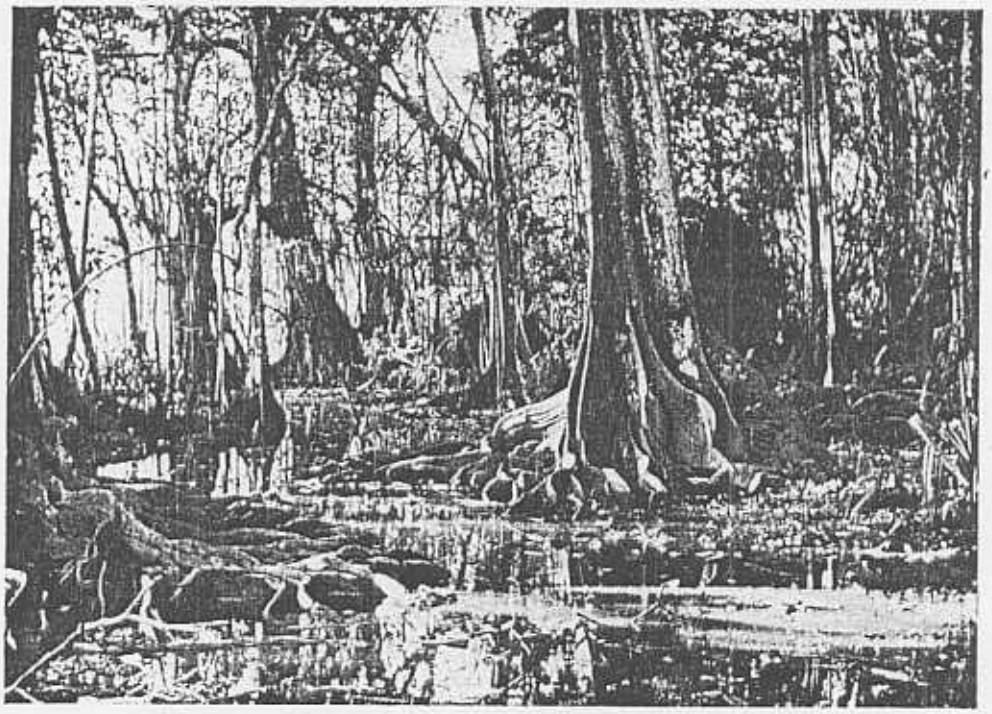
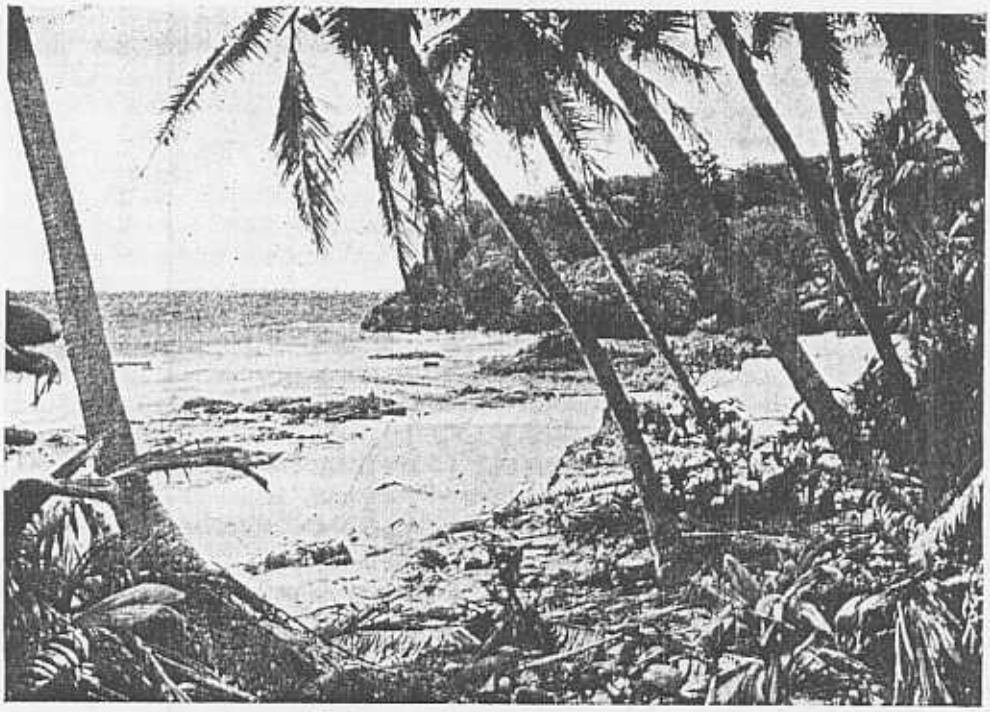


Christmas Island: fresh water marsh at Anderson Dale.



Christmas Island: Dolly Beach.

Notes on the Birds of Christmas Island

By C. A. GIBSON-HILL, M.A., M.B.O.U.

Several very thorough collections have been made of the birds on Christmas Island. The most extensive are those by Lister (1888), Andrews (1897–98) and Mr. M. W. F. Tweedie (1932). These were reported on by Lister (Proc. Zool. Soc., 1888, pp. 517–529), Bowdler Sharpe (Monograph of Christmas Island, 1900, pp. 37–50) and Chasen (Bull. Raff. Mus., 1933, pp. 55–87).

In writing his paper Chasen re-examined all the specimens in the collection of the Raffles Museum and discussed the affinities and extra-territorial distribution of the indigenous species in some detail. Two years later, when producing his *Handlist of Malaysian Birds* (Bull. Raff. Mus., 1935, pp. 1–389), he went over the material again, and made a few alterations in the nomenclature. My own collection consisted of about 200 specimens, taken under his directions, and he had contemplated a further discussion of certain points as an introduction to the notes that follow. Unfortunately this had not been written at the time of his death in 1942. Not wishing to embark on the subject for the moment at least, I am publishing my notes in the form originally planned, using the nomenclature of the *Handlist of Malaysian Birds* and omitting all questions of taxonomy.

The sections as they appear here consist of a short note on the strays added to the island list during my stay there, an account of the habits of the breeding birds based on field work between September 1938 and December 1940 and a check-list of the species recorded from the island.

ADDENDA to the list of recorded birds

Between September 1939 and November 1940 I took examples of six species not previously recorded on Christmas Island. They are,

Erolia minutilla subminuta (Middend.)—two males taken from a party of three seen on Dolly Beach, September, 1940. This species winters from China and Japan, southward to Ceylon, eastern India, Burma, Malaysia, Celebes and the Philippines: it has also been taken in North Australia. In Malaysia it has been recorded from the Malay Peninsula, Banka Island, Borneo and Java.

Tringa totanus eurhinus (Oberh.)—one male taken on the beach at Flying Fish Cove, September 1939. The general wintering range of the Redshank is very wide, and no general agreement has yet been reached on the status and boundaries of the forms occurring in Asia. In Malaysia this race has been recorded from the Malay Peninsula, Tambelan Islands, Sumatra, Simalur Island, Borneo, the North Natuna Islands, Java and Bawean Island.

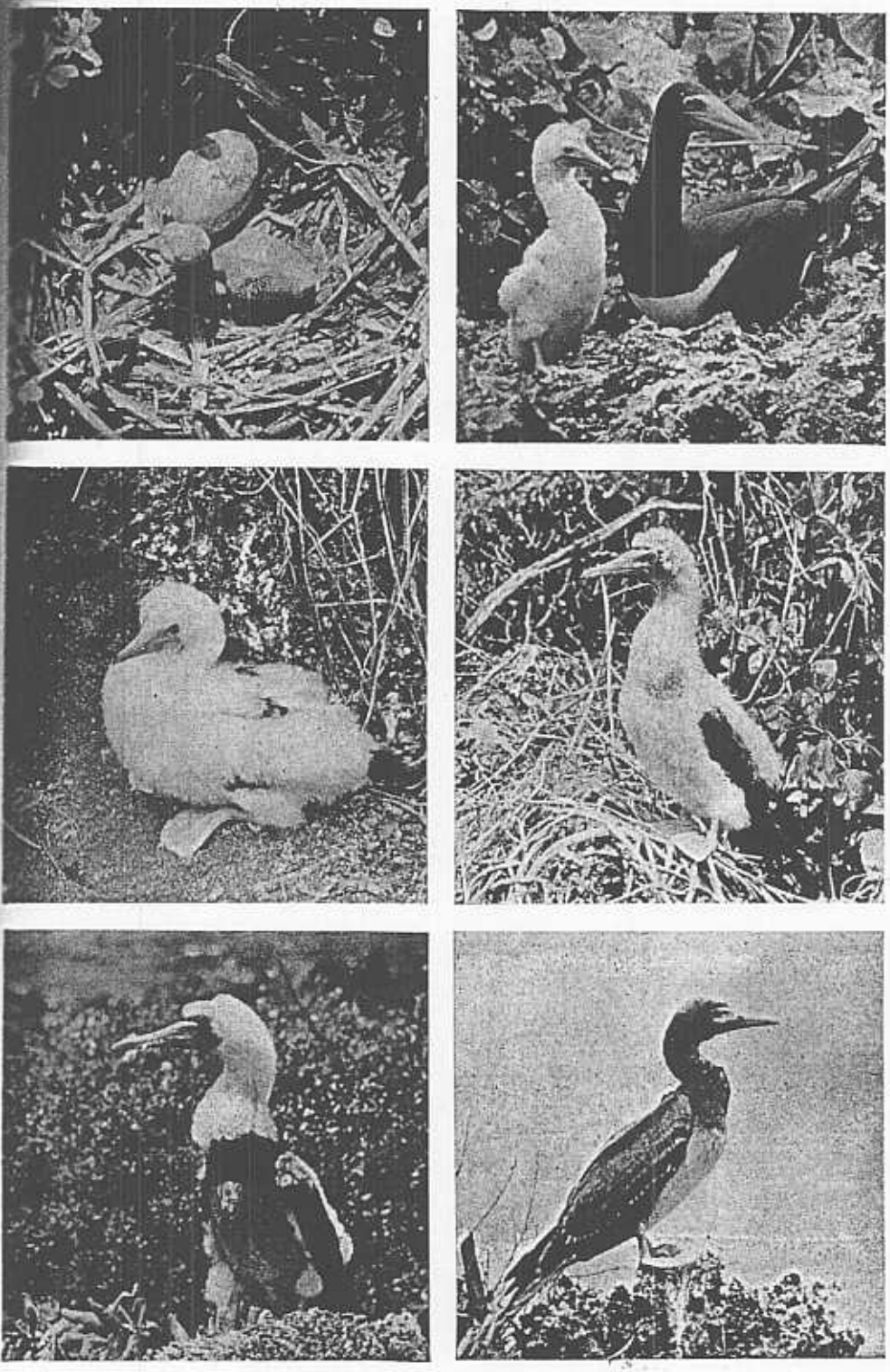
Tringa glareola (Linn.)—one female taken in Flying Fish Cove, in November, 1940, in company with several Common Sandpipers. The wintering range of this species is wide: in Malaysia it has been recorded from the Malay Peninsula, Anamba Islands, Sumatra, Borneo, the North Natuna Islands, Java and Bali. The specimen is in full winter plumage.

Egretta garzetta nigripes (Temm.)—Two birds seen, one male taken, on the fringing reef near Norris Point, April, 1940. The specimen collected is in winter plumage. This race, which is distinguished from the typical form by its blacker toes, occurs from Australia west to the Celebes and Java. The Raffles Museum collection contains two specimens from Cheribon in Java: it is also said to have been taken on Bali, the Kangean Islands and the Cocos-Keeling Islands.[1]

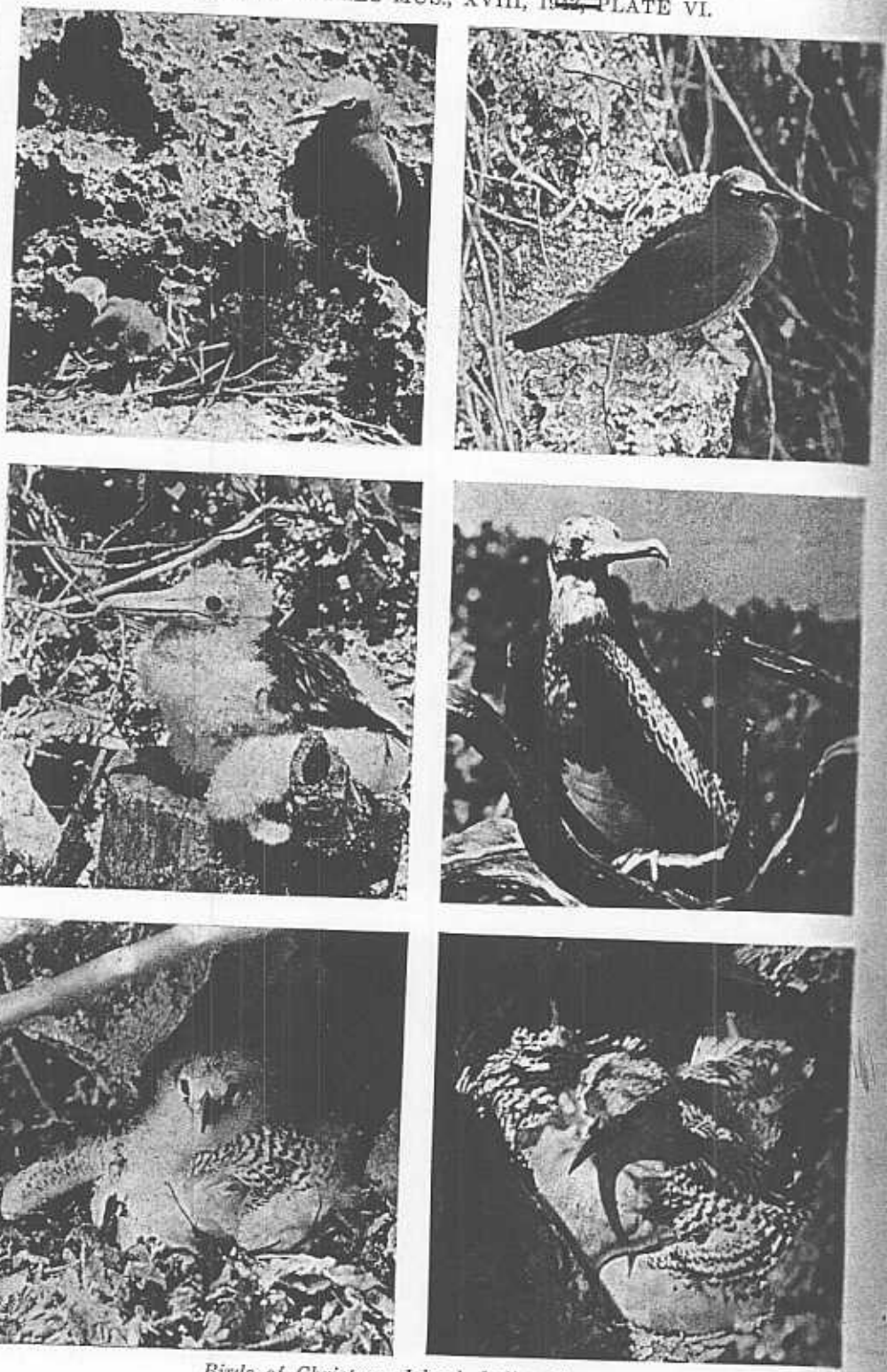
Notophoyx novaehollandiae (Latham)—two males seen and taken on the north-east coast between Rocky Point and Rusholme's Reef, in November, 1940. This is the first record of the occurrence of this species in the Malaysian sub-region. Peters (*Checklist of the Birds of the World*, Vol. 1, 1931. p. 102) gives its normal range as the Lesser Sunda Islands from Lombok eastwards, Celebes, Timor, New Caledonia, Australia, Tasmania and New Zealand.

Nycticorax caledonicus hilli Mathews—a male in full breeding plumage seen and taken on the north-east coast in August, 1939. Peters (*loc. cit.*, p. 115) gives the normal range of this bird as the Moluccas, New Guinea and Australia. Chasen (1935, *loc. cit.*, p. 57) includes one locality in Malaysia, the Cocos-Keeling Islands. This reference is based on H. O. Forbes, who describes *N. caledonicus* nesting in high *Pisonia* trees on West Island (*A Naturalists Wanderings in the Eastern Archipelago,*

1. In listing these additional localities Chasen (1935 *loc. cit.*, p. 56) writes, "We have associated birds from the above localities (except Java) with *nigripes* purely on geographical grounds: the only specimens we have seen are from the type locality." The record of this species on the Cocos-Keeling Islands appears to be derived from Forbes (1885, p. 33) who writes of its nesting in the *Pisonia* trees in company with *Demigretta s. sacra* (Gmel.). In the absence of specimens from this locality it seems probable that he had taken the white phase of *D. s. sacra* for *Egretta garzetta nigripes*.



Birds of Christmas Island, Indian Ocean.



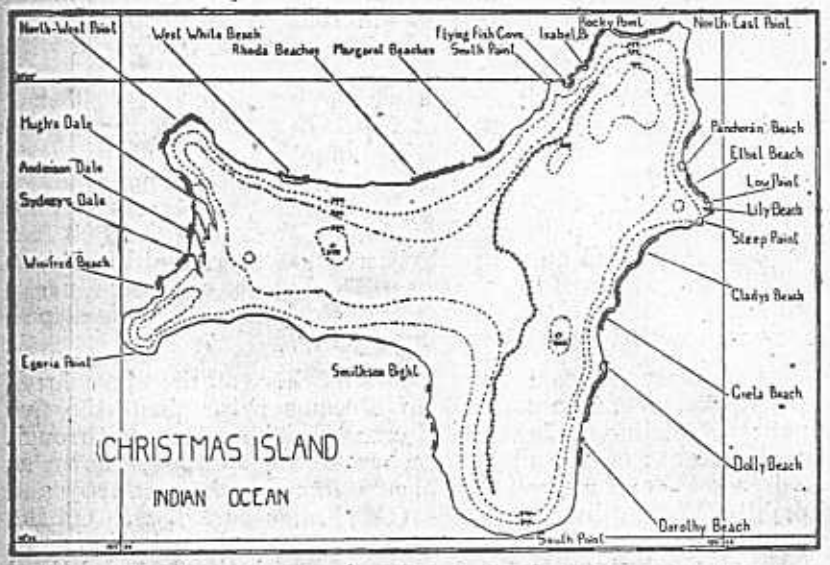
Birds of Christmas Island, Indian Ocean.

1885, p. 33). F. Wood Jones, who was resident on the Cocos-Keeling Islands from June 1905 to September 1906, makes no mention of it (*Coral and Atolls*, 1912), and I found no evidence of a resident Night Heron in 1941. I did, however, shoot one male of *N. c. hilli* from a flock of four seen on the borders of a small lagoon on Pulo Panjang (West Island) at the end of July, and a solitary female in September. It is possible that Forbes's birds were only vagrants: herons certainly stray considerably in this area, as our other records show. At the moment one would say that *Nycticorax caledonicus hilli* is not resident in Malaysia, but that it has occurred recently as a vagrant on the Cocos-Keeling group and Christmas Island.

FIELD NOTES on the Breeding Species

These notes are based largely on observations made between September, 1938 and February, 1940, with the addition of certain further data obtained between the latter month and the end of the year. The work was directed primarily towards a study of the breeding habits, but in a few cases I have added notes on general behaviour.

