group of islands. (A comparable case is seen with the lesser black-backed gulls (*Larus fuscus*) in Britain where eggs and constantly brooded young chicks occur in open grassland, the bracken fronds sprouting as the chicks grow, so that they have ample cover during their vulnerable adolescence.)

The almost universal coverage of dead grass in the Wizard nesting areas shows that these do not follow quite the same successional sequence as the Pagoda ones. It seems that the grass invades before the seedling bushes become established, although the earlier herb phase of the two successions runs parallel. (Diamond's only reference to booby vegetation in March is to 'long grass' (Stoddart et al 1970: 49), but there was little sign of its regeneration in February 1970, so the sequence may not be the same each year.)

Predation and aggressiveness

Predation of boobies in the air over Wizard was serious, hundreds of Greater and Lesser Frigate-birds harrying them in flight. It was not possible to judge whether frigates selected their victims only from among birds returning with newly caught fish, but many boobies were

seen to regurgitate at the end of a noisy, squawking aerial chase. The food was invariably caught by one of the pursuing frigates as it fell. As many as 5 or 6 of these would join forces against a single booby in a spectacular pursuit from which the quarry's only escape was to alight, either on land or sea. (Frigates are clumsy on land and get waterlogged at sea, but are past masters of flight.)

More serious predation on Wizard was by cats. The booby colonies were thickly littered with cat droppings consisting almost entirely of booby feathers and down with, sometimes, a little fibrous plant material. A cat was seen, not resembling the expected feral animal of domestic origin, but larger, spotted and with a long tail, although how a wild cat could arrive on an uninhabited coral atoll remains a mystery.

Many adult boobies were on empty nests and, of the remainder, most had eggs. Only a few chicks were seen, none very large. Chicks would be very vulnerable to cats, and it is suggested that the regarded state of breeding as compared with the adjacent Pagoda Island, where no cat dung was seen, may be due to replacement-laying by robbed parents. It could be significant that surviving chicks had particularly aggressive parents, more likely to hold their ground in defence of young. (There was no indication on Latham Island that birds with chicks were more aggressive than birds with empty nests or eggs. This seemed to be an attribute of some individuals only, and on Wizard Island an attribute aiding race survival.) Wizard Island birds with no chicks tended to take to the air when approached to within 6 m. Those with chicks stood their ground, lunging at the intruder when handled. While chicks were very young the parent manages to maintain their positioning — one on top of each of the grey webbed feet — while swivelling round to face the disturbance and jab at outstretched hands, quite unintimidated.

Diamond (in Bayne et al., 1970) suggests that cats may be responsible for the partial or complete loss of terns from Wizard Island. He found only skeletons and feathers in long grass and on dune ridges. They clearly suffer heavy mortality, whether from predation, starvation or disease is not known; but the most likely culprits would seem to be the cats, of which 2 were seen and one shot (A. W. Diamond, personal communication). Baker (1963) refers to a tern breeding area at the north of Wizard Island, but none were seen in March 1968 nor February 1970.

Pagoda Island was occupied by advanced booby chicks progressing from the downy to the feathered stage and falling about awkwardly as they exercised their wings. Few were less than half grown and only 3 eggs were seen. These older chicks were left for longer periods unattended and were exceedingly noisy and aggressive. They started squawking when the intruder was still a long way off and when he passed within 2 m he was likely to receive a jab in the leg sufficient to draw blood.

As far as could be ascertained, there was no predation of boobies on Pagoda apart from food thieving by frigates, and this was less prevalent than on the larger island, only 40-50 frigates being seen.

Landings by man on so small an island surrounded by reef must be few.

Continuity of bird pressure on vegetation

The most depauperate, bird-suppressed vegetation seen by me in this part of the Indian Ocean in early 1970 was on Latham Island. Most of this area was currently occupied by breeding sea-birds in late January and it is likely that there is a fair continuity of bird pressure there, because all former records for terns and noddies have been from June-September, and for boobies from October-November and again in March (Mackworth-Praed and Grant, 1957). This, in conjunction with the prevalent salt-laden winds, precludes bush growth and limits the flowering plants to three low-growing herb species: *Portulaca oleracea*, *P. australis* and *Ipomoea pes-caprae*.

Local curtailment of bush growth on Wizard Island may be due to a similar sequence of nesting by different individuals on the same site. Even if only boobies are involved, it has been established that these have no regular annual cycle, in either the Indian Ocean or the Atlantic.

With an incubation period of 42-46 days (6½ weeks) and a fledging period of 120 days (17 weeks), it is likely that the oldest, still down fledglings on Wizard in February 1970 came from eggs laid in October, and the predominantly older, half-feathered fledglings on Pagoda Island from eggs laid in September. Eggs and younger chicks, which were almost exclusive to Wizard, could have been laid at any time between November and February.

The possibility of occupation of the same sites by terns or noddies at other seasons cannot be excluded. Both have been recorded breeding on Wizard, and the predominance of dense, creeper-covered bushes limits the amount of suitably open terrain. All the sites seen without bushes were occupied to a greater or lesser degree by boobies, but the whitening by guano on some of these was more than could be attributed to the present occupants alone. Only future visits to the atoll can establish such joint use of the open spaces.

Other breeding seabirds observed in the part of Wizard Island visited in February 1970 were Red-footed Boobies (*Sula sula*), scattered in small parties amongst the taller coastal bushes, with eggs and chicks at all stages, and considerable flocks of free-flying brown immatures. Several hundred Cattle Egrets (*Bubulcus ibis*) and Lesser Egrets (*Egretta garzetta*) (mostly of the white phase, with no pied intermediates such as occur on Aldabra) thronged in larger trees further inland, but were not examined to see if they were nesting.

Other Lesser Egrets fed on the reef with Grey Herons *Ardeola cinerea*, Crested Terns *Thalasseus bergii*, Crab Plovers *Dromas ardeola*, Great Sand Plovers *Charadrius leschenaultii*, Curlew Sandpiper *Erolia testacea*, Sanderling *Crocethia alba*, Whimbrel *Numenius phaeopus* and

Turnstones *Arenaria interpres*. Of the two species of frigate bird, the Greater were present in larger numbers.

Very abundant land birds were the Souimanga Sunbirds *Nectarinia sovimanga*, taking nectar particularly from the big scarlet flowers of *Cordia subcordata*, and the constantly chattering, streaky Madagascar grass warblers *Cisticola cherina*, making short, lark-like flights over the bushes and occasionally over the sea. These warblers were present on Pagoda Island, but not the sunbirds, which would have failed to find *Cordia* and the other flowering trees which they favoured in this more exposed habitat. There were probably 50-100 pairs of Red-footed Boobies nesting on Pagoda and some 20 Red-tailed Tropic birds (*Phaethon rubicauda*) indulging in what appeared to be complicated courtship flights over the island. One bird on a nest beneath a dense *Pemphis acidula* bush screeched and spread wings and body feathers menacingly when approached, yielding no ground. Two others had nests under thickets of *Plumbago aphylla*.

Several flocks of 20-30 Black-naped Terns *Sterna sumatrana* had taken up positions on the rocky shore to which they returned soon after flushing, as though they might have chicks concealed beneath the rocks, but no young or eggs were seen. A single flock of about 30 crested terns fed on one of the sandy beaches. The air was full of terns above the next island of the atoll, which was almost certainly a breeding area, but was unfortunately not visited. Other shore birds were Turnstones, some of these leaving the pebbly beaches to forage among the low *Boerhavia* and *Euphorbia* of the booby areas. These and various other waders also fed around the enclosed tidal pool behind the ocean storm beach.

The deep hollow in which the pool lay was partly filled with bushes thronged with Red-footed Boobies. Other slopes carried *Sesuvium portulacastrum* near water level (a characteristic halophyte of mangrove swamps elsewhere), leading up through stands of either *Plumbago* or *Cyperus* to the short *Boerhavia* turf of the Blue-faced Booby colony.