Seventeen species were found to be breeding on the island. Eight of these are land birds, of which seven are indigenous and



Sketch map of Christmas Island (Indian Ocean), based in part on the survey made by Sir John Murray in 1908. The interior of the island is divided by contour lines drawn at intervals of three hundred feet. The margin of the map is marked off in statute miles.

the eighth, the Java Sparrow, *Padda o. oryzivora*, a cage bird liberated between 1904 and 1923. The remaining nine species are coastal or sea birds. Eight of these are resident: the ninth, the Noddy, *Anous stolidus pileatus*, is to a large extent present only round its breeding season, from April to November. The coastal bird in this group, the Reef Heron, *Demigretta s. sacra*, had not previously been proved to be nesting on Christmas Island, though it was one of the first species to be recorded there.

Local Distribution

The account of each species begins with a short summary of its distribution on the island. This has been included to establish the kind of terrain that the birds normally inhabit, and in the hope that it may be of use in a future survey.

The whole island is densely wooded, except where clearings have been made in the immediate neighbourhood of the two settlements and along the railway line joining them. Its shape is a roughly-drawn capital T, lying on its side, and with the top and the base irregularly concave. The greater part of the coast is formed of steep, often undercut, limestone cliffs, ranging from thirty to seventy feet high. Above these is a terrace, of slightly varying width, which runs almost completely round the island. The outer edge of this is devoid of soil and, for the most part, consists of bare, jagged pinnacles of limestone. The remainder, although there are a number of outcrops of irregular, fissured limestone, is fairly well provided with earth and is covered with open jungle and belts of pandanus. Behind the shore terrace is a second cliff, the inland cliff, which rises, sometimes sheerly, to a height of about five hundred feet. In places this is replaced by a steep slope, and wherever its plane is not too abrupt it is clothed with trees and undergrowth. Above the inland cliff a series of poorly defined terraces and low, irregular cliffs climb to the level of the plateau. This lies between 600 and 800 feet above sea level and on it are three groups of gradual hills lying roughly at the ends of the T arms. The highest of these, Murray Hill, rises to 1,170 feet. The whole of this plateau, and its slopes, is covered with jungle of varying density.

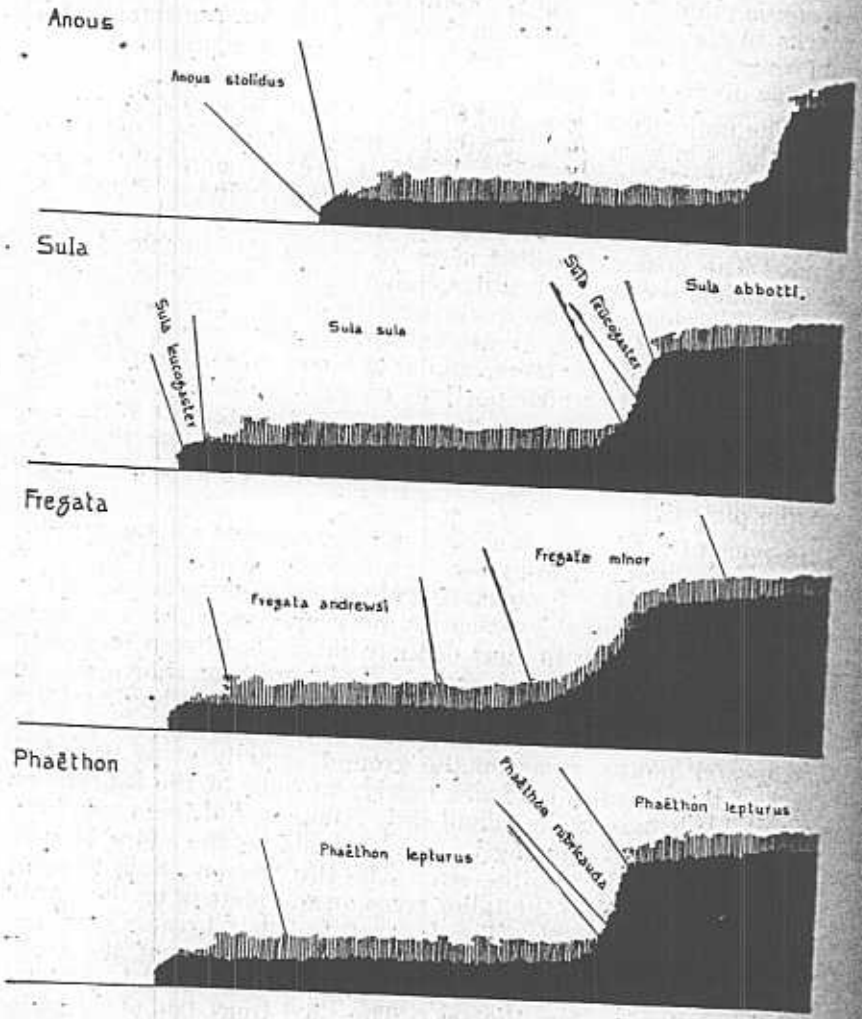
Free water is scarce, and occurs nowhere on the upper level. On the west coast a number of streams arise about the five hundred foot line, or lower, and cross the shore terrace through small chasms; on the upper reaches of one of these, known as Anderson Dale, is a small marsh, surrounded by banyan trees and inhabited chiefly by land crabs (*Cardisoma carnifex*). On the east coast there are three groups of streams, in the neighbourhood of Ethel, Gladys and Dolly Beaches, of which the first and third arise almost on the shore terrace itself. There are no others.

The distribution of water is of interest, particularly as both the pigeon and the dove appear to suffer if the drought in the dry season is unduly prolonged. Under normal conditions the pock-marks in the lime-stone hold enough water for the land-birds, and they are not usually found in increased numbers in the vicinity of the streams.

The majority of the land birds are fairly evenly distributed over the whole island. Two, however, (*Accipiter fasciatus natalis* and *Ducula rosacea whartoni*) are not normally found on the shore terrace, and the recently-introduced *Padda o. oryzivora* is still confined to the neighbourhood of Flying Fish Cove. The goshawk would seem to prefer the thicker jungle of the plateau, except when drawn out by the chances of an easy meal in the vicinity of the various settlements. The distribution of the imperial pigeon is determined largely by the range of suitable fruit-bearing trees, and this again would keep it to a great extent on the upper portions of the island. Both are said to have been seen more frequently on the shore terrace when the island was first visited, but apparently at that time the area round Flying Fish Cove had a rich jungle rather similar to that on the plateau.

Some of the sea birds show a marked vertical zoning in their normal choice of nesting sites. This is particularly interesting in the case of the boobies, frigate-birds and bo'suns. Each family is represented by two or more species which are very similar to each other in most of their habits, but breed in clearly different areas. The phenomen is similar to that shown on the British coast in the case of the Cormorant and the Shag, and the Common and Black Guillemots. One of the boobies, *Sula leucogaster plotus*, nests on the ground, usually at or near the crest of the sea cliff, or, more rarely, on some of the beaches or on suitable ledges on the inland cliff. Another, *Sula sula rubripes*, builds in trees, of varying height, but only on the shore terrace and frequently close to the sea. The third booby, *Sula abbotti*, is largely confined to the taller trees on the plateau or the upper portions of the inland cliff. I never found it breeding at less than five hundred feet above sea level; a number of the nests were at a height of seven to eight hundred feet, and between one and two miles in from the sea. The Christmas Island Frigate-bird, *Fregata andrewsi;* nests only in medium-sized or high trees on the shore terrace, and normally only on the outer portion of this narrow area. *Fregata m. minor*, on the other hand, generally builds on tall trees a short distance back from the sea, and at a height of three to five hundred feet. The Golden Bo'sun, *Phaëthon lepturus fulvus*, may be found nesting in suitable trees

anywhere within about a mile of the coast, and at any height above the sea within this area. The other bo'sun, *Phaëthon rubricauda westralis* breeds only on ledges on the steeper portions of the inland cliff, at a height of two to five hundred feet.



Diagramatic sections through typical portions of the shore terrace on Christmas Island, showing the different breeding zones of the members of the genera *Anous*, *Sula*, *Fregata* and *Phaëthon*. The solid portion represents the island itself, and the vertical shading the covering vegetation.

It is, perhaps, of interest to compare these habits with those of the birds on the island of North Keeling, in the Cocos-Keeling group. The latter is a low atoll of coral shingle, rising to a maximum height of less than twenty feet, and covered mostly with a dense growth of coconut palms or *Pemphis*. *Phaëthon lepturus fulvus, Sula abbotti* and *Fregata andrewsi* are absent from this island. Such frigate-birds as occur there nest close together in low *Pemphis* bushes a few feet from the ground: the species form fairly distinct colonies, adjacent to each other and, as among terns in many parts of the world, stragglers from one species may be found breeding in among the other. Here *Sula leucogaster* nests only on the crest of ground above the beach, and *Sula sula rubripes* in *Pemphis* or *Scaevola* immediately behind it. The *Phaëthon* spp., which include *Phaëthon rubricauda westralis*, breed on the ground, in the shelter of low bushes, much as they do on the Pacific Islands.

Breeding Seasons

The majority of the birds on Christmas Island have fairly distinct breeding seasons. The possible exceptions are *Sula leucogaster plotus* and *Phaëthon lepturus fulvus* whose behaviour is discussed in the corresponding sections below. The data for *Demigretta s. sacra*, is insufficient to draw any definite conclusions.

The true sea birds normally lay between March and the end of August. Against this six, and possibly more, of the land birds have at least their peak periods between the end of October and the middle of March. The climate at its best is uncertain, but discontinuing its vagaries it can be divided roughly into two seasons. The longer and drier of these stretches from May or June to the end of November, with a steady south-east trade as its prevailing wind. During the remaining months, which are much wetter, the wind frequently moves round to the north and north-west, with sudden squalls and occasional storms. Working on this basis it may be said that the sea birds breed during the period of settled winds, and the land birds during the rainy season.

The concentration of the sea birds on the drier months covers the periods during which they have chicks rather than that during which they lay their eggs. Some begin laying as early as the middle of March, and even May is often an unsettled month. Taking the mean of the readings from 1930 to 1939 it had a heavier rainfall than January and only 1.02 inches less than March. Even June had an average of seventeen wet days, and a total rainfall of 8.01 inches. The sea birds would seem, therefore, to start their breeding season too early, before the weather

has quite cleared. The advantage probably comes at the other end. September and October, when the greatest number of young birds are leaving their nests, are the quietest as well as the driest months.

The two exceptions to this general rule, as mentioned above, are *Sula leucogaster plotus* and *Phaëthon lepturus fulvus*. Fresh eggs of the former may be found at all times of the year, but the exception is only a partial one in that the greatest number are laid between the middle of March and early June. *Phaëthon* is rather more peculiar. It nests in the hollowed trunks of dead trees, and is thus almost a land bird in its choice of site. Its egg-laying period appears to run on the end of December, with the majority deposited between May and September, rather later than those of the other sea birds. It may be that it requires the more settled weather before it will venture in among the trees to seek out a suitable nesting place.

The land-birds appear to start breeding just as the weather is breaking. Few of them have eggs much before November, and November though considered dry, can be a very tricky month. The recorded rainfall ranges from 0.23 inches in 1913 to 29.10 inches in 1912, while the average for the last ten years was 7·36 inches spread over eleven days. December is somewhat similar, although its mean total was lower than that of the previous month. The young birds, therefore, are reared during the less-settled, windier, wetter portion of the year. The compensation, for some of the species at least, may lie in the far greater number of insects which are active in the wet season, especially near its beginning. This is particularly noticeable in the case of the rather succulent larval stages of the large, short-horned grass-hopper which appear, in vast numbers over every bush and creeper early in January. The smaller moths, and especially their larvae, also become much commoner at the beginning of the wet period, and one of the mosquitos, (*Aëdes* sp.) which is crepuscular, appears in swarms after the first few rainy days. Many of the other Diptera, which are very abundant during the first four to five months of the year, disappear almost entirely in the dry season. November to March is also the period during which at least the four commonest of the island's land-crabs breed[1], and some of the birds are not averse to eating crab if they can get it. Finally the wind, except in conditions of very abnormal severity, is only likely to trouble *Ducula* and *Accipiter*. The remaining land-birds, except the cave-nesting *Collocalia*, usually build in low to medium-sized bushes, or saplings, in the jungle itself, where they are well protected by the larger trees.

1. *Geocarcoidea humei, Cardisoma carnifex, Ocypoda ceratophthalma* and *Birgus latro*.

The one definite exception among the land birds would seem to be the Java Sparrow, *Padda o. oryzivora*, whose main egg-laying period is between April and August. This bird, however, is not indigenous, and has been resident on the island for less than thirty-five years. It has also been taken to the Cocos-Keeling Islands, and there again it nests largely from May to August. There is relatively little definite information about its breeding season in Malaya, but it is probably over roughly the same period. It would appear that this species, undeterred by being moved to an area south of the equator, is still following the rhythm current in its more northern breeding grounds.

Numbers

Unfortunately no assessment can be made of the numbers of the various species of land birds present on the island. The older residents affirm that *Ducula rosacea whartoni* and *Chalcophaps indica natalis* are less plentiful than they used to be, but the statements, though acceptable, have no statistical basis.

Estimates of moderate accuracy can be made in the case of the sea birds. The most plentiful are undoubtedly the Redfooted and Brown Boobies (*Sula sula rubripes* and *S. leucogaster plotus*) and, during its breeding season, *Anous stolidus pileatus*. The least numerous are the Golden Bo'sun, *Phaëthon lepturus fulvus*, and the Reef Heron, *Demigretta s. sacra*. The latter is a widely spread species, occurring at suitable points from Burma eastwards to New Guinea and the south Pacific islands. The former, unfortunately, is a local race peculiar to Christmas Island and the only form of *Phaëthon* with the full golden apricot plumage; even on the Cocos-Keeling Islands the *Phaëthon lepturus* subsp. is white.

The figures given below are for breeding pairs, and the species are listed in order of descending numerical strength. In all, except possibly the Noddy, a number of non-breeding birds are also present on the island, but they have not been included in the totals.

Sula leucogaster plotus, 5,000–6,500 pairs.
Sula sula rubripes, 4,500–6,000 pairs.
Anous stolidus pileatus, 4,000–5,500 pairs.
Fregata m. minor, 2,000–3,000 pairs.
Fregata andrewsi, 1,000–1,500 pairs.
Sula abbotti, 500–750 pairs.
Phaëthon rubricauda westralis, 400–600 pairs.
Phaëthon lepturus fulvus, 300–450 pairs.
Demigretta s. sacra, 15–20 pairs.

Enemies

In general the birds of Christmas Island have a fairly sheltered existence. In certain cases, however, their numbers and range are curtailed to some extent by predators. These are discussed below under four headings in order of increasing importance.

Crabs. Land crabs are abundant on Christmas Island, but to a large extent they are a nuisance rather than a serious menace. The most plentiful species, *Geocarcoidea humei natalis*, is primarily a vegetable feeder. Two others, *Coenobita clypeata* and *Birgus latro*, are definitely scavengers, and will take any flesh that comes their way. They could not, of course, catch an adult bird, but they would undoubtedly be troublesome to any species nesting on the ground. In part at least they must be responsible for the rather peculiar sites used by the two bo'sun-birds. They are probably also one of the factors limiting the range of the Noddy, which nowhere breeds on the shoreward boundaries of the beaches, as it does on so many other islands. The absence of a resident land rail may also be due to their presence.

Man. Man probably comes rather nicely between the crabs and the more serious predators in his effect on the population as whole. He has no appreciable influence on the sea birds, but he is undoubtedly reducing the numbers of one of the land birds, *Ducula rosacea whartoni*. Both Malays and Chinese also take occasional Emerald Doves, and will eat the island thrush. At the moment the human population is relatively small, and food easily obtainable from other sources. Were this not so it is probably that both pigeons (which are very good eating), and later possibly the thrush, would disappear.

Birds. The land birds include two predators. The larger and most important of these, the Christmas Island Goshawk, *Accipter fasciatus natalis*, certainly includes the white-eye, the thrush and the Java Sparrow in its diet, and probably also takes the Emerald Dove. It is a great hunter of domestic chickens, and has been known to kill fairly large birds. The second species, the owl, *Ninox forbesi natalis*, is appreciably smaller and feeds chiefly on insects, but it will also eat the white-eye and possibly the Java Sparrow. Both these species are widely spread over the island, and, though not particularly numerous, must take a steady toll of the smaller birds.

The sea birds include two frigate-birds. These, as in other parts of the tropics, feed largely on fish stolen from other species, in the manner of the skuas. On Christmas Island the principal victims are the boobies, but they will also attack the bo-sun birds and occasionally the Noddy. On an average they probably feed once a day, or at the least twice in three days. Even at the lower figure they must be depriving the other sea birds of 5,000

to 7,000 meals a day, or, as far as the boobies are concerned, just under two meals a week each.

Rats. The indigenous rats, which were very numerous when the island was first visited, seem to have been largely vegetarian. Andrews described the diet of *Rattus nativitatis* as consisting of wild fruits, young shoots and possibly the bark of some trees. The natural food of *Rattus macleari* was also mainly fruits and young shoots, but apparently it was to some extent omnivorous, and it is said to have destroyed any boots or skins left exposed during the night by parties camping in the jungle.

Their successors, *Rattus rattus* subsp. and *Rattus norvegicus*, subsp., are certainly becoming at least equally plentiful, and they have wider ranging appetites. At the moment they appear to be causing relatively little harm to the birds, but it is difficult to see how they can fail to have a serious effect on the ground-nesting species in the future. The young of both *Sula leucogaster* and *Phaëthon rubricauda* are easily accessible to rats. If the former disappeared it would also inevitable reduce the number of frigate-birds, unless the other boobies increased sufficiently to take its place. It is, of course, difficult to see where the present limiting factor lies. If there were more boobies there could, presumably, be more frigate-birds. There are certainly plenty of suitable trees without breeding colonies. It may be that there is not sufficient food available in the adjacent waters for a greater number of birds. If this is so, then a decrease in the numbers of *Sula leucogaster* would not result in a corresponding increase in *Sula sula* as the former feeds largely on flying fish and the latter on surface-swimming cephalopods.

Ducula rosacea whartoni (Sharpe).

Christmas Island Imperial Pigeon.

This bird, known locally as Burong Pergam, occurs patchily all over the inland plateau. It does not venture down onto the shore terrace, although it was formerly said to be plentiful in the neighbourhood of Flying Fish Cove and Panchoran Bay. In both these situations there were then streams of water which have since disappeared or been considerably modified. As fruit-trees are scarce on the terrace, and the bird does not visit the lower level even in the more isolated portions of the island, it is possible that these changes were in part responsible for its disappearance. There is also no doubt that, as a result of continued heavy trapping for food, the pigeon is growing less plentiful.

When Lister visited the island at the end of 1887 he found the Imperial Pigeon "very abundant." Andrews, eleven years later, described it as "very common." In 1904 the District Officer became concerned about its condition, and Dr. R. H. Hanitsch of the Raffles Museum was sent down to investigate.

He decided that the pigeon "had greatly decreased in numbers" since the first occupation of the island, but "that there were still large numbers" left (Chasen, Bull. Raff. Mus., 1933, p. 58). Twenty-five years later anxiety was again felt, and in 1932 Mr, M. W. F. Tweedie was sent to make a report. After a careful study of the available evidence he came to the conclusion that it was less common than in 1904, but that it was in no immediate danger of extinction. It is very difficult to make an accurate estimate. The pigeon spends most of its time in the dense leafage at the tops of the tallest of the jungle trees, and without considerable experience it is frequently impossible to detect it. Then in very dry dry-seasons it may collect in groups of an hundred or more and come down to the ground in search of water. Nevertheless, it seems to be the considered local opinion that the bird is again less plentiful than at the time of the last official visit. I would suggest that at the present rate of progress, in spite of the four months' close season, it will ultimately die out, but that it is not likely to disappear in the immediate future.

Heavy slaughter for eating will undoubtedly be the precipitating factor if the pigeon does become extinct, but it may not be the only influence at work. In October, 1939, I obtained a pair of birds closely resembling the immature *whartoni* except that the normal deep blue-grey general colour was replaced by off-white: the soft parts were also a little different, the legs and beak being rather redder, and the iris a creamier yellow than in typical birds; the eyelids were orange-brown. These skins were identified by Chasen as sports of *whartoni*, with the suggestion of an unstable, deteriorated stock. A similar pair of birds is said to have been shot in October, 1912, and a number have been seen during the intervening period.

The normal call of the adult bird is a slightly hollow, fruity, drawn-out *coo*. This can be heard at any hour of the day, and the pigeons generally answer each other. As a result a rough imitation of this sound is used by the catchers to make the birds disclose themselves. The note of the immature bird is huskier and softer. Occasionally, the males produce a deeper, booming call which has been likened, somewhat fancifully, to the roar of a tiger. This note is heard most frequently during the late afternoon and early morning, in the last three months of the year.

The diet consists almost entirely of small berries. In the wild state these may be taken, always from the tops of the taller trees, when semi-ripe or ripening. In captivity the birds will eat only the red berries, and these only if they can pull them themselves from the twigs. As they are clumsy enough to drop as many as they swallow, they are difficult to keep alive for long.

The two sexes do not differ appreciably in size, plumage or in the colour of the soft parts—iris, rich yellow; eyelids, grey

with a black edge; bill, dark grey-black, or black; and feet, dull madder-red, or dull crimson—and they cannot be distinguished in a living bird.

It is probable that the close season, from January to April, covers at least most of the period of greatest reproductive activity. The woodcutters are of the opinion that *whartoni* breeds spasmodically all the year round, with a peak period during those four months. The only nest which Andrews found was being built on December 24th, and on January 6th he took an apparently single egg from it. I discovered five inaccessible, but obviously occupied, nests between the middle of January and the end of February, and one at the end of December. Two female birds shot in the latter month contained large ova, about 30 mm. in length, and in most of the mature males the testes were turgid. A memorandum in the District Office records a pigeon taken in the middle of November, 1904, which was found to contain "an egg without a shell." It is also said that gravid females were shot on Phosphate Hill on several occasions in October between 1900 and 1925. Unfortunately it is not possible to examine birds in the close season, and there is a slight gap in my records over July and August, but during the remainder of the year I have found few signs of activity. I would therefore assume that the conclusions of the woodcutters are fairly correct, except that I would place the beginning of the peak period in November or December and not in January. This would fit in with the increased vocal activity from October to the end of the year.

This does not, however, exhaust all the possibilities. When enquiries were being made at the time of Dr. Hanitsch's visit certain of the Chinese expressed the view that *whartoni* reproduced twice in the year, once at the time of the second moon (March) and again at the eighth (September-October). Andrews himself made the same suggestion—"there seem to be two broods a year"—on the grounds that he had found large numbers of immature birds in April and November. But it seems to be the considered opinion of the most successful of those now taking the pigeons, that young individuals can be obtained equally easily at all times of the year. In any estimate it must be realized that *whartoni* itself is much less difficult to shoot during the dry season, when the foliage of the trees is thinner, and similarly that if there is a great increase in building activity as early as October one would expect those nests to have been recorded rather than the less easily detected ones in the wetter months.

The nest is built on the forks of small branches, among the thickish leafage, at the top of the taller, jungle trees. It is thus both difficult to see and difficult to reach. It is the usual loose-knit, slightly untidy, flat platform of dried twigs, common to pigeons; it is about fifteen inches across, nearly twice the size

of that of *Chalcophaps*. I have not seen the egg. The clutch is, probably, normally two; although two of the nests which I found appeared to contain only one chick and Andrews account of his nest would suggest that the egg was single.[1] It is possible, particularly in the presence of other signs of deteriorated stock, that the clutch is growing smaller.

For the first four or five days the young chick is practically naked, with the bare skin a dull grey colour. After that the feathers grow fairly rapidly. The colours of both the plumage and the soft parts are a little different from those of the adult. The head and neck in the immature bird is a slightly paler, harsher, drier grey, with the whitish patch on the crown stronger, particularly in front, and tailing off more sharply over the head. The purplish, vinous bloom is absent from the breast and belly, though its place may be taken by a pale, dull, earthy wash. The edge of the wing is slightly mottled with rich buff. The metallic green sheen, which is present over the back and mantle of newly moulted adults, is absent. In the soft parts the principal difference is in the iris and the feet. The former is a browny yellow in the young bird, while the latter start almost black and become dark grey. At the time of the moult into adult plumage, the iris is yellowish brown, with the brown colour stronger at the periphery, while the feet have developed a faint suggestion of red. Normally this does not mature into the full dull crimson of the adult bird until after the moult has finished, but occasionally young *whartoni* can be found in complete immature plumage with reddish-brown feet.

Chalcophaps indica natalis Lister.

Christmas Island Emerald Dove.

The ground-pigeon is fairly numerous in all the areas of more open jungle, although, in spite of the richness of its colouring, it is often difficult to pick out as it flies. It is most plentiful round the north-east corner of the island, and least numerous away towards the west coast. It is said, by some, to have grown less common in the last thirty years, but it is not easy to make an accurate estimate. It is much more conspicuous in the middle of the dry season, when it comes to the vicinity of the settlements and similar places in search of water and food, than in the wet season, when it keeps more to itself. Under normal circumstances it is far less tame than either *Turdus* or *Zosterops*.

1. I was under the impression that this egg, or eggs, together with another said to have been taken at a somewhat later date, was deposited in the British Museum of Natural History, but since writing the above Mr. N. B. Kinnear has informed me that there are no eggs of *Ducula rosacea whartoni* in the collection.

It feeds principally on small fruits and berries, which it always takes from the ground. It has shown a marked affection for papaya since this fruit was introduced, and it will occasionally eat rice. Unless the weather is unsually dry, when the birds may gather in small flocks, they generally search for food singly or in pairs.

For the field-naturalist the most obvious differences between the plumage of the two sexes lie in the dorsal region, along the back, head and tail. In addition to these there is a certain amount of individual variation which is *accentuated under living conditions* by the play of sunlight on the highly refractive feathers of the wing-coverts and mantle. The head in the female is dull chestnut, darker on the crown. In the male the crown is a fine blue grey, paler over the forehead and dropping fairly sharply to white above and in front of the eyes; the darker colour is continued down the dorsal surface of the neck, while the sides and shoulders are washed with a faint sherry-purple. The lower rump and tail coverts are a rich chestnut in the female, with a few of the coverts slightly tinged with black at the tip, and deep blue grey in the male. The lower tail coverts are almost black in the male, and chestnut in the female. Again the rectrices are much browner in the female, particularly the centre ones which lie on top, and the pale dull buff bands across the lower back are much more conspicuous. In the male the rich green of the wing coverts, especially in newly moulted birds, is a slightly more golden, bronzy green, and there is a conspicuous fleck of pale greyish blue dropping to white on the shoulder. Taken in detail, or examined on dead skins, these differences seem relatively small, but when the pigeons are seen alive in breeding plumage they are considerable. At such times the female appears to be a chestnut-coloured bird with wings and mantle of light peridot, while the male seems to be entirely dark blue-grey with bright, slightly tawdry, green wings.

The males are slightly longer in the wing than the females (♂ 140, ♀ 135 mm.; figures obtained from an average of ten birds of each sex). Excepting the bill, the colour of the soft parts is about the same in both sexes (iris, dark brown; eyelids, dark blue-grey with rose-madder edges; and feet, a watery purplished red, sometimes slightly more crimson in the male). The bill is reddish-brown, darker, almost black, at the tip and base, in the female; and a rich red-brown, purplish at the base, in the male. In the breeding season the anterior three-quarters of the bill in the cock bird becomes a very bright orange-red and is most conspicuous.

The breeding season, which is well defined, extends from October to the end of February. The peak period is during November and December, just before, or at, the beginning of the heavy rains. The earliest signs which I found were a nest with two eggs on October 25th, and one with young chicks at the beginning of November; the latest a bird practically ready to fly on February 11th.

The nest is a loosely-knit, somewhat untidy, flat platform of dried twigs, covered with a few dead leaves. It is usually built between five and ten feet from the ground, on the fork of a thin horizontal branch of a small bush. No nests were found among the pandanus, where Andrews was told to look for them.

Two eggs are laid. They are oval in shape, about 26 mm. long and 20–21 mm. broad, with a matt surface. The colour is off white, with the slightest suggestion of very pale biscuit. The sitting bird is most timid, and generally leaves the nest before one is near enough to see it. The eggs hatch some time after the seventeenth day.

The young chicks are lead-grey in colour and naked except for a few fine strands of down over the back and shoulders. Although indicated by slightly darker lines along the spine and wings, the sheathed feathers do not break the surface of the skin until the third day. The eyes begin to open at about the same time. The bill and legs are a yellow grey, darkening with age. When first hatched the chick stands with difficulty, but by the fourth day it has become very alert and pugnacious. By that time teleoptiles, in sheath, have appeared on the wings and back. The following day, the fifth, they sprout on the breast, and on the sixth in two rows over the crown. At this stage the chick is about 82 mm. long and the bill and legs have already lost some of the yellow tone.

The primaries burst through the ends of their sheaths about the seventh day, and the rectrices shortly afterwards. From this point development is rapid, and by the tenth to eleventh day the chick is well-feathered and capable of fluttering to the ground. It is now some 119 mm. long and the bill and legs are a dull, dark lead-grey. This is about as dark as they become, and from here onwards the legs and the middle of the bill grow slowly paler. The young bird may leave the nest any time after the twelfth day, when it is capable of running short distance rapidly, and flying about fifteen to twenty-five feet. The actual time of departure seems to be determined either by the parents becoming less attentive, or the chicks more adventurous. Some young birds stay on the nest until the fifteenth or sixteenth day. Even then,

when they leave, the primaries and rectrices are still only half to two thirds of the adult length, the axillary feathers are thin and the feathers over the crown are still in their sheathes, so that the head appears to be covered with little rods of silver wire.

The juvenile plumage which is developing when the young bird leaves the nest is of some interest. The belly, breast, neck and head are a dull rufous-brown, the feathers faintly barred with light to smoky grey, paler, almost fawn, round the beak, and richest on the top of the head. The male rump feathers are black, washed with a band of dull chestnut, and the tendency to erythrism in the primaries and rectrices, to which Chasen drew attention in the adult, is very marked. The wing coverts, in both sexes, are black with a band of rufous-fawn at the tip and a large eye-spot of the same colour half-way down the shaft. At the time when the young bird first flies these feathers are widely spaced and barely overlapping, so that the wings appear to be irregularly barred with brown and black. This potentially fawn plumage never matures fully, because the first moult begins early and starts on the coverts. As a result bronze-green feathers appear on the shoulders, and work across the wings, before the black areas have been overgrown.

This first moult seems to start about three to four weeks after the bird has left the nest and proceeds rather slowly. By the time that it has reached the belly and the throat the young pigeon is practically full-grown. The beak is about 19.5 mm. long, the tarsus 25 mm. and the total length, after subtracting the tail, about 125 mm. (an adult bird averages 21, 26, and 161 mm. respectively). Young birds about half-way through their first moult are common at the beginning of December, and can be found easily from then on until the end of April.

When the bird leaves the nest the irides are yellowish-brown and the eye-lids grey, with little or no suggestion of blue, and with the edge only faintly tinted with pale rose-madder. The bill is at first horn-brown with a darker, almost black, tip and base. This slowly changes to a mulberry brown in the female, and a red brown in the male, and these in turn pass on to the adult colours. The feet are a dark grey-purple, paler in the young male; they become much lighter before assuming the watery purplish-red of the mature bird. It is difficult to assess accurately the time which these colour changes take, but I would suggest that it is about six months. Certainly by the beginning of the mating season, at the end of September, there are very few birds in which the soft parts have not reached the full adult coloration.

Anous stolidus pileatus (Scop.)

Common Noddy.

On Christmas Island the Noddy occurs largely as a breeding visitor, arriving about April and leaving during November. In the intervening months it is very common all along the coast. It nests only on ledges on the sea cliff[1], and never ventures inland. It is less plentiful where the cliffs are absent (except at Lily Beach) throughout the middle part of this period. A few birds remain after November, but they represent a very small proportion of the total number. They seem to gather mostly at the extreme ends of the north coast, at Low and North-west Points.

The basic note of the adult bird is a low, harsh croak, *kar-r-rk*. Sometimes this is emitted in flight, particularly at night. When the Noddy is frightened from its nest, or when it is trying to drive an intruder away, the sound is shortened and the key raised. The call then ends on a hoarse, angry, grating cry, as though the bird were attempting to screech. The young, when anxious for food, make a shrill, harsh squeak, and this can be heard all through the night in the nesting season.

The usual diet is small, live fish: in addition I have several times seen birds pecking at the fruit of the pandanus. The fish are skimmed from the surface of the water while the Noddy hovers over it. It normally fishes only by day, but it will also do so at night if the moon is full. The young are fed by regurgitation. The Noddy does not appear to dive, and seems, in general, very reluctant to enter or settle on the sea. On the other hand, it often stands on the crest of a beach where the salt spray is being blown over it, as though enjoying the sensation of a mild shower bath. This is most noticeable at the end of the breeding season, in the one or two months immediately before the birds leave the island for the open sea.

The two sexes do not differ appreciably in plumage, size or the colouring of the soft parts; in the field they can only be separated by their behaviour. The adult has the iris dark brown, the bill black, and the legs and feet a dark, slightly purplish red-brown.

The breeding season, though wide, is definite. On Christmas Island it runs from the beginning of April to the end of September. The earliest eggs were seen on March 24 (near Greta

1. The only exception to this which I found on Christmas Island was a nest in the crown of a small pandanus, projecting over the beach of a sheltered cove (Margaret Beach). On the Cocos-Keeling Islands the birds are breeding in two situations: those on North Keeling are on the shingle bank behind the beach (which would seem to be their most usual habitat), while the members of a small colony on an island at the south end of the main atoll are nesting in the tops of the coconut palms.

Beach), and the latest on September 3 (near Ethel Beach). The majority are laid in May and hatch in June. On North Keeling the season appears to last from December to June. The Christmas Island birds therefore breed later than their neighbours on the Cocos-Keeling group.

At the beginning of the breeding season unpaired birds often collect in small groups on the beaches, or on certain of the rock ledges. Occasionally one will begin bowing to the bird next to it. After a short interval the latter may reciprocate its actions. Sometimes a bird obtaining no response from one neighbour turns to another. The bow is relatively simple, the head being lowered slowly until the point of the bill almost touches the chest, and then raised again rather more sharply. Occasionally a bird carries a small twig, or picks up a piece of dead seaweed, and presents it as the opening move in a bowing ceremony. At this stage it is not possible to determine which is the male bird, except in so far as one can assume that it is the male that takes the initiative.

Later the birds take up definite positions on suitable ledges on the sea cliff, in pairs. Here one, the female, remains for long periods on the site of the future nest, while the prospective mate brings occasional offerings of dried sticks or other flotsam. His gifts are followed by more prolonged and deliberate bowing, after which the birds may stand side by side, gently caressing each other's head and shoulders with their bills. As time passes the male also regurgitates fish for the female, giving it to her mostly in the late afternoon, and spends longer periods standing by her. At intervals he begins bowing again, and if she responds appreciatively, emitting a short, purring chuckle, he attempts to mount her. After a successful mating he frequently remains by her side, pressed against her, as though in gratitude.

In spite of the male's often numerous presents of twigs and dead cabbage-tree leaves no real nest is built, though the rock may be covered with an untidy layer of debris over an area of about a foot square. As the fragments are not worked together they frequently fall off the ledge. Some attempt is made to keep up the number. Fresh bits are added occasionally all through incubation and the fledgling period, but by the time that the chick is ready to fly the rock is generally bare.

Only one egg is laid. If it is removed or destroyed the bird lays again, and will continue to do so until three or four have been produced. If two eggs are put into one nest the brooding parent attempts to displace one of them. If an egg and a small, suitably-shaped stone are put in, it is usually the egg that is pushed out as it moves more easily.

The eggs are broad for their length, and from a distance sometimes appear almost round. Thirty ranged from 51 to 56

mm. in length, and 35 to 38 mm. in breadth. The shell is about .3 mm. thick, with a slightly rough surface which has a gritty feel. The ground colour is a warm off-white, with pale, purplish grey smudges and dark, red brown specks and blotches, few in number and mostly at the wider end. The egg takes between thirty and thirty-five days to hatch: certain of the short periods may have been under estimated, and it is probable that the average time is thirty-three to thirty-five days.

Both parents incubate. The shifts are normally short, and they may make as many as five changes in the course of a day. The egg is seldom left unattended for long, though I have several times seen the sitting bird fly down to the water for a few minutes to moisten its feathers. Once incubation has become well established the parents take little notice of each other, except when changing over at the nest. The returning bird usually calls as it approaches the ledge, and is answered once or twice by its mate. The relief ceremony consists only of mutual bowing. It may be quite perfunctory, but some pairs habitually saluted each other for several minutes. The male, however, no longer feeds the female, and they seldom stand side by side caressing each other, as they do so frequently before the egg is laid.

The parents become increasingly attentive, and aggressive, as incubation progresses. Towards the end of the period the sitting bird rises to drive any intruder away, regardless of its relative size. As it does so it utters a harsh, guttural *kar-r-rk*, ending in a grating cry, as though it were screeching with fury. One parent usually remains with the chick until it is three to five days old. During this period it is even more aggressive than before. The basis for this increased response appears to be visual rather than hormonal. If a fourteen-day egg is removed and a young chick put in its place the adult rapidly becomes most pugnacious, and will even sally out to attack passing frigate-birds which it had ignored a few hours before.

At first the chick is fed at short intervals of two to four hours, and the material passed over is liquid in form. Towards the end of the first week it is usually left alone most of the time, and its food, brought only five or six times a day, is more nearly solid. If an egg is put in place of a chick one or two days old, the parents begin incubating again, but if the chick that has been removed is older they take little notice of the egg and may even try to chivy it off the ledge.

The young birds emerge covered with down. Usually this is a smoky colour, paler over the forehead and belly, but it may be a uniform, dirty white. Early growth is fairly rapid, and regular. On the third day the chick is about 135 mm. long. By the eighth this has increased to 177 mm., by the thirteenth to 212 and by the eighteenth day to 247 mm. The bill starts at

about 22 mm., and lengthens to 28, 34, and 37 mm., measured to the gape[1]. In the very young chick the nostril is situated well forward, and the base of the bill is broad, but the proportion between the culmen and the gape soon approximates to that in the adult.

The earliest feathers are a longitudinal plaque down the back and a patch over each shoulder, which start to sprout on the seventh day. The remiges, on the radius first, appear about the same time, and the rectrices shortly afterwards. Nevertheless, as late as the tenth day the young bird, on superficial examination, still seems to be clothed only in down. Then by the twelfth day the juvenile feathers have thrust themselves forward all over the dorsal surface of the body; and by the twentieth to twenty-second day the down is represented only by a few fluffy fragments adhering to the feathers of the belly, wing coverts and gular area. At this stage the total length is 258 to 263 mm., of which some 30 mm. are covered by the rectrices, while the wings are just under 100 in length. By the thirty-fifth day the young bird is capable of limited, though reluctant, flight. The wings are now between 180 and 200 mm. long, and the tail is approaching 100 mm.

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1. These measurements are based on three chicks recorded in July and August, 1939. In 1940 I repeated the observations with a series of ten nests, of which a typical specimen is given below. Six of the eggs hatched between sunrise and noon, and the other four during the early afternoon. No attempt was made to climb down to the nest the first day. All linear measurements are given in millimetres. Some of the chicks were also weighed, but the resultant lists were considered highly suspicious by the Japanese when they found them, and appear to have been destroyed as seditious documents.