Little Green Herons *Butorides striatus* fed from shoreward rocks and Grey Herons perched in statuesque positions on the tops of bushes, waiting to move down to the reef to feed. The greater and lesser frigates never alighted and were presumably from the breeding colonies in Aldabra, which supply most of the Western Indian Ocean frigates.

The ecological niche normally occupied by scavenging gulls, crows or kites, was filled by crabs, both land crabs and hermit crabs, hordes of which were busy devouring regurgitated fish and the occasional dead bird. The land crabs lived in burrows as much as 20 cm in diameter in hollows of the champignon.

Postulated vegetation sequence in sea-bird colonies

Even on so small an island as Pagoda, the climatic climax vegetation consists of bushes sufficiently large to satisfy the breeding needs

of Red-footed Boobies. Close nesting by these causes the dying back of the branches and eventually the entire shrubs. Heavy pressure by Red-footed Boobies, therefore, could destroy the scrub and leave the way open for herb and sapling woody species - i.e. the sort of environment favoured by Blue-faced Boobies.

The protracted nature of the nesting season on Cosmoledo enables degenerating and regenerating plant successions to exist side by side, so that the vegetation fluctuates between a dead or living herb cover and a sapling cover up to 0.5 m high. With the low nesting densities obtaining in February 1970, this state is likely to be maintained in the booby colonies. With increasing booby pressure, as on Latham Island, bareness could prevail, to give the sort of habitat favoured (and induced or maintained) by terns and noddies.

These two smaller species nest sufficiently close together to inhibit all plant growth in their chosen area, but they do not necessarily return to the same site in successive years. If they move away the vegetation will return - first the herbs, then the saplings and finally a full scrub cover, if given long enough without further disturbance. This change, however, makes the terrain suitable once again for the booby species, which may expand into it from nearby colonies. Colonially nesting sea-birds inevitably modify the vegetation amongst which they nest, and this may be to their own disadvantage and the advantage of others.

The vegetative degeneration: regeneration cycle associated with nesting birds might thus be as follows:

Degeneration:

Mangroves and other trees . . .	Red-footed Boobies and egrets
<i>Pemphis</i> and other shrubs . . .	Red-footed Boobies and Tropic birds
<i>Boerhavia</i> and other herbs . . .	Blue-faced Boobies and Tropic birds
Bare Soil . . .	Terns and noddies.

Regeneration:

Herbs and grasses . . .	Terns, noddies and Blue-faced Boobies
Shrubs . . .	Red-footed Boobies
Trees . . .	Red-footed Boobies, egrets, heron, etc.

Comparison between Cosmoledo and Aldabra Atolls

Colonies of ground-nesting sea-birds are more extensive on the Cosmoledo Atoll than on Aldabra, where the main colonial nesters are frigate birds and tree-nesting boobies in the mangrove fringes. The tree nesters defaecate into the intertidal zone, and so have little or no effect on the land flora.

The only sea-birds on Aldabra which are sufficiently numerous to affect the terrestrial ecosystem are the noddies of the tiny mushroom

islets in the lagoon, and many of the islets are so small and low as to be devoid of macroscopic vegetation. Crested, Caspian, and Black-naped and White Terns, Red-tailed and White-tailed Tropic birds, Grey Herons, Little Egrets and Sacred Ibises, if not nesting so diffusely as to have very localised effects on plants, are tree nesters.

The situation is very different with Cosmoledo's most important colonial nesters, the Blue-faced Boobies. This species has an immediate and obvious effect on the vegetation in which they nest and have changed the face of the islands considerably. It does not nest on Aldabra.

Thus, although Aldabra supports an unparalleled example of relatively undisturbed native scrub, Cosmoledo shows in this respect a much more interesting and complex interaction between flora and fauna.

Cosmoledo's vegetation is 'spoiled' if looked at in purist terms, but it is spoiled mainly by natural causes. The fact that the plants which have taken over in the wake of the birds are also plants which take over after disturbance by man, detracts nothing from the naturalness of their origin.