Age, in days	*Total length*	*Gape*	*Wing flat*	*Longest primary*	*Longest scapular feather*	*Longest rectrice*
1	108	22	—	—	—	—
3	130	23·5	—	—	—	—
5	143	25	—	—	—	—
7	158	27	—	—	—	—
9	177	28·5	—	—	3	—
11	196	30·5	—	8	17	—
13	210	33	—	17	24	14
15	220	34	56	26	34	16
17	235	35·5	68	35	40	19
19	247	37	78	37	45	22
21	258	39	89	39	49	25
23	263	41	100	50	49	30
25	267	42	117	60	50	34
27	280	43	134	61	50	43
29	307	46	148	65	50	48

Measurements were not continued beyond the twenty-ninth day. At this stage the chicks, though still unable to fly, were very willing to precipitate themselves into the sea to escape capture when the ledge was approached.

Left to itself the chick begins to fly about the fortieth day, but for some time after that it remains near the nesting ledge and returns there to be fed. This practice is continued for a number of weeks, and I have found apparently full-grown birds bullying their parents to regurgitate food for them. The latter are very patient in this respect, although in most others the Noddy is rather querulous.

The plumage in which the young bird leaves the nest resembles that of the adult fairly closely, although there are a number of minor differences, dependant largely on the freshness of its feathering. A few pale feathers are still present round the vent and under the wings. The dark nigger of the primaries and rectrices, is a little darker and harsher and lacks the adult's faint suggestion of dark red-brown. The white cap extends back from the forehead no further than the level of the orbit, where it passes fairly rapidly into the general body colour, continuing above the eye only as a thin white line terminating at the posterior canthus. The gradual, very delightful, merging of the two shades over the posterior half of the scalp is absent. As a result the white patch has an untidy appearance, looking much as if a splodge of bird lime has landed between the eyes. Finally, the feet and webs are darker, almost black in the youngest specimens, and without the reddish tinge of the adult bird.

Demigretta sacra sacra (Gmel.)

(Eastern) Reef Heron.

This is the least plentiful of the resident birds on Christmas Island. It occurs in very small numbers, from one to four or five, on most of the north and east coast beaches at all times of the year. The dark phase is seen slightly more frequently than the white. It was among the first species recorded from the island, but it was not known to breed there until the discovery of a nest on the cliff face, about half a mile south of Dolly Beach, in August, 1940.

On Christmas Island the Reef Heron feeds mostly as the tide is ebbing or at low water, taking its food from the small pools left on the exposed portions of the reef or, in calm weather, from the edge of the sea itself. It normally moves forward over the reef with quick, stilted steps, turning its head from side to side and occasionally darting its bill down to seize a victim. More rarely it stands motionless, poised watching a suitable pool intently, for a long period. Its diet appears to consist chiefly of small fish, including a fair proportion of the little *Periopthalmus* spp., and various crustaceans. It may also, though much more rarely, be seen working over bare ground above the cliff-top in search of grasshoppers and other insects. One stomach that was examined contained the remains of three large larval *Locusta migratoides*, and the elytra of two beetles. Feeding birds are shy and

difficult to approach: I never succeeded in getting a satisfactory photograph during my two and a quarter years on the island. On the other hand, a stray *Egretta garzetta nigripes*, which was with us for about a fortnight, allowed me to crawl to within fifteen feet of it.

The Reef Heron is normally silent. It occasionally emits a grunted croak of *ork* when feeding, presumably to signalise the acquisition of an unduly tasty morsel. It may also produce a longer, harsher call of *arrk* when alarmed, but both notes are unusual.

The single nest that was definitely located was the work of a pair of white birds. It was a low, rather untidy pile of dried weed, dead *Scaevola* leaves and a few sticks, situated on a rock shelf in a cleft, about twenty-five feet up from the sea. It contained two pale, but dirty, eggs[1]. Unfortunately it was not possible to climb down to the ledge, or even to visit the locality regularly. When it was next seen, five weeks later, there were two chicks, covered with a rather long, scraggy-looking, greyish down. Their bills appeared to be yellowish grey: the legs and feet were not visible. At the following visit, three weeks later, they seemed to be about half the size of the adult bird, and had well-developed plaques of white feathers on the shoulders, back and rump. The bills were a stronger yellow, with the tips blackish.

It seemed probably that there was a second nest about sixty feet away, on the face of a slight headland, but it was not possible to reach or over-look the place. In this instance at least one of the birds was of the dark phase. It was flushed from the neighbourhood of the spot twice on our first visit, returning after less than fifteen minutes the first time, and once on our second visit. It did not appear to be present in October, when I made my third, and last, inspection of the locality.

Sula leucogaster plotus (Forst.)

Brown Booby.

The Brown Booby occurs in small numbers all round the island. It is nowhere abundant but it has, in total, the largest population of any of the sea birds. It breeds mostly on or near the summit of the sea cliff, and it is seldom seen over the land. A few pairs occur on suitable ledges on the inland cliff, but these normally fly straight to and from their nests, in marked contrast

1. In 1941, after writing these notes, I found this species breeding regularly in the crowns of coconut palms on the Cocos-Keeling Islands. The data obtained would be out of place here (and is being reserved for a later paper), but it is of interest to record that ten eggs from the latter islands ranged from 42 to 47 mm. in length and from 32 to 36 mm. in breadth. They were all a uniform, very pale blue, with a slightly rough surface.

to the Redfooted Boobies which can often be seen gliding up and down above the trees on the shore terrace.

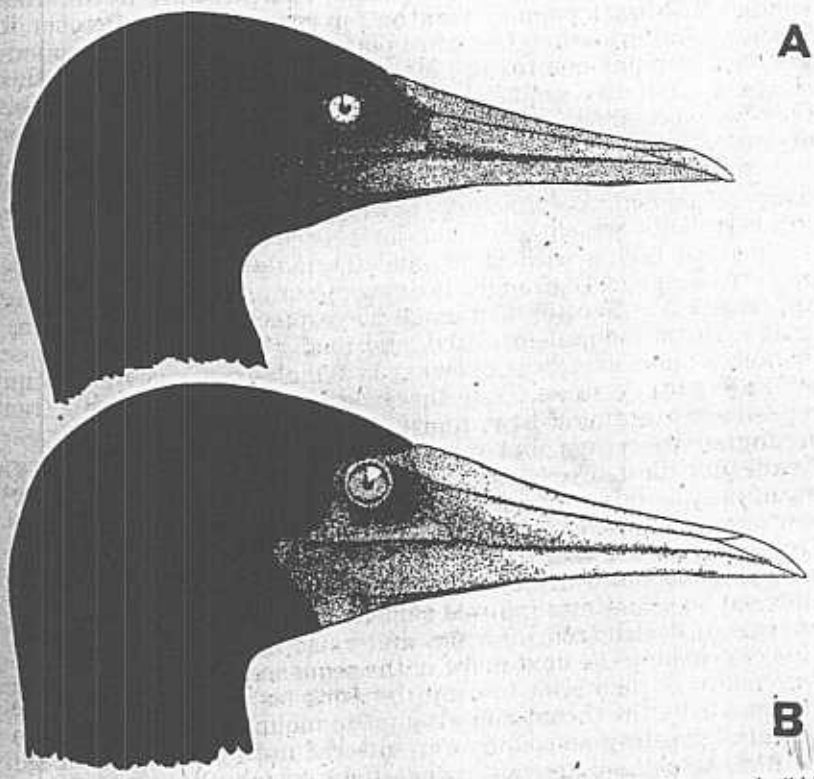
The Brown Booby is more silent than most of the members of its family. It rarely calls on the wing, except when attacked by a frigate-bird, when it may emit a single, agonised *karrk*. It is also much quieter on the ground. In part this might be attributed to the fact that it frequently nests in isolated pairs, and seldom has neighbours to disturb it. There are, however, two areas on Christmas Island were a number of birds breed close together, and even here they make relatively little noise. The calls, when uttered, have much the same range as in *Sula sula* but there are specific and sexual differences. The basic note of the female is a harsh, quacking *kaak-kaak-kaak*....., lower in tone and less strident than that of the Redfooted Booby. This is used as a greeting to its mate or chick, or, with much intermittent rattling of the mandibles, in threatening an intruder. The male has a more sybilant, almost hissing, call, which in annoyance may become completely lost in the rattling of the mandibles. When saluting its mate it produces a sound rather like a soft *iruk, iruk, iruk*...., in clear contrast to the female's *ar-k, ar-k, ar-k*..... Young birds keep the syllables much shorter and sound as if they are grunting, *agk, agk, agk*, ..., but here again the noise of the mandibles is often more prominent than the note from the syrinx.

On Christmas Island the food of this species consists largely of a flying fish, *Cypsilurus bahiensis* (Ranz.). The majority of the stomachs that were examined contained one to three fish, ranging from four to eight inches in length. The largest that was measured was vomited by a living bird: it was just under eleven inches (272 mm.). The Brown Booby also takes other surface swimming fish and cephalopods, but the latter appear to form only a small proportion of its diet. It feeds almost entirely by day, in contrast to the Redfooted Booby which does most of its fishing in the evening or early hours of the night. Like all the *Sulidae* it catches its food by diving from the air, and subsequent pursuit under the water. The wings are partially flexed during the downward drop, and then folded completely as it enters the sea. Birds and conditions vary but in general it appears that thirty to fifty feet is the normal height from which it dives, and that it mostly stays under the water for only twenty-five to forty seconds. It seems to be rather more solitary in its feeding than the Redfooted Booby, and it is usually seen singly or in small groups of a dozen or less. Fishing birds seldom call to each other and, as mentioned above, it is normally silent on the wing.

The young birds are fed by regurgitation. During the first two to three weeks the material is brought up in a well digested,

almost fluid form, and the parent dribbles it into the chick's opened bill. Later more solid food is produced, and finally, from the age of seven to nine weeks onwards, the youngster is given whole fish, barely affected by the adult's gastric juices. When this stage is reached the chick does not wait to be fed, but thrusts its bill into the parent's gullet, while the latter is retching, to meet its prospective meal on its way up.

The two sexes are similar in plumage, but vary in size and appearance. The male, which is smaller (♂, total length 781 mm., tail 202 mm., wing pressed flat 389 mm., culmen 98 mm., and tarsus 42 mm.; ♀, total length 811 mm., tail 201 mm., wing flat 413 mm., culmen 104 mm., tarsus 44.5 mm.: figures obtained from an average of six specimens of each sex), manages when in new plumage, in spite of the broad, anencephalic forehead, to look neat and dapper. The female, especially beside him,

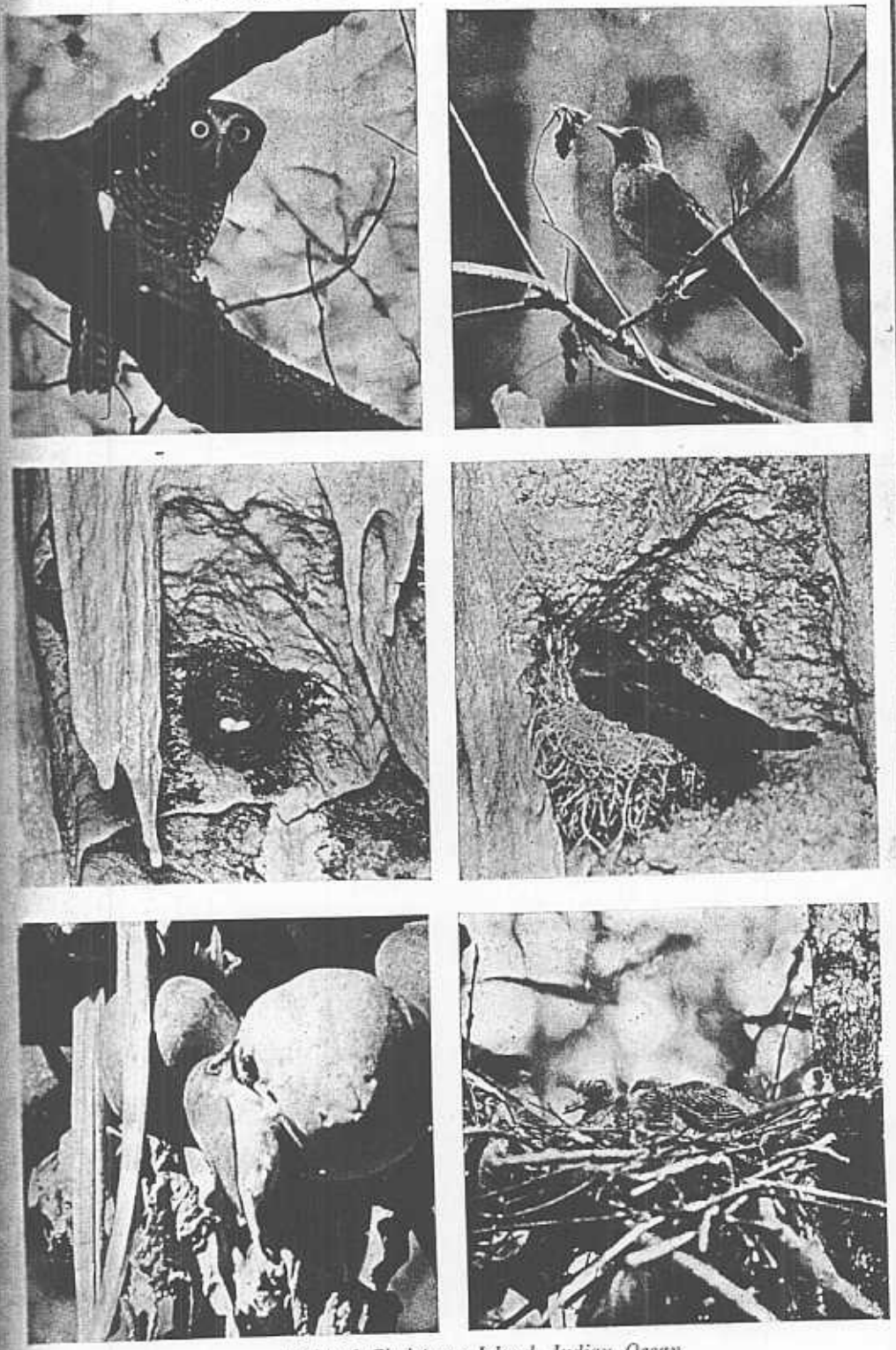


Heads of adults of the Brown Booby, *Sula leucogaster plotus*, male "A", above, and female "B", below, to show the differences in the colouring of the soft parts in typical specimens from Christmas Island. (× ½).

appears coarser and heavier. The eyelids and iris (eyelids dull blue, iris grey or yellowish grey) are the same in both sexes, but there is also a difference between them in the shape of the bill and the colouring of the remaining soft parts. To some extent these are subject to individual variation, and the difference is more marked in some pairs than in others. In general, however, the female has a much heavier, broader bill, which is a light greenish yellow, paler, almost whitish, at the tip: the facial and ramal skin areas are the same colour, though some birds have a dark, slate blue patch immediately in front of and below the eye: the feet are usually a pale yellowish green. In the male the bill is a greenish grey, with the facial, ramal and gular skin areas dull purple or a dark purplish grey, and the legs and feet pale arsenic green.

Sula leucogaster definitely breeds all the year round. Each point on the coast has its peak period, and these are at different times. The least popular months for eggs are from October to January, but even then there are places where they can be found; the most popular months are March to May. Individual nesting sites are often used annually between the same dates; in two cases they were occupied for three successive seasons by the same pair of birds.

The initial stages of courtship appear to consist of little more than occasional, perfunctory bowing. This was observed at several places which were not later used for nests. - The two birds stood facing each other, and the male then raised his bill upwards and slowly brought it down again until he was touching his chest. The second bird made no response, and after bowing several times the male desisted, and finally flew away. In other instances males were seen bowing to females that were standing by rudimentary nests. On these occasions the females often replied with a single bow, and then spent some time coyly rearranging the twigs and leaves on which they were standing. Again they did not respond further, unless the male had an offering of nesting material with him. When he had the female would bow several times, and then attempt to take it. Usually the male dropped it in his excitement and she, pulling it loosely into the pile, paid no more attention to him. If the male retained the material he sometimes induced sufficient excitement in the female for her to desist from bowing, and raise her head up to bray. This is probably the next move in the sequence, as on one occasion the male was then seen to drop the stick he was carrying, seize the female by the throat and attempt to mount her. Apart from an initial greeting no sounds were uttered until the female raised her head to call. Later still, when the nest is well advanced, the birds give out their respective calls when one returns, but apart from this pay little attention to each other. It would seem, in



Birds of Christmas Island, Indian Ocean.

general, that courtship is much more limited in this species than in the temperate Gannets, though the birds sometimes spend long periods standing side by side.

The size of the nest varies considerably. It may be as much as five or six inches high, and over three feet across at the base, or it may consist only of a lining to a shallow depression scraped in the ground. The materials used are dried twigs and dead leaves, frequently from the cabbage-tree. It is usually placed in the open on the edge of the sea cliff, or if it is steep the inland cliff, but it may be hidden in amongst the limestone pinnacles. The birds do not seem to seek shelter and frequently refuse to avail themselves of it.

The egg is elliptical in shape, and rather variable in size: ten range from 56 to 65 mm. in length and 37 to 45 mm. in breadth. The shell is thick, with a rough surface. It is a uniform bluish white in colour, sometimes with a faint suggestion of green in it, but it is normally covered with a coating of lime which rapidly becomes mud-stained and dirty. The majority of the birds lay only one egg to a clutch, but in a count of fifty nests sixteen, that is 32%, were found with two: the second egg is usually laid about forty-eight hours after the first.

Both parents incubate, sitting with the feet over the egg or eggs in the manner of the Gannet. It was not possible to time the shifts, and I did not see the changeover. The bird remains tenaciously on its nest when approached, and will often stand its ground until it is pushed away. Its normal response is to begin by stretching its neck forwards and upwards, half opening its wings and clattering its mandibles. After one or two forward thrusts it drops its head down and rearranges the material on the outer edge of the nest, tucking it in and tumbling it over much as the female does in courtship. There are no additional movements. Each time that one advances the bird thrusts out its head, and then as soon as one is still reverts to tidying the nest. This continues until one is within striking distance, when it delivers a vicious jab with its bill or, more often, seizes whatever is nearest to it. If it should establish contact it holds tightly for a few minutes, and then draws its head away without opening its bill: if it has caught one's hand the result can be very painful.

The egg hatches between the fortieth and forty-third day. If there are two eggs incubation usually ceases with the emergence of the first chick, and the second seldom hatches. Even if it should hatch, the smaller youngster gets little of the food available, and dies within a few days. The chick emerges naked and with the eyes closed. The skin is a slaty grey, with the face and bill about the same colour. The eyes open on the third day, and by the eighth the nestling is thickly covered with a fine down, pure white in colour.

One of the parents usually remains with the chick for at least the greater part of the day, often sheltering it from the sun, until it is two to three weeks old. Sometimes both birds are equally attentive, and may be seen standing proudly together. In the early stages it is defended in much the same manner as the egg, and the disturbed parent may even attempt to tuck it under its feet in the intervals between lungeing out at the intruder. Their interest wanes as the chick grows older until finally it is visited only to be fed.

In spite of this apparent devotion the adult's reactions are based on the nest rather than on the offspring. On several occasions we exchanged the chicks in neighbouring nests, often with three to four weeks difference in their ages, and on its return the parent accepted the newcomer without question. When the youngster was merely removed and placed on the ground nearby the adult waited disconsolately by the empty nest, failing completely to recognise its off spring if the latter was more than six to eight feet away. On three occasions eggs of the Redfooted and Brown Boobies were transposed. The adults treated the chicks as if they were their own, in spite of the slight colour differences. The only trouble, in part a minor one, was that their natural reactions were different. Young Brown Boobies when agitated on their nests behave rather as the adults do, bowing down to tidy the nest and then striking upwards towards the intruder. Redfooted Boobies, on the other hand, habitually strike downwards, almost below the level of the nest, when disturbed. The transposed chicks continued with their normal (and inappropriate) reactions. In addition, while the young Redfooted Booby has no difficulty in standing on the ground, the young Brown Booby is most inept at balancing on the branch of a tree. They are also far too inclined to wander from the nest. As a result one fell and was killed when about seven weeks old: a second fell shortly afterwards and starved to death as the foster parents would not descend to feed it: only one survived to leave normally, after about fourteen weeks.

The development of the chick follows fairly closely the sequence described for *Sula sula*. Juvenile contour feathers begin to sprout during the fifth week, and the primaries, rectrices and scapulars are apparent by the end of the sixth. By the ninth week the secondaries have appeared, the scapular patches have united in the midline, and the rectrices are sufficiently developed to form a good, strong fan; the down is growing thin behind the eyes and over the breast. By the twelfth week it survives only on the head, neck, thighs, flanks and, in fragments, among the secondaries. During the following week it disappears from the head and neck, and by the fifteenth week the juvenile plumage is complete. The young bird is now practically fully-grown and

capable of a limited flight. At this point it makes occasional excursions, returning to the nest to be fed at the end of them. These preliminary flights become longer and more frequent, until ultimately the chick remains away for so long that the adults lose interest in the site. Thus it is usually the young Brown Booby which abandons its parents, rather than the parents which abandon the young bird.

The immature plumage is characteristic. Those areas which, in the adult, will be dark chocolate are a dull brown with a hint of grey. The future white parts, including the axillary areas and the long bar under the wing, are a very pale dirty grey. The boundaries between the two colours are clearly marked, but they are a little irregular and not as neat as in the mature bird. The feet are pale lemon-yellow, almost white, and the beak is pale grey with a slight hint of blue; (at the end of the sixth week the feet are pinkish and the beak, slaty grey). The adult plumage seems to appear first among the darker feathers, and it is possible to find birds with chocolate mantles and mottled breasts. But the birds do not breed in this stage, and I have never seen, among some two hundred pairs, a nesting *Sula leucogaster* with anything but the complete, mature plumage.

Sula sula rubripes Gould

Redfooted Booby or (incorrectly) White-Booby.

This species is very common along the north and east sides of the island, where it is the most numerous sea bird. It is less plentiful in the neighbourhood of South Point, and on the long stretch of coast flanking Smithson Bight. In depth it spreads widely over the shore terrace, and it may even roost in trees on the lower slopes of the inland cliff, but it seldom penetrates as far as the plateau itself. Its normal range is thus between those of the Brown Booby and Abbott's Booby. It may be met with at least an hundred miles out at sea, and I have passed birds, either from Christmas Island or from North Keeling, half-way between these two islands.

It is relatively silent in the air by day, unless it is attacked by a frigate-bird, when it usually emits one or two indignant calls of *karrk*. The tone of these cries varies considerably, and one is tempted to believe that they are influenced by the condition of its stomach: certainly the frigate-birds sometimes leave a bird alone after it has called out once, while at other times they pursue it with increased zeal. When flying at night it frequently gives a rather harsh, grating call of *karr'uk, karr'uk*, as a warning when another bird passes too near to it.

It produces a variety of notes, in the neighbourhood if its nesting site, none of which are pleasant. In general they appear to be based on the warning *karr'uk* or *karr'k* which is heard in flight at night. The commonest is a succession of these harsh,

grating quacks, which given together sound like a badly forced laugh, or an inferior wooden rattle revolving slowly. Its tone seems to vary with the degree of annoyance with which it is uttered, and it is frequently followed by a prolonged clattering of the mandibles. When one bird alights too near to another there is always an indignant squawking and squeaking, which both may continue for some time, in the manner of querulous fish-wives. Early in the breeding season pairs greet each other with a much lower, softer note, followed by a gentler, almost murmurous clattering of the mandibles. Immature birds, when worried by too much attention, also produce a subdued, gentle clattering, sometimes without any initial cry, often continuing it for a considerable period.

The food consists largely of cephalopods or, less frequently, fish from four to eight inches in length. It is pursued and caught under the water. Usually the birds dive from a height of thirty to fifty feet, but under exceptional circumstances they may drop much further. When searching for fish they collect in groups of five to fifteen, frequently strung out in Indian file, and fly with a strong, regular stroke low over the water. Occasionally they mass in larger numbers, and I have several times seen three to four hundred birds following a shoal of fish. They are very greedy, and sometimes fill themselves so full that they cannot rise into the air again.

The two sexes are alike in plumage, size and in the colour of the soft parts—iris, dark brown; upper eyelid, dull blue; lower eyelid, pinkish; bill, pale blue, slightly washed with pearl-grey, and pink round the base; line of bare skin over the fore-head and round the gape, pink; feet, madder-rose, slightly orange on the legs and with a blue tinge in the shadows; and claws grey-blue to pink. The interramal skin, and the thin line of bare skin running up to the angle of the gape, are most interesting. Normally, the former is blue-grey, with a hint of mauve, and the latter pinkish. At the beginning of the mating season the colour becomes dull purple, and later it darkens. By the time that the nest is finished these parts are almost black. They begin to fade again, slowly, shortly after the egg has hatched. This change occurs in both sexes and is a certain indication of a breeding bird.

The breeding season is limited and definite. Nests are built from the middle of April to the beginning of June. The eggs are laid from the end of May, and nearly all have hatched by the middle of July. The young birds start to fly in October and November.

The nest is an untidy platform, about twelve to fifteen inches across, of dried twigs, covered with a few dead leaves. The central depression is very shallow. The whole structure is loosely-knit and begins to disintegrate shortly after the egg hatches.

Usually it is placed high up in the branches of tall trees on the shore terrace, but in the neighbourhood of Lily Beach the birds build in low cabbage-trees, between ten and fifteen feet from the ground. On the shore terrace they frequently nest in the same trees as *Fregata andrewsi*.

Only one egg is laid, and the birds seldom leave it voluntarily. It is elliptical in shape, ten ranging from 56 to 59 mm. in length and 36–40 mm. in breadth. The shell is thick with a rough surface. The ground-colour is a bluish-white, but it is usually covered with lime. Both parents incubate, and the egg hatches some time after the thirtieth day.

The newly emerged chick is about 120 mm. long, blind and practically naked. The skin is a dull lead-grey; the face and bill are much darker, and soon become almost black. The down (pre-plumule) grows fairly quickly, and by the seventh to tenth day the bird is entirely covered with a short, white coat like lamb's wool. Later this becomes long and of a fine texture; it is always pure white in colour. The eyes open about the third day.

By the end of the fourth week the chick is about 453 mm. long, with the beak 81 mm. measured to the gape and the culmen 71 mm. At this stage it usually appears to be even larger than it really is as it generally stands up when the parent is on the nest with it while the adult bird sits beside it. The first contour feathers begin to sprout at this time, but owing to the thickness of the pre-plumule down they are not visible under normal conditions for another six to eight days. The primaries appear first, and are shortly followed by the scapulars and the rectrices. By the end of the sixth week all three groups are clearly discernable, and the rectrices are about 37 mm. long. The secondaries appear during the seventh week, and by the eight week the two scapular patches have united in the midline and most of the upper back is covered with adult feathers. By the beginning of the ninth week the rectrices are about 112 mm. long, and the down is growing thin over the breast and behind the eyes. During the next two weeks it is replaced by feathers over the whole of the breast, upper belly, lower back and temporal region of the scalp. Some down still remains among the coverts. By the twelfth week down is left, in appreciable amount, only on the back of the head, the neck and the thighs. This disappears during the succeeding week, the last fragment to go usually being a small patch, like a forelock, on the forehead. At this stage the young bird is practically fully-grown. The culmen measures about 82 mm., the gape 97–100 mm., and the total length is 671 mm. of which 177 mm. lie in the tail.

The chick usually wanders away from its nest during its third month, and clambers about on nearby branches. In some

cases this is necessary, as the nest is already disintegrating, but in others it is no more than an expression of the bird's innate restlessness. It normally begins to fly when between thirteen and fifteen weeks old. At first it returns to the neighbourhood of the nest after each excursion, and is still fed there by one or both parents. Gradually, however, it remains away for longer periods, until finally, by about the end of its fourth month, it is completely independant. Even then it may return to roost nightly in the same or a neighbouring tree. For the first few months of its free existence it seems to fish largely by day: about half those that were examined contained flying fish remains.

The juvenile plumage is a dull grey brown, paler on the belly and lower breast: in some examples the under tail coverts and vent area are white. The colouring of the soft parts at this stage still differs considerably from that of the adult bird. The iris is greenish grey, the bill almost black with the skin of the face a dark grey blue, and the legs and feet greyish pink, more deeply coloured on the webs than on the digits. These colours mature slowly, and by January and February the iris is definitely more brown, the bill mid-grey, darker at the tip, and the legs and feet redder. The full dark plumage appears to be retained until July or August. From then onwards it becomes increasingly scarce in flying birds, until the next season's youngsters take to the air in October. Thus the brown juvenile plumage would appear to be abandoned by the end of the first year.

The colour of the next, or first intermediate, stage is rather variable. Typically the birds have the breast and belly pure white, with the throat lightly washed with ochre grey, and the head mottled with pale grey brown, stronger on the nape. The mantle and rump feathers, the median and inner coverts, and the axillaries are grey brown with pale, almost white tips. The lesser coverts along the anterior edge of the wing are whitish. The rectrices and primaries are silver grey, with some white feathers among the secondaries. The colouring of the soft parts approximates fairly closely to the adults—iris, light yellowish brown; eyelids, very pale prussian blue, deeper at the edge; bill, pale blue, dark horn brown at the tip and very slightly pinkish at the base of the lower mandible; interramal skin, pale blue; and legs and feet, deep pink with a hint of mauve, with the claws off-white. In the field birds in this stage appear less plentiful than the first-year juveniles, and, of course, much less numerous than the fully mature adults. Possibly some at least move out to sea, while others may telescope this and the next stage, and thus reach a mature plumage at the end of two years.

Birds with the plumage outlined above moult after a further year into a much paler, but still not completely white, dress. In

it the mantle and back are mottled with white and pale grey brown, the wing coverts are largely white, and the remaining body feathers completely so. The rectrices are usually a pale, brownish grey, except, occasionally, for the centre pair. The soft parts are much the same colour as in the earlier phase described above. This plumage is probably worn for a complete year, but birds with it are even scarcer than those in the second-year stage. Again they may be out at sea, away from the sight of land, or some individuals may omit this plumage and moult directly into the full white of the mature bird. There is nothing at the moment to suggest that the adult *Sula sula* migrates, or even disperses, outside the breeding season, but this does not make it impossible for the juveniles to do so. It should not be forgotten that immature birds are rare in the neighbourhood of the nesting grounds of the South African Gannet, even though some at least of the adults remain throughout the year.

In conclusion it is of interest to stress a negative point. On Christmas Island *Sula sula* does not normally breed in a dark or parti-coloured plumage[1]. Nearly three hundred nests were examined closely and always the birds were found to be in full, white, adult dress. Also it is worth noting that the intermediate phase, with the head and under parts light brown, the back and wings darker and the rump and tail white, in which these birds are said to breed on the Marquesas and other islands, does not occur on Christmas Island, even as a passing plumage. Among the Christmas Island birds the tail is always the last area to become white, not one of the first.

Sula abbotti Ridgway.

Abbott's Booby.

Abbott's Booby is the least known of the *Sulidae*. It occurs on only two islands, Christmas Island and Assumption[2], on both of which it breeds in tall trees, well in from the coast. Unfortunately it is not plentiful on Christmas Island, and its nesting sites are very inaccessible: in consequence relatively little work was done on it. Such observations as were made suggest that, though heavier in build and more clumsy in movements, it is, in the main, rather similar to *Sula sula*.

As a breeding bird it appears to be restricted to the west and southwest portions of the island. It nests only in jungle trees on the lip or summit of the inland plateau, at a height

1. The only hint of a possible exception was a solitary female, shot in the middle of February, which had a ripening, though pale, ovary about 17 mm. long and with follicles up to 2 mm. in diameter; the plumage was white on the breast and dark on the mantle, coverts and rump.

2. Lying to the South of the Aldabra group, between these islands and the northern tip of Madagascar, in the western portion of the Indian Ocean.

of five to eight hundred feet above sea level. It is occasionally seen off the north coast west of Smith Point and, more regularly, in Smithson Bight. I never saw it off the east coast or at the north-east corner of the island, where I was living. There is, however, usually a small colony near Anderson's Dale, a second half way between this area and the point known as the Banyan Tree, and a third half a mile from the railway line, to the north-west of the new woodcutters' camp.

This is certainly a noisy bird. The basic note, in which no sexual difference was detected, is a harsh, croaking quack, *ko'ark, ko'ark, ko'ark* ....., repeated several times on a descending key, and louder and deeper than that of the Redfooted Booby. When two pairs are breeding in the same tree they can be very quarrelsome; as with the latter species each bird generally calls out whenever one of its neighbours moves. When attacked in the air by frigate-bird it emits a single, loud, deep croak. Courting birds also produce a long, monosyllabic note which starts as a croak, and tails away into a deep-bellied rumbling sound, most nearly resembling a hearty and prolonged belch from a confirmed and portly beer-drinker.

The diet appears to consist largely of flying fish, though squids and other fish are also taken. Such observations as could be made lead to the conclusion that Abbott's Booby feeds mostly during the middle of the day rather than by half light, many of the birds returning from the sea between four p.m. and sundown. The method of fishing is the same as in the other boobies. On several occasions birds were seen flying in small groups of three or four, and it seems probably that if they were more plentiful they would collect in very large numbers like *Sula sula*.

The plumage of the two sexes is similar, and there is not much difference in size, although, in the field, the female appears a little fuller and more thick-set. The colouring of the adult soft parts is the same in both sexes—iris, dark brown; eyelids, black, with a small bluish-green area on the lower lid; bill, fleshy white to fleshy grey or green, with the tip almost black; bare skin of the face, dark dull grey, almost black, except the interramal skin and that at the base of the mandible which are a pale bluish-green; tarsus and proximal two joints of the toes and webs, dull, slightly greenish, grey, with the web more slaty and darker, almost black, along its free border.

There seems to be a fairly definite breeding season. The nests are built in April and May, towards the end of the bad weather, and the eggs are laid in the latter month and in June. Some of the sites are deserted by the end of September, and most of them by the end of October.

The nest is the usual untidy, flattened platform, about eighteen inches across, of dried twigs mixed with a few dead leaves. The whole structure is very loosely-knit and begins to disintegrate early. It is always placed high up in the branches of tall trees, generally on the edge of the plateau. Where the inland cliff is absent the birds may nest in trees growing on the slope, but I do not think that they ever come down as far as the shore-terrace itself. They are always too far from the sea to mingle, like *Sula sula*, with the frigate-birds. As stated earlier some of the nests were as much as eight hundred feet above sea level, and several miles from the sea. It is difficult to determine the significance of this, unless it is that they are seeking relatively stable trees: those growing in the main block of the jungle, on the plateau, presumably sway less with the wind, and provide a firmer foundation for nest-building, than those round the edge of the coast. Escape from the frigate-birds cannot be an important factor. The latter seldom trouble the boobies while they are nesting, even when they share the same tree with them, and birds breeding well inland have to pass the coastal patrol on their way home as inevitably as any others.

Details of development are difficult to obtain. The nests are not easy to find, and when they are found it is usually impossible to reach them or even to get near to them. One, typical, lime-covered egg is laid; the newly hatched chick is naked, and dull grey in colour, with the face and bill a little darker. The down, which grows fairly rapidly, is long, pure-white and thickly placed. The subsequent stages seem to be much the same as in the other boobies. The young birds reaches two-thirds of the adult size before the contour feathers, which sprout first on the wings, scapulars and tail, are apparent. Some four weeks after the tail quills have appeared they are about as long as the bill. By then the down is wearing thin over the breast and behind the eyes, and most of the upper back is covered with feathers. Three weeks later the down has practically disappeared[1].

1. Such juvenile feathers as were seen suggest that the first plumage is an uneven, rather brownish grey on the back, and paler and more mottled on the under parts. Unfortunately at the time of my stay on the island I was not aware that the juvenile plumage had not been recorded; and so, deterred by the difficulty of reaching even the area of the nests, did not collect a young bird for detailed examination. Adults can be obtained by lying off the north coast in a *kolek*, and repeatedly throwing a fish on the end of a long line into the water, thereby attracting them to within gunshot range. I never saw a bird that I felt sure was a juvenile Abbott's Booby on the wing. This is not surprising as the immature forms of the other two boobies are much less plentiful than the adults, and *Sula abbotti* is itself relatively scarce.

Fregata andrewsi Mathews

Christmas Island Frigate-bird: the local Malays sometimes refer to it as *Burong Kachip*, from the scissor-like action of its tail when in flight.

On Christmas Island the distribution of *Fregata andrewsi* seems to follow that of *Sula sula rubripes*. In general it is very plentiful on the north coast, especially between Smith and North-East Points. It also occurs on the east side, and towards the south-west corner, but it is much less numerous in these areas. It roosts and breeds in the tall trees on the outer portion of the shore terrace, and seldom penetrates further inland.

Its extra-limital range is very restricted. Peters (Check-list of Birds of the World, Vol. 1, 1931, p. 95) gives it as the Cocos-Keeling and Anamba Islands, and off the coasts of Sarawak, Celebes and India, but even this list is too long. *F. andrewsi* has been taken, but not proved to nest, on Pulau Ringi in the Anambas. Chasen visited the islands in September and October, 1925, and while there collected seven females and one male, all in mature, but not breeding, plumage; he found the bird plentiful and there can be little doubt that it is resident somewhere in the Anamba-Natuna group. Granted this one would allow the record of occasional strays on the Sarawak coast, and possibly also the Malayan[1]. The remaining localities can only be based on misidentifications or very rare vagrants, and should be omitted from its normal range. It certainly does not breed on the Cocos-Keeling Islands, and I would much doubt if it ever visits them: even more it cannot be reaching the Indian coast regularly unless it has a third, quite unsuspected, breeding ground much nearer to it. Frigate-birds are magnificent fliers, but they are to a large extent tied to the land by their feeding methods, and they do not habitually make long flights over open water.

The different frigate-birds behave very similarly in the air, and in general their flight has been described satisfactorily in several papers. One would like, however, to stress the difficulty

1. There are no known specimens of *F. andrewsi* from the Malay Peninsula. The only visual records so far reported are four by Mr. C. G. Young, given in a short note in the Malayan Nature Journal (Vol. 1, No. 2, 1940, p. 62). Mr. Young's birds were all in flight, and apparently at some distance from him. Unfortunately he does not state their age or sex, of which he should have been aware if he were in a position to determine their specific standing with certainty. Except under very favourable conditions juveniles of the majority of the frigate-birds cannot be separated in the field. In the adult, the plumage differences between the male and female *F. andrewsi* are at least as considerable as those between them and a female or immature male *F. ariel*.

which *F. andrewsi* in particular appears to experience in becoming airborne. It breeds in fairly tall, rather isolated trees on the shore terrace, and thus normally has both wind and a clear drop to assist it in taking off from its nest. During the whole period of my stay I saw only three birds, on different occasions, resting voluntarily within ten feet of the ground. They were on small bushes at the side of a sheltered path through the jungle. None were able to fly when approached, and after floundering and flapping for some time each came to rest in tangled vegetation. Two were caught and thrown into the air, and they still failed to rise satisfactorily.

The Christmas Island Frigate-bird also appears to be quite unable to get up from a calm sea. The only occasions on which I saw it even near to alighting on the water were on days of gusty wind and broken, choppy waves. At such times it rises fairly neatly, opening its wings quickly when on a crest and making a strong half beat as the wave drops from under it. In general, however, there is no doubt that it is helpless on any flat surface, land or water, or in any sheltered spot. Equally it is interesting to note how much it delights in being in the air. Birds spend hours idling up and down above short stretches of coast, in preference to roosting. Only complete calms, when flying would be unduly laborous, keep them down in appreciable numbers. Even then the majority are on the wing again as soon as the wind begins to rise, while an approaching storm entices all but the sitting birds into the air.

F. andrewsi is normally silent on the wing, but when several are competing for the food of one booby individuals occasionally emit a harsh, grating sound, midway between a croak and a caw. This is also used as a warning note by a gliding bird if another passes too close to it, and it can be heard, with variations, in the neighbourhood of the nesting sites throughout the breeding season. It is, apparently, produced equally readily by both male and female birds. In addition the former have a call peculiar to courtship, which is discussed below. Both also clop their mandibles together freely when disturbed on the nest. The chicks produce a rather plaintive, rat-like squeak, which is repeated with great persistancy for long periods when they are hungry.

The diet consists largely of fish and cephalopods, but *F. andrewsi* will take almost any animal food that is obtainable easily: one stomach that was examined contained the remains of several grasshoppers. During the breeding season adults will also steal the egg or chick from a neighbouring nest, if it is left unattended for long. The usual method of feeding, as with all frigate-birds, is by robbing other birds in the air. The favourite victim is the Redfooted Booby, although the Brown

Booby and the bo'sun-birds, particularly *Phaëthon lepturus*, are also attacked[1]. They are normally intercepted, within sight of the coast, while returning from fishing. Frequently two or more frigate-birds fly round them, pecking at the back and wings, until they vomit their meal to save themselves from serious harm. The food is then caught as it falls or picked from the surface of the water before it sinks. If the booby attempts to escape by dropping on to the sea, or if it is too heavy to rise easily, the frigate-birds swoop over it, striking with their bills as they pass. As soon as it empties its stomach they allow it to fly unmolested past them.

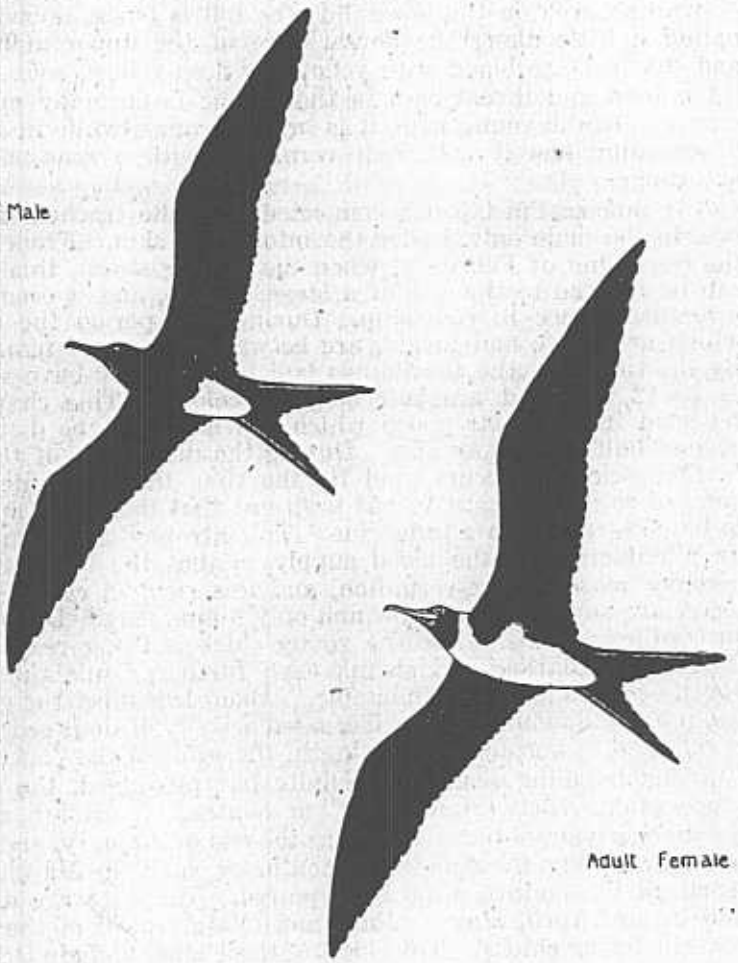
In suitable weather these birds sometimes fish for themselves, picking small fry or cephalopods from surface shoals with considerable skill. When doing so they hover for some ten or twelve half strokes of their wings, with their breasts a few inches above, or even touching, the water, while their bills swing down with the regularity of a pendulum. They will also swoop down to gather anything edible from an open beach, and at such times take carrion and even sewage. In addition I have seen the smaller frigate-birds (but not the present species) catching flying fish in the air, pursuing them, like hounds of heaven, along the troughs of the waves.

The young bird is fed in the same manner as the young booby. Initially fluid, or semi-fluid, material is vomited up and dribbled into its open bill. Later it receives less well digested food. Finally, when it is about two or three months old, it is so voracious and impatient that it generally puts its head into the adult's gullet to meet the meal on its way up.

The two sexes differ in plumage and size, the females being appreciably larger (♂ total length 907 mm., tail 388 mm., wing flat, 610 mm., bill to gape 131 mm., and gape to vent 399 mm., ♀ total length 999 mm., tail 419 mm., wing flat, 650 mm., bill to gape 157 mm., and gape to vent, 434 mm.: figures obtained from an average of ten fully mature birds of each sex) especially in the body. The difference in the mature plumages is most conspicuous, although the details are few. In the breeding male

1. On Christmas Island *Sula sula* feeds largely on cephalopods, while *S. leucogaster* takes a much higher proportion of flying fish. The extent to which *F. andrewsi* concentrates on the first species gives it also a diet rich in cephalopods, while *F. minor*, which attacks the second *Sula* equally frequently, receives a greater proportion of flying fish. The latter also fishes on its own more often than *F. andrewsi*, taking mostly small fry and *Cypsilurus*. This difference between the diet of the two species is born out by an examination of their stomach contents, cephalopods being more usual in *F. andrewsi* and flying fish in *F. minor*. The point, of course, that is not certain is whether the former concentrates on the Redfooted Booby to obtain cephalopods, or because it finds it an easier bird to attack.

the belly only is white, while in the female the white spreads up and covers the breast and clavicular region as well. In the fresh plumage in the female there is only a slight greenish gloss on the mantle, while in the male there is a dull purplish sheen over the whole breast and throat, and a fine oil-green iridescence over the back, neck and crown where the feathers are long, narrow and lanceolate.



Adults of the Christmas Island Frigate-bird, *Fregata andrewsi*, in flight, seen from below, to show the different distribution of the white areas on the breast and abdomen in the two sexes.

The colouring of the soft parts, except for the iris which is always dark brown, is also different in the two sexes. In the female the upper lid is pale, or reddish, mauve; the lower lid is usually grey-white, though it may occasionally be similar to the upper lid, or even black. The bill is generally salmon-pink, sometimes brownish, almost black, at the tip of the upper mandible; and the feet are white, or rarely pinky white, with black claws. In the male the eyelids are black with a light blue or whitish area on the lower lid; the bill is black, occasionally paling a little along the dorsal edge of the upper mandible; and the feet are black with yellow, or flesh-yellow, soles. The interramal and throat skin in the female is normally pinkish-mauve. In the young male it is bright orange, while in a male of breeding age it is a rich vermilion with a seasonal hint of orange.

A mucous-lined pouch connected with the tracheal system lies, in the male only, under the interramal skin. From about the beginning of February, when the mating starts, this pouch can be inflated to the size of a large pomalo, and it occupies a prominent place in courtship. During this period the testes, which are white and turgid, are between 15 and 17 mm. long. By the time that the female has laid her egg they have shrunk to 10–12 mm. and are pale beige in colour. This change is reflected in the gular pouch which can no longer be distended beyond half its former size. During the incubation of the egg further sclerosis occurs, and by the time that the chick has hatched so much elasticity has been lost that the pouch appears to be no larger than a tangerine. This atrophy is accompanied by a reduction in the blood supply so that the throatal skin becomes more orange-vermilion, and less rich, in colour. The testes are now pinkish-yellow and only 8 mm. long. During the succeeding months, while the young chick is being reared, the testes grow darker and shrink even further, while the gular pouch becomes almost uninflatable. About December the gonads begin to swell again, and the increased activity of their secretions is reflected in a gradual loosening of the walls of the pouch.

The breeding season is definite but prolonged, the whole process taking between nine and ten months. Courtship, among the more advanced birds, begins at the end of January, and nest-building during the following month, or early in March. By April all the mature birds have paired. The eggs are usually laid in late April, May or June, and by July most of the nests contain downy chicks. The oldest of these start to fly in October, and during November young birds of the year, in full juvenile plumage but with the long-bones still soft, are common. Most of the breeding adults undergo a complete moult, the males

earlier than the females, between the end of November and the beginning of February.

The nest is usually placed high up in the forking branch of a tall tree on the shore terrace. The favourite tree is the Sea Almond, *Terminalia catappa*, which is without its leaves for the greater part of the breeding season: the birds also build in a species of *Grewia* and, more rarely, *Gyrocarpus americanus*. They are gregarious and normally between three and ten pairs breed close together in the same tree. Frequently a site is used from year to year, and the new nest built on the guano-cemented remains of earlier ones. When completed it is an untidy, flat platform of dead sticks and pieces of dried creeper, fifteen to twenty inches across, with a shallow central depression. It is very loosely constructed. Often the fresh material is represented by less than a dozen sticks by the time that the chick is ready to fly, and each year's ultimate contribution to the pile is small.

It would seem that work on the nest is begun by the male before the birds have paired. Both sexes roost in the breeding trees throughout the year, and may be said to be resident in them rather than on the island as a whole. During the resting months they perch at any convenient point. Later, from early February onwards, the males begin to take up definite positions on the branches, frequently on the site of an old nest. Occasionally they add further sticks to the pile, but as a considerable proportion of these are stolen from their neighbours, and then stolen by others in their turn, the series as a whole progresses very slowly.

When the pouch is completely flexible the males often sit, in groups of two or three, with it fully extended, their wings half open and their heads well back. If a female flies near, or attempts to alight on the same tree, they raise their heads, rock backwards and forwards, and set up a great high-pitched clamouring of *keew-yee, keew-yee, keew-yee* ..... or *keew-yoi, keew-yoi,* ..... At intervals they pause to clatter their mandibles, producing a peculiar, hollow, clopping sound. Sometimes their mood changes and they croak, raven-like, in place of the full call. Each bird raises and lowers its pitch during the proceedings, and ultimately deflates its pouch with a long, banshee-like wail. They do not, however, make any attempt to keep in time with each other. Each operates individually, so that the noise from a group rises and falls, and changes from predominantly clattering to mainly wailing and back again, quite unexpectedly. It is not possible to convey the general effect directly in words: it is perhaps nearest to the combined noises of fighting donkeys and chattering monkeys, mingled with the enthusiastic cries of the supporters of an American football team.

The birds may display at all times of the day, but they are heard most frequently in the early morning and late afternoon.

At first this performance is general in nature. Several males display together, though in competition with each other, for any of several females attempting to alight on the same tree. During this period the noise is considerable, and over-enthusiastic birds may take to the air, still calling, with the pouch half or fully inflated. Later the males appear to become more specific in their actions. They display to only one or two of the possible females, and merely croak and clatter their mandibles at the others. The females at this stage alight much closer to the males, and, ultimately, join them at the nest or on their particular branches. The birds then perch facing each other, or side by side, with half-opened wings. Sometimes they call gently, or clop their mandibles and stroke the feathers of their partner's head and neck with their bills. Occasionally they grasp each other's bills, the male usually seizing the female's, after she has caressed his inflated pouch.

Later still the female brings back occasional pieces of stick for the nest, which the male guards through the greater part of the day. By the time that this point has been reached the responses are completely specific. A male displays only and singly to a particular female, while all others are treated with the bill clopping and croaking of irritation or annoyance. Now, if not before, the female's attempt to stroke the male's head and gular area may result in his seizing her bill, then her neck and finally mounting her.

The nest stage is signalised by the appearance of the egg. Only one is laid, and it does not appear to be replaced if it is destroyed. It is a regular oval in shape, with a rough white shell, well covered with lime: no examples were measured. The male still spends the greater proportion of the time on the nest, and in consequence does much of the incubating. He is, however, relieved at intervals by the female, and when she arrives to take his place there may be a considerable display of bill clopping and mutual preening. During the early weeks of incubation the male often sits placidly with his pouch fully distended. Later it is used less frequently, and by the time that the egg is near to hatching it is seldom inflated, or even inflatable.

Incubation takes over forty days, but it was not possible to time the period more precisely. The young chick has to be guarded as carefully as the nest and the egg. Initially this is still done by the male, while the female brings much or most of the food. Later the male becomes less attentive (possibly because the chick grows more voracious and clamorous, and ultimately pesters any bird near it incessantly), and spends a

decreasing amount of time with it. The female, nevertheless, keeps up her regular feeding, and in consequence is seen relatively frequently at the nest towards the end of the fledgling period, while the male is only an occasional visitor.

The chick emerges naked, but rapidly develops a thick covering of long, fine pre-plumule down. Initially this is white, but it is later replaced by a rather coarser plumule down, which is a pale, smoky grey, on the dorsal surface, the back of the neck and the sides of the breast. Semi-plumes soon appear on the head, and the earliest example that I have (a chick of 325 mm., total length, with an exposed culmen of 53 mm.) shows pale rufous on the forehead, crown and foreneck. The bill and feet are white at this stage, with the claws dark grey and the iris umber brown.

The earliest contour feathers begin to thrust through the skin during the fourth week, and are first apparent above the down at the end of the fifth or the beginning of the sixth. They form two small, olive brown plaques over the scapular bones. Later these spread, and by the seventh week there are two parallel bars of dark feathers down the back and a cluster at each shoulder. The coverts of the outer secondaries have also appeared by this time, and those of the inner primaries are just beginning to sprout: it is interesting to note that the upper coverts of the remiges long precede the feathers themselves, and are about 75 mm. in length before the latter appear. The bill is now between 80 and 90 mm. long, with a slight hint of blue creeping into the white: the feet are still dead white and the claws pale grey. During the next four weeks the dark saddle-shaped area on the back grows larger, the rectrices and primaries sprout, additional coverts appear and the rufous tone of the head becomes stronger.

At the twelfth week the feathers along the anterior margin of the wing appear at the wrist and start to work inwards (completing their course by the sixteenth). During the thirteenth to fourteenth week the young bird reaches the messy half-and-half stage. A chick (bill, 115 mm., tail, 215 mm., wing, 376 mm., gape to vent, 322 mm., and total length 691 mm.) taken at this period typifies it very well. The bill, lids and interramal skin are all pale blue-grey, the feet white with dark grey claws and the iris dark brown. There is white down on the belly, and grey down on the chest, the lower half of the back, the wrist and the under surface, and anterior edge, of the wings. Rufous semi-plumes cover the head and the upper 25 mm. of the neck, the remainder of which is almost bare. The saddle-shaped area of olive brown feathers, paler at their borders, has spread over the whole scapular-deltoid region and is stretching in a V towards the nape of the neck. Coverts, dark grey-brown in colour

tipping almost to white, cover the ulna, with some down still present amongst them. The primaries and rectrices, short and in sheath at the base, are black with a purple-black gloss.

During the next two weeks dark feathers appear on the sides of the breast and begin to work across towards the midline, while the patch on the back grows down towards the rump. The primaries and rectrices are increasing in length fairly rapidly (by the end of the sixteenth week the wing flat measures over 500 mm. and the tail over 250 mm.) and the forked form of the tail begins to be noticeable. Rufous feathers appear at the base of the neck during the seventeenth week, above the apices of the black triangular areas growing in from the axillae. Down still covers the belly, but it has practically disappeared from the lower back. The neck, by the eighteenth week, is thinly clothed with pale rufous feathers. The wing flat, in a male bird, measures about 562 mm. and the tail 351 mm. The gular pouch has not begun to develop. A female of about the same age has a total length of 879 mm. with the wing flat measuring 581 mm., the tail 368 mm., and the bill to its gape 145 mm.

By the twentieth week down remains, in an appreciable amount, only on the lower breast and belly (where most of the feathers are in sheath at the base) although there is still some present among the wing coverts. At this stage the majority of the primaries have lost their sheaths, and the head and neck appear fairly well covered, while the main measurements are only about five per cent. less than the adult. But the young bird, though the nest has probably already left it, is reluctant to fly and may not do so until as late as the twenty-second, or rarely, twenty-third week. At this point, for a male, the total length is about 883 mm., the wing flat 608 mm., the tail 387 mm., and the bill, measured to the gape, 129.5 mm., though some birds may be smaller. Females fly a week or two later, with a total length of about 971 mm., the wing flat 647 mm., the tail 416 mm., and the bill, 152 mm. The young of *Fregata andrewsi* thus do not appear to take to the air voluntarily until their wings and tail are practically fully-grown. Even then the parents continue to feed them for several weeks.

The first juvenile plumage has the head and neck rufous, a rusty red patch on the centre of the breast, the sides of the breast and a narrow band across the pectoral region blackish, and the belly white. There may also be a white or whitish area between the dark band on the chest and the rusty red at the base of the neck. The feathers in a broad line running through the outer lesser and median coverts, along the forewing, are broadly edged with ivory white, or very pale creamish white, giving from a distance the effect of a whitish bar across the wing. A number of the upper scapulars and mantle feathers

are much paler at their tips, producing a markedly lighter belt across the shoulders. The bill is pale blue or mauve grey, and the interramal skin, eyelids and feet whitish.

This plumage is probably carried for at least a year, until the bird's first autumn after leaving the nest, though juveniles are surprisingly scarce from May to September. During this period the feathers of the wing and shoulder bars lose much of their pale edging through wear; nevertheless the lighter areas remain much more conspicuous than in worn specimens of *F. minor*. The plumage acquired at the first moult is very similar to the original version of the one that it replaces, except that the new feathers across the shoulders are a more nearly uniform olive brown. The wing bar is restored to its former pallor, and remains prominent. The new head feathers, on the other hand, have lighter centres, so that the resultant colouring is less rufous. The dark areas on the sides of the breast are also reduced slightly.

The next stage differs principally in having the head appreciably paler, and the breast whiter. The dark area on the latter usually disappears completely in the midline, though it remains on the flanks; it may also be leavened with a few brownish rufous feathers. This plumage again is apparently lost after a further twelve months, so that, as far as one can tell, birds acquire an adult, non-breeding dress by the beginning of their fourth year.

Fregata minor minor (Gmel.)

Lesser Frigate-bird.

The Lesser Frigate-bird is fairly evenly distributed, in small colonies, round the greater part of the island. On the north side it is probably least plentiful along the short strip of coast between Smith and North-East Points, where *F. andrewsi* is most numerous. On the other hand it reaches its highest concentration in this area in the neighbourhood of West White and Lily Beaches, where the latter is relatively scarce. It is also equally numerous along the flanks of Smithson Bight, on the south side, where it is usually the only frigate-bird present. To some extent, therefore, the two species divide the coast between them.

In general the habits of the Lesser Frigate-bird are very similar to those of the preceding species, and for the most part this account is confined to describing the minor differences. Like *F. andrewsi* it breeds in tall trees, but it usually chooses those on the slope or lip of the inland cliff, instead of any along the outer section of the shore terrace. It also has less difficulty in getting into the air, and is not, therefore, so dependant on high

branches for a resting place. In the neighbourhood of Lily and West White Beaches the birds often perch on low bushes, within ten or even five feet of the ground. On a number of occasions I have even found them, with their wings spread out, basking in the sun on the crest of a shingle bank on the beach itself. In these situations they are more nervous than usual, and fly as soon as one approaches, rising comparatively easily. The posture when basking is rather peculiar, and I have never seen it adopted by other frigate-birds: they perch or squat with the head well up, the bill slightly open, and the wings almost fully extended and turned forward, so that the ventral surface is uppermost.

The Lesser Frigate-bird has much the same range of calls as *F. andrewsi*, but the sounds produced are rather different. The warning note is appreciably nearer to *kraw* than *kawk*, while in *F. andrewsi* it is about halfway between the two. Juvenile birds are noisier in this species, and call to each other more often when flying in groups. The mating cries of the male are also distinctive. The sounds are variable, but they can be reduced to three groups, a high-pitched, canine sound, halfway between a yap and a whine, a long braying *braah-yoi, braah-yoi, braah-yoi* ....., and a long, liquid tremolo, frequently descending slightly. The first two calls are made with the pouch fully distended, and may be interrupted by spells of mandible clopping. The third apparently accompanies, or immediately precedes, the deflating of the pouch. In general they are at least as noisy as the Christmas Island Frigate-bird while courting, but the sounds are more pleasant.

When stealing food they concentrate less on the Redfooted Booby, and appear to attack the Brown Booby at least as often. They also fish for themselves more frequently. They seem, in fact, to be much addicted to picking things up, and small groups of birds of various ages often play follow-my-leader over a rock-pool, each in turn swooping down over the water and pausing just above its surface. They also take a great delight in pulling up pieces of dead creeper, and in trying to break prominent branches off low trees. Finally I have seen members of this species pursuing and catching flying fish of the genus *Cypsilurus* in the air.

The two sexes differ in size, plumage and the colouring of the soft parts. As in the other frigate-birds the female is appreciably larger than the male (♂, total length 863 mm., tail 381 mm., wing flat 565 mm., and bill to gape 115 mm.; ♀, total length 932 mm., tail 408 mm., wing flat 587 mm., and bill to gape 128·5 mm.: figures obtained from an average of five birds of each sex). In flight the adult male may appear

completely black, although there is usually a brownish tinge on the underparts and there may even be a few white feathers on the flank. In the female the throat is grey, with the supra-clavicular region, breast and side of the body pure white; the belly is black and the darker colour spreads, in the midline, as far forward as the lower breast. There is also a brownish collar on the back of the neck, and only a very slight gloss on the mantle. The breeding male has elongated, lanceolate feathers on the back and crown, with an oil-green sheen, somewhat similar to that in *F. andrewsi*. The iris is dark brown in both sexes. The eyelids are black in the male and crimson, or occasionally madder-pink, in the female; in both there is a white spot on the lower lid. The bill, which is rather variable (slaty, steel or blue-grey often darker or brownish at the tip) is roughly the same in both sexes, although there is usually a pinkish area at the base of the lower mandible in the female. The interramal and throat skin is pale scarlet in the male and dull crimson in the female. In the former there is a gular pouch which follows a similar sequence of changes, in relation to the reproductive cycle, to that recorded for the preceding species. The colour ranges from a light scarlet during the resting period to a crimson scarlet during the mating season. The feet are dark, or reddish, brown with pale pinkish-white soles in the male, and entirely flesh-white in the female.

There is a definite breeding season, the whole process taking about eight or nine months. Courtship starts at the beginning of January or the end of December, and nesting in February. The prenuptial stage is shorter than in *F. andrewsi*, and most of the eggs are laid in March, April, or early May. Chicks in down occur during the latter two months, and a few immature birds can be found on the wing as early as the end of July. Most of the youngsters start to fly in August or September, and the adults undergo a full moult between the end of the former month and November. Some birds are not so advanced and follow the same time-table as *F. andrewsi* but, for the most part, *F. minor* breeds earlier than *F. andrewsi*.

The nest is an untidy, flat platform of dead twigs, mostly taken from the cabbage-tree, and pieces of creeper. It is a little larger than that built by *F. andrewsi*, and is usually placed high up in the forking branches of trees further inland. Only one egg is laid; it is a slightly elongated oval; five range from 62–67 mm. in length and 40–43 mm. in breadth. The shell, which is rough and white, is covered with lime.

The newly hatched chick is quite naked, with the skin a pale blue-grey, almost white, but it soon acquires a thick covering of long, fine down (pre-plumule). The bill and feet, at this

stage, are white, with the claws dark horn-grey. The subsequent development resembles fairly closely that described for the preceding species. The covering of white down is still complete at the end of the fourth week. At the beginning of the fifth, when the bill is about 79 mm. long, the first contour feathers start to sprout. By the end of the sixth they have appeared in the form of two small plaques over the scapulars which later spread down the back and out over the deltoid region. The next feathers to become visible are on the wings. By about the ninth week, when the greater upper wing coverts start to sprout, the head has a definite rufous tint and the bill is a very pale grey-blue. The saddle-shaped patch on the back continues to spread along the humerus and down towards the rump, and later up to the base of the neck.

By about the thirteenth week the head and mantle area are clothed with untidy feathers, while down remains across the lower back and belly, and on the breast and neck. The rectrices have grown fairly fast and the tail measures some 163 mm. and the wing, flat, about 335 mm. The forked shape of the tail is barely apparent. During the following week feathers appear on the sides of the breast, and by the fifteenth week, the tail has increased to about 220 mm. During the next two weeks most of the down disappears from the wings. It survives longest on the lower breast and belly, where it remains until after the eighteenth week. This is the opposite of the boobies in which the down leaves the belly before it is shed from the upper-breast, neck and occipital region.

There is probably no reason why the birds should not fly after the twentieth week, but they seem to be singularly reluctant to do so, and may remain round the nesting perch for nearly a month more. The plumage at this stage differs considerably from that of the mature adult. The head and neck are white, with a number of rufous-red feathers on the crown. The mantle is dark dusky-brown. The rectrices and primaries are black with a slight, faint purple sheen. The lower back, rump, tail coverts and wing feathers are dark grey-black, except for a broad band of umber feathers widely bordered with ivory or creamy white, (giving from a distant the effect of a pale bar) along the forearm. The upper breast has a large, median, rusty-red patch, as though the bird had been stabbed, while the lower breast and flanks are dark grey-black, and the belly and belly-flanks are white. The feet at this stage are off-white, with dark horn-grey claws. The iris is dark brown, and the remaining soft parts largely pale blue-grey, the colour of the bill being a little variable.

In general this first juvenile plumage is very similar to that in *F. andrewsi*, but there are the following distinguishing points:—

(*a*) In *F. andrewsi* the head and throat vary from rufous to white, with the shafts of the feathers rufous, whitish or white, but never smoky. In *F. m. minor* these areas range from rich rufous to smoky rufous, with the shafts of the feathers, and sometimes the basal portions, smoky or pale grey.

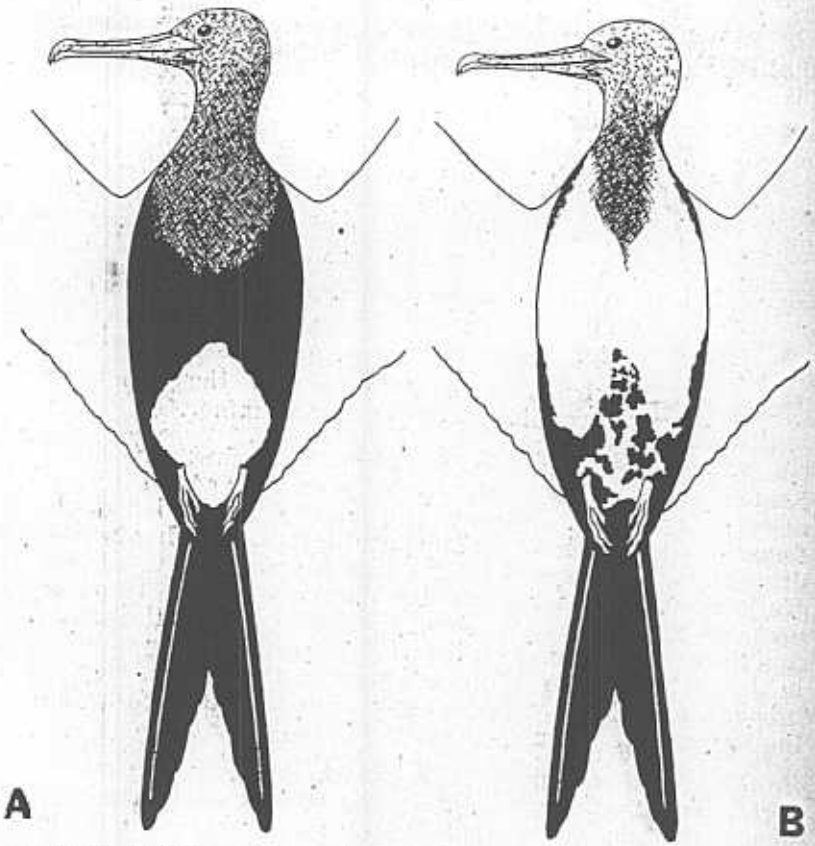
(*b*) In *F. andrewsi* the inner secondaries are olive brown, while in *F. m. minor* they are almost black on the outer webs and very dark umber on the inner.

(*c*) The back, particularly across the shoulders, is appreciably darker in *F. m. minor*.

This plumage is worn for at least the first year, until the September or October following that in which the bird left the nest. As with *F. andrewsi*, juveniles are surprisingly scarce from May to September. During the year the wing bar almost disappears, as a result of abrasion of the pale edges of the feathers, which leaves only the darker centres. The blackish areas across and at the sides of the breast fade at the same time to a dark, slightly greyish brown. It is interesting to note that in *F. andrewsi* the white edgings to the upper coverts are broader, and they wear less extensively, so that in that species the bar always remains prominent.

The head and neck become darker and less rufous at the first moult, the new feathers being largely whitish with dark, smoky grey shafts and centres. The black areas on the breast disappear and this area becomes completely white up to the rufous patch at the base of the neck. The latter area is also smaller, and does not spread so far down on to the breast. The belly, on the other hand, is liberally spotted and blotched with black on a white ground, about one third of the new feathers being black and the remainder white. The fresh wing coverts drop only to a hoary olive brown at their borders, so that the bar is barely discernible at a distance.

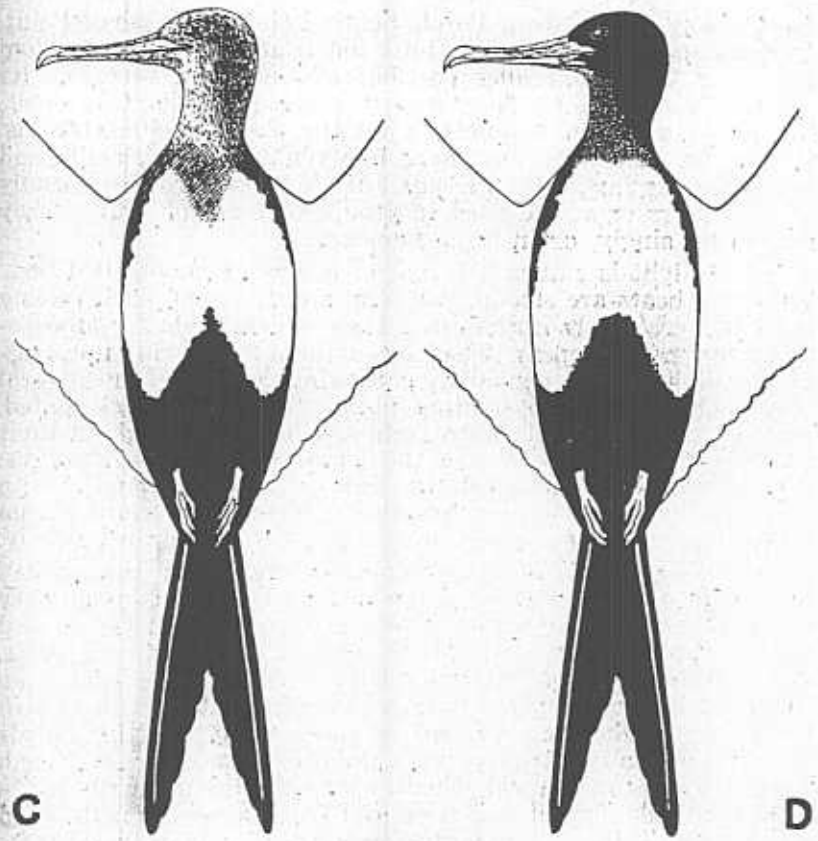
What appears to be the final stage is also acquired between September and November, presumably a year later. It differs from that preceding it in having the belly and sides of the belly completely blackish, the rufous patch at the base of the fore-neck still smaller, and the head and hind neck streaked with blackish feathers. The nape is a dull, brownish black, merging imperceptibly into the mantle below it and the smoky black streaking of the head above it. Females at this stage have the eyelids a pale,



Female *Fregata minor minor*, drawn from specimens taken on Christmas Island, in the Indian Ocean. "A" is a bird in the first juvenile plumage, and "B" a bird in the second juvenile plumage. Reddish brown tints in the half-tones are shown by cross-hatching, and greyish tints by lines drawn in the long axis of the feathers.

dull crimson, and males a deep, purplish grey, both with a light blue spot on the lower lid.

These plumage changes suggest three stages of immature colouring (characterised by having at least the foreneck rufous or reddish and some trace of pale feathering on the head), with the acquisition of an adult, largely dark dress at the beginning of the bird's fourth year. It is unlikely that *F. m. minor* nests as soon as this, and it is probable that the first apparently adult plumage is born by a non-breeding bird, or that one of the stages outlined above is carried for two years instead of one. In favour of the former suggestion it may be pointed out that non-breeding



Female *Fregata minor minor*, drawn from specimens taken on Christmas Island, in the Indian Ocean. "C" is a bird in the third juvenile plumage, and "D" a non-breeding adult. Reddish brown tints in the half-tones are shown by cross-hatching, and greyish tints by lines drawn in the long axis of the feathers.

adults, with small, undeveloped gular pouches in the male, and smaller, less glossy crown and mantle feathers in both sexes, can be seen throughout the breeding season.

Phaëthon rubricauda westralis Mathews

Redtailed or Silver Bo'sun.

In total numbers the Redtailed Bo'sun is more plentiful than the next species, the Golden Bo'sun, but it is less evenly distributed round the coast. It is confined largely to the immediate neighbourhood of those areas where the inland cliff is sheer and bare. It is thus found principally round Flying Fish Cover,

North-East Point, Steep Point, South Point and Egeria Point. It never penetrates further into the island, and very seldom flies over the intervening portions of the shore terrace. Its seaward range cannot be assessed accurately as it also breeds, though in very small numbers, on the Cocos-Keeling Islands. It may be met with anywhere between the two islands, and northward as far as Java Head. At sea these birds are usually seen in pairs or at the most in groups of three or four. They seldom fly singly, or in large numbers.

The flight is rather like that of a large, heavy-bodied tern. The wing beats are strong, powerful and frequent, each raising the bird perceptibly in the air. They seldom glide for any distance, and never appear to use air currents for soaring upwards. They alight very clumsily, pancaking badly after several trial flights past their landing place. The narrow, elongated, central tail feathers are surprisingly stiff, and throughout their length keep fairly rigidly in the plane of the other rectrices. When the latter are flexed sharply, the centre feathers move with them, and when a bird is braking suddenly they can be seen projecting ventrally almost at a right angle to the line of the body.

The Redtailed Bo'sun, though quieter than the Golden Bo'sun, is definitely noisy in the air. Whenever two or more birds are together they call to each other frequently. The normal note is essentially harsh and unpleasant. It is a very short, high-pitched squawk, rising almost to a screech, and then dropping away sharply. It is similar to that of the Golden Bo'sun, but shorter and more penetrating. Sitting birds occasionally call out in answer to others passing overhead. They are also most vocal when disturbed, starting with a few slow, relatively low-pitched cries, and then increasing both speed and pitch until they are almost screaming. Chicks of two months or more go through a similar performance, though they fail to reach as high a note as the adults: a youngster of some three months can be likened best to a very irrate Donald Duck. Adults also have a second, quite distinct, call of *pit-ya, pit-ya, pit-ya*, rather like a creaking gate, which is seldom heard in the air.

The diet consists of small fish and cephalopods. The birds generally fish well out at sea and, apparently, mostly early in the morning, returning to the island an hour or so before noon. Less frequently they go out late in the afternoon, and then often feed much nearer in shore, so that it was sometimes possible to watch them from the veranda of my bungalow. On these occasions they usually dived from a height of twenty to forty feet, dropping with the wings half-folded in the manner of the Gannet. They made a considerable splash on entering the water, and stayed under for a remarkably short time (often less than

twenty seconds, with an average for ten consecutive dives of 26·6 seconds), so that they seemed to be in the air again before the spray had settled fully. Usually nothing could be detected in their bills as they rose and one must conclude that they had been unsuccessful, or had swallowed their meal before emerging. On a few occasions, however, they rested on the surface for a short time before returning to the air, and then sometimes still had fish in their bills. Eight stomachs were examined, and in all cases they contained the remains of small cephalopods (quite different from those found in the Redfooted Boobies), small herring-like fish, or flying fish, either *Cypsilurus bahiensis* or *Exocoetus volitans*.

The plumage of the two sexes is similar, and there is no appreciable difference in size. The colouring of the soft parts is also approximately the same—iris, dark brown; eyelids, black; bill, bright orange-red, paler or slightly brownish at the base, with a small black bar in the plane of the nostril; feet and proximal one-third of the toes, pale blue-mauve or bluish white, with the distal two-thirds and the web, black.

The breeding season is limited and well-defined. The eggs are laid in May and June, with a few late birds running into the first half of September. Most of the nests contain downy chicks in July, and juveniles in full speckled plumage by September. The most advanced birds fly during the last week of the latter month, and the majority of the remainder during October. The few stragglers wait up to the end of the year.

Courtship is a point on which I can say nothing definite. It has been suggested that bo'sun-birds fly together in a nuptial dance something akin to that postulated in the case of Leach's Forktailed Petrel, or the aquabatics of the Black Guillemot. It is possible that this is so. Certainly on Christmas Island groups of two, three or four adults frequently fly round for an hour or more, calling loudly to each other, on their return from fishing in the mornings, and sometimes again early in the afternoon. One such party often performed high above my bungalow. Unfortunately they did so at all times of the year, and the note was almost invariably the harsh *kaark-ka*, not the softer *pit-ya, pit-ya* heard in greeting at the nest.

The egg is placed on the earthy floor of a small cranny, or on a beetled shelf, between one to two-thirds of the way up the face of the steep, bare portions of the inland cliff. The crack or fissure selected is always one which is roofed with rock. If the bird makes use of an open ledge it cowers in the sharp angle between the wall and the floor or under the shelter of a bush. If dead leaves have collected naturally in the cranny they may be arranged to form a bed for the egg, but *Phaëthon rubricauda* never attempts to gather nest material for itself.

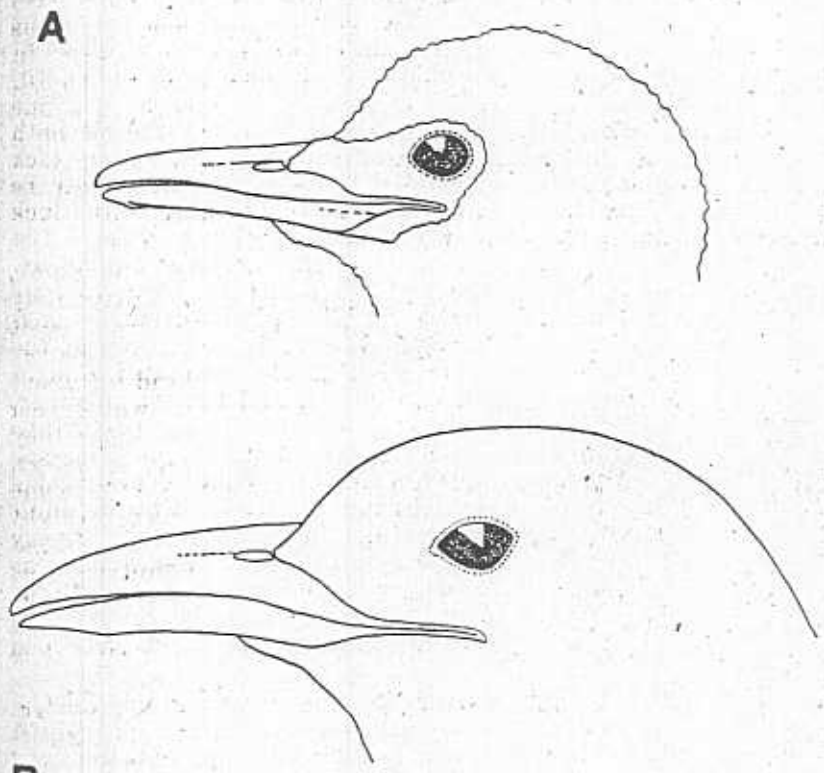
This is to be expected as the birds never alight on open level ground; and are so reluctant to fly amongst trees that they only frequent those limited stretches of the cliff which are too sheer to support any.

One egg only is laid. It is a little longer in proportion to its breadth than that of *Phaëthon lepturus*, though it still appears rather round. The size is less variable; five specimens ranged from 68 to 71 mm. in length and 47·5 to 50 mm. in breadth. The shape, in the plane of the long axis, is almost, but not perfectly, symmetrical. The shell is thick with a fine matt surface. The colouration is not constant. It may be a very pale terre verte, almost white, with a few fine purplish-black smudges, like smuts, mostly at the broader end; or it may be white, or reddish-white, covered thickly or thinly with dark purplish brown, or purplish black, streaks and speckles.

One adult in each of three pairs was marked with paint, and there is no doubt that both parents incubate. Unfortunately the nests were difficult to reach, and it was not possible to visit them sufficiently frequently to time the shifts. One changeover was watched. The oncoming bird flew round overhead for about half an hour, calling harshly to its mate and being answered each time that it passed. When it finally landed on the ledge they greeted each other with a prolonged creaking call of *pit-ya, pit-ya, pit-ya*, with the accent on the first syllable. After some time the sitting bird shuffled off its egg and moved straight to the cliff-edge and flew away. The other immediately settled down on the nest, and within a few minutes had shut its eyes and was apparently asleep. The incubation period is long. It was not possible to time it fully, as I never discovered a nest before the egg had been laid. All that one can say is that it is at least twenty-five days, and may well be much longer.

The chick emerges covered with a fine, white, powder-puff-like down. This differs from the down in the chicks of *Fregata* and *Sula* in being, age for age, longer and softer, and pre-pennal not pre-plumule. The bill, eyelids and a line of bare skin from the orbit to the angle of the gape are black, giving the young bird, with its great fluff of white wig, a perky, solemn, judge-like appearance. The iris is a very dark brown, and the tarsus pinkish with the distal two-thirds of the toes and web black. Growth is steady, but not as rapid as in the case of the boobies. At the end of the third week, when the first contour feathers start to sprout, in the scapular region and along the primaries, it is only about 304 mm. long, with a bill, to the gape, of some 65 mm.[1] By the beginning of the fifth week when the primaries, rectrices and scapulars, with a few coverts, are all clearly visible, the total length is still about 321 mm. The bill, however, seems to grow fairly

quickly during this period, (mostly in front of the nostril) and by between the seventh and eighth week the gape-culmen ratio is within ten per cent of the adult figure. This development results in an interesting change in the shape of the bill, which initially is rather like that of a squat version of the Gull billed Tern's.



Outline drawings of heads of young *Phaëthon rubricauda westralis*, showing the change in shape of the bill with age. "A" is of a downy chick, about five weeks old, and "B" of a fully feathered immature bird, about thirteen weeks old. Both drawings are approximately two-thirds life size.

From the beginning of the sixth week the coverts spread along the wing and by about the middle of the ninth week the young bird is almost entirely clothed, on the upper surface, with contour feathers. Some down, however, still remains, particularly in the axillary region, on the ventral surface and along the anterior edge of the wing. At this stage the primaries are between half and two-thirds of the adult length, the outer

feathers having relatively further to go than the inner. The rectrices form a complete fan, although the central feathers are a little longer than the outer ones. Down remains over the rump, among the tail coverts, along the belly, up the breast, and round the neck. Feathers, appearing first on the forehead, have spread down the cheeks beyond the eyes, and back over the crown past its mid-point. The bill has grown paler at the base, and is now a crimson-grey darkening almost to black at the tip, while the tarsus is a pale madder-blue. The iris is still dark brown.

Within the next two weeks, that is by about the eleventh week, most of the remaining down disappears, except for fragments amongst the coverts and the silver-white feathers of the lower breast, belly and flanks. In the latter situations it is not conspicuous but may remain for several weeks. The young bird is now virtually in the complete immature plumage. It does not usually leave the nest for a further three to four weeks, or even longer. During the interval the primaries and rectrices grow to almost full adult length, (though even at the end of the period there is no sign of the elongated central feathers) and the body seems to fill out and become plumper. The coverts and small feathers also push forward a little further so that they overlap more; and thus, as the darker portions are less exposed, the plumage appears whiter. This is particularly noticeable on the head, neck and rump, where even in the adult the feathers are black at the base and on the shaft with silvery tips. Apart from this small strengthening of the pale areas there is little change in the colouring before the juvenile bird leaves the nest. No hint of the faint rosy bloom is acquired and there are no signs of a moult amongst the black-patterned feathers.

The chick is fed by regurgitation, the adult inserting the tip, and latter almost the whole, of its bill into the chick's gullet to do so. For the first three to four weeks the parents visit the young bird frequently, and at all times of the day. The food given at this stage is well digested and semi-fluid. Later more solid stuff is brought, and feeding takes place largely, or even only, shortly after sunrise. Judging from the material vomited by recently fed youngsters their diet consists chiefly of cephalopods with a relatively small proportion of fish fragments. Finally it seems that the parents abandon the young bird completely, and cease to return even in the early morning. Three chicks that I was watching were certainly not visited in the last eight to twelve days before they themselves disappeared from the nest. Unfortunately my weight records are lost, but in each case the youngster was appreciably heavier than the average of the adults shot for examination. It is, therefore,

probable that it is thirst and not hunger that drives it from its ledge. Juvenile birds seem to move out to sea as soon as they have left their nests, and remain there until mature. One never meets them in flight over or near the island.

The full juvenile plumage is a satiny white, with black spots or bars on the head, back, wings and tail (*see* plate VI, lower photographs). The extent of the black shows slight individual variations, but in general it consists of the following markings (in addition to the black crescent running round the eye which is also present in the adult). The feathers of the crown have black centres, passing on the back of the neck into two black bars. The feathers of the mantle and upper back have three black bars each, dropping to two on some of the feathers of the rump. The upper tail coverts have three black bars on the inner web. The shorter scapulars have three or sometimes four crescentic black bars, and the longer scapulars black centres. The lesser and median wing coverts have two or three black bars. The greater coverts are usually entirely white, though they may have two black spots on the outer web. All these feathers with black markings also have black shafts. The primaries and primary coverts have black shafts and one, two or three black spots, or an irregular black centre, towards the distal end. The flank feathers have black shafts and irregular black centres, larger and more conspicuous on the posterior feathers. The rectrices have black shafts, broadening in the centre pair to form a black tip, and with two or three black spots towards the free end of the outer feathers. The iris is dark brown and the eyelids black. The bill is black, with a pale, blue-greenish grey area at its base, continuing forward along the cutting edge of the upper mandible. The legs and feet are pale blue grey, with the distal half of the lateral three digits and the webs between them black.

Phaëthon lepturus fulvus Brandt

Golden Bo'sun.

The Golden Bo'sun is relatively evenly distributed all round the coast. It usually nests on the edge of the inland plateau, anywhere within a mile or so of the sea, or, less frequently, on the shore terrace. Flying birds can be seen or heard over all parts of the island. It spreads outward as far north as Java Head, and it is said to occur occasionally over the Cocos-Keeling Islands, 530 miles to the west of Christmas Island. It is, however, conspicuous rather than plentiful, and the population is probably no more than 300 to 450 breeding pairs.

This species is similar to the Redtailed Bo'sun in much of its behaviour, and, except that it habitually nests in trees, the differences are largely of a minor nature. It has one interesting

structural difference in the formation of the elongated central rectrices, which are broader, longer and more pliable. As a result they trail rather than project behind it in the air, and when it banks or turns bend much more obviously than in *P. rubricauda*. Sometimes a series of oscillations pass down them as it rises and falls, so that it seems to be whipping its way along.

The Golden Bo'sun is even noisier than the preceding species in flight. This is especially noticable during the early part of the afternoon.[1] The normal call in the air is a short, high-pitched, crackling squawk, which tails away into a squeaky-creaking sound. It resembles most closely the dull protest of the dry castors of a heavy chesterfield which is being moved for the first time for many years. Occasionally flying pairs emit only the later, creaking portion of their call, and omit the initial squawk, producing a sound rather like *kee-ya-ya-ya*. When disturbed on their nests, which they leave with the greatest reluctance, they give a series of harsh, rasping caws, ending on a short, high note, rather like the screech of the Redtailed Bo'sun.

There is no appreciable difference between the sexes in plumage, size or the colouring of the soft parts, and they cannot be separated in the field. In the adult the iris is dark brown; the bill yellow with the base greenish, or the whole greenish yellow, darker at the base; and the feet and legs whitish or greenish white, with the web and greater part of the toes black.

It is possible that a few individuals breed in each month of the year, but it would seem that the majority of the eggs are laid between June and October. Between September 1938 and February 1940 I found seven birds in juvenile plumage, barely capable of flying, on the ground in December and about half that number in each of the other months between September and January. None were seen at any other time of the year. Eggs were found in May, July, September (two nests) and October, young birds in down in July, August and September, and immature birds, still in their nests, in August, October and December (one each). Andrews records eggs and young taken in August and September, and Sharpe a juvenile just beginning to fly which was collected on September 20th. Chasen (Bull.

1. It would seem that the Golden Bo'suns return from fishing much later than the Redtailed Bo'suns. The latter are usually back, and crying round above the shore terrace, by eleven a.m., but the former are seldom conspicuous before two or three o'clock in the afternoon. It may be that the Golden Bo'suns set out later, and feed on fish rather than cephalopods, or that they travel further from the island. There is some evidence to support both contentions. The stomachs that were examined contained mostly fish fragments, and I only once saw the birds feeding within sight of the island.

Raff. Mus., 1933, p. 76) mentions a downy nestling dated October 10th, and an immature bird of the year caught on August 28th, both in the Raffles Museum collection. The only exceptions to this general principle are an inaccessible nest which I found in March, and an egg taken by Andrews on December 25th.

The nesting place is peculiar. The egg is deposited in a small cavity in the trunk of a dead or dying tree, at a height of twenty-five to fifty feet from the ground. A favourite site is the hollow which has rotted inwards where a main branch has fallen away. It is usually spacious enough to admit the whole bird, whose head is frequently level with the orifice. It may be lined with dead leaves, but normally these are so few that their presence is probably accidental. The bird sits with its tail curled round, or sticking out of the top of the hole. One nest had a fairly large entrance, through which the tail projected, and a second aperture through which the brooding bird poked its head.

Only one egg is laid. It is broad for its length, with the oval almost, but not perfectly, symmetrical. The size is variable; six ranged from 53·5 to 48 mm. in length and 40 to 37 mm. in breadth. The shell is thick with a fine matt surface. The ground colour is white, or very pale terre verte, thickly speckled with dark purplish brown.

Owing to the difficulty of reaching most of the nests no attempt was made to obtain an ordered account of the development of the young bird. There does not, however, appear to be any reason for supposing that it is different from that of the preceding species. The earliest chick was entirely covered with a long, fine, white down, and looked like a soft powder-puff. The bill and the skin of the face were off-black. The bill, which was relatively much broader at the base than in the adult, measured about 29 mm. to the gape. The irides were dark brown, almost black. The legs were pinkish, with the webs and distal two-thirds of the toes off-black. A later bird was sprouting contour feathers among the coverts, over the scapulars and across the forehead; the primaries and rectrices had already appeared. This example was about twice the size of the downy chick. Another, still larger, had only a great collar of down on the neck, and patches of down among developing feathers on the breast, belly, rump and wings.

The juvenile plumage is very similar to that of *P. rubricauda*, but there are certain essential, though minor, differences. Taken collectively they are sufficient to separate the young birds if they can be examined closely. They comprise differences in size (as in the adults), the amount of black on the feathers of the back and wings, and the colouring of certain of the soft parts. The

smallest, fourteen-week, juvenile of *P. rubricauda* which I measured had the gape 86 mm. long, the culmen 58 mm. and the wing when pressed flat 310 mm.; the largest *P. lepturus* had the gape 74·5 mm., the culmen 52 mm., and the wing 287 mm. long. The young of this species are thus appreciably smaller than those of *P. rubricauda*. The back feathers of the latter have three or four black bars, and the wing coverts two or three: in *P. lepturus* there are one or two, very rarely three, bars on the feathers of the back, and nearly always only one on the wing coverts. The black on the primaries is restricted to the outer webs (except the distal inch) of the outer three feathers and the proximal three-quarters to half of the shafts. The rectrices have only the proximal inch and a half of the shafts black, instead of the greater part or the whole length. Finally the base of the bill in *P. rubricauda* is a pale greenish or greyish blue, and the tarsus pale bluish grey: in *P. lepturus* the base of the bill is bluish grey, with a hint of crimson or madder, and the tarsus pinkish or greenish white.

Andrews seems to have formed the opinion that the silver and black juvenile plumage is shed before the young bird flies, but I cannot agree with him. I found sixteen juveniles in this plumage well out in the open, and two of the immature birds mentioned earlier had no hint of apricot on them within a fortnight of disappearing from their nests. The same applies to the juvenile, "just beginning to fly", described by Sharpe in the Monograph. In addition Andrews's argument should apply equally to *P. rubricauda*, (since speckled specimens of the latter have also never been seen in flight) but in this species seven birds disappeared within two weeks of being in complete juvenile plumage, three of them within seven days. It seems very unlikely that all nine youngsters were taken by rats. Finally an immature bird, again with no sign of the adult apricot colouring, found on open ground on November 12 was appreciably smaller (bill to gape 64 mm., tarsus 22 mm., wing flat 219 mm., total length 364 mm. and head body 243 mm.) particularly in the wing and body, than the two specimens referred to above. They, when last examined, on their nests, had wing measurements of over 235 mm. and head and body measurements of over 255 mm.

Accipiter fasciatus natalis (Lister)

Christmas Island Goshawk.

The Goshawk is fairly common over the whole island. Except in the neighbourhood of the settlement in Flying Fish Cove it is more plentiful on the inland plateau than on the shore terrace. It seems to prefer the areas of slightly thinner growth on the edge of thick jungle, or the borders of clearings, where

it can be found sitting motionless on the branch of a tree, some fifteen to twenty feet from the ground, waiting patiently for movement in the bushes below.

It is not very communicative. The usual cry is a sharp, slightly moist *tweet-tweet* repeated several times. This sound causes considarable alarm among the smaller birds on the island, but it is not heard at all frequently. When the adult is alarmed it may emit a single syllable more loudly and harshly, as it flies away. The chick has a shriller, more clamourous, note and is much more vociferous.

The normal diet consists of small birds, *Turdus, Zosterops, Chalcophaps* and *Padda,* rats and large insects. The Goshawk appears to be very partial to young chickens; considerable numbers are sometimes killed, and the Chinese refer to it, with some feeling, as *Burong makan ayam* in place of the more correct *Burong L'ang.* The worst offenders seem to be the immature birds. Six stomachs were examined, of which three were from juveniles that had been shot in the neighbourhood of chicken runs. Two of the latter contained the remains of young chickens, of a probable length of seven to nine inches, and the third fragments of a white-eye and two Java Sparrows. All three also had a number of insect remains, mostly from the grass-hopper *Locusta migratoides* and the preying mantis. One of the jungle birds contained only two beetle elytra and several unidentificable pieces of chitin. The remaining two birds, both adults, yielded evidence of a Ground-Thrush, an Emerald Dove, a young rat and a large *Scolopendra morsitans.*

There is a slight difference in the adult plumage of the two sexes. The females have the throat washed with rufous-brown, while in the male the feathers are white specked with smoky-grey. The latter also frequently have a small group of rich-brown feathers among the inner wing coverts. The females seem to reach an appreciably larger size than the males (♀ total length, 420 mm., tail, 200 mm., wing flat 260 mm., bill from gape 29–30 mm., culmen without cere, 20 mm. and tarsus, 72 mm.; ♂ total length, 360 mm., tail, 168 mm., wing flat 230 mm., bill from gape, 25 mm., culmen without cere 16 mm., and tarsus, 60 mm.: figures obtained from an average of four and five specimens respectively). The colouring of the soft parts is the same in both sexes. Iris, yellow; eyelids, bright yellow; cere, greenish yellow; bill, black, frequently blue-grey at the basal angles; and feet, yellow with black claws.

The breeding season is probably from about October to the end of February. Four nests, including one recorded by C. A. Andrews, have been found, all within that period. Andrews's nest was discovered on January 24: he describes it as made of

twigs and pieces of creepers, and placed near the top of a high tree; it contained a single chick. Two of my nests were found in November, and one on December 26. The bird from the latter had flown by the end of January. The moult seems to be from May to September, but the evidence is not conclusive, and I have not had an opportunity of examining specimens during the first five months of the year.

The nest of December 26 was a rather flat, somewhat untidy, dirty structure, about fifteen inches across, and built of small branches, twigs and leaves. It was situated in an almost horizontal fork, some thirty feet from the ground, near the top of a smallish tree. The chick, which was sprouting contour feathers down the back, over the shoulders, on the crown and along the wings and tail, was about 180–200 mm. long. The down was whitish and rather coarse. The bill was a very dark horn grey, almost black, with the cere green. The feet were straw-coloured, and the iris a bright yellow brown. The two earlier nests were at a height of fifty to sixty feet in much taller trees, and quite inaccessible. Like the first they were on almost horizontal forks, and appeared to be between twelve and eighteen inches across. Both were occupied. One contained two down-covered chicks. It was not possible to determine the contents of the other which may, therefore, have had eggs in it.

There is a distinct juvenile plumage. In the earliest example examined (a young male with a total length of 360 mm.) the throat is streaked, and the remaining under parts broadly barred with reddish brown on a white ground: the feathers of the upper parts are dark brown, broadly edged with rufous or rich sienna: the tail is barred with dark grey brown, faintly on the central feathers and strongly on the inner webs of the outer feathers, which shade from brown through reddish brown to pale yellow[1]. The rufous edging of the feathers on the upper parts wears with age, and it is much less conspicuous in specimens with frayed rectrices and remiges. There is also considerable