Modification of natural vegetation by large colonies of nesting sea-birds cannot fail to be of interest biologically. Intense modification usually implies the accumulation of guano in sufficient quantities to be a commercially viable proposition to mining companies, so that the natural outcome of the association is destroyed. So long as any of the birds remain, however, they have an inevitable impact on the existing vegetation, and examples of such bird-dominated vegetation should be jealously guarded.

Colonial sea-birds in large numbers are all too rare in the Tropics. In the interests of scientific investigation, it is very desirable that these semi-exploited islands should be conserved while birds are still in residence and governing the competitive efficiency of tolerant plants species over intolerant ones.

The rim of the Aldabra Atoll affords an admirable control area to show uplifted reef vegetation in the absence of colonial birds, but its reef islets are scarcely adequate to show reef vegetation in their presence. Cosmoledo shows this on a big scale, and the double interest, botanical and ornithological, cannot but be a useful adjunct to our knowledge of the botanical alone.

Tropical sea-birds are so much rarer than temperate and arctic ones that there would seem to be a very strong case for conferring reserve status on selected islands of the Cosmoledo Group. These would be ideal sites for instituting long term investigations on the delicately fluctuating balance between changing numbers of sea-birds and vegetation types having different levels of tolerance of trampling and guano deposition.

Acknowledgements

I am much indebted to Mr. Basil Bell, formerly Director, of E. A. M. F. R. O., and Mr. Mike Williams, Captain of the 'Manihine', for sea passage to Cosmoledo, and to Dr. J. B. Gillett, Dr. Brian Harris and Mr. Jack Frazier for the identification of plants.

AppendixList of plants in and beside Blue-faced Booby colonies on Cosmoledo

<i>Acalypha claoxyloides</i>	<i>Plumbago aphylla</i>
<i>Achyranthes aspera</i>	<i>Portulaca oleracea</i>
<i>Avicennia marina</i>	<i>P. australis</i>
<i>Azima tetraacantha</i>	<i>Scaevola taccada</i>
<i>Boerhavia repens</i> (?)	<i>Sesuvium portulacastrum</i>
<i>Cassytha filiformis</i>	<i>Sida parvifolia</i>
<i>Cleome strigosa</i>	<i>Suriana maritima</i>
<i>Cordia subcordata</i>	<i>Tournefortia argentea</i>
(Curcubitaceae)	<i>Tribulus cistoides</i>
<i>Euphorbia prostrata</i>	<i>Xylocarpus granatum</i>
<i>Ipomoea pes-caprae</i>	<i>Dactyloctenium aegyptium</i>
<i>I. macrantha</i>	<i>Eragrostis eiparia</i> (?)
<i>Lagrezia sarmentosa</i>	<i>Fimbristylis cymosa</i> (?)
<i>Launaea sarmentosa</i>	<i>Cyperus ligularis</i>
<i>Passiflora suberosa</i>	<i>Sporobolus virginicus</i>
<i>Pemphis acidula</i>	
<i>Pleurostelma cernuum</i>	

References

- Bayne, C. J., Cogan, B. H., Diamond, A. W., Frazier, J., Grubb, P., Hutson, A., Poore, M. E. D., Stoddart, D. R. and Taylor, J. D. 1970. Geography and ecology of Cosmoledo Atoll. *Atoll Res. Bull.* 136: 37-56.
- Bourne, W. R. P. 1966. Observations on islands in the Indian Ocean. *Sea Swallow*, 18: 44-43.
- Dorward, D. F. 1962. Comparative biology of the white booby and the brown booby (*Sula* spp.) at Ascension. *Ibis*, 103b: 174-220.
- Mackworth-Praed, C. W., and Grant, C. H. B. 1957. *Birds of East and North East Africa*. 1: Longmans.
- Piggott, C. J. 1961. A report on a visit to the outer islands between October and November 1960. Directorate of overseas surveys, Land Resources Div. Typescript 1-71. Chap. 6 Cosmoledo. 27-30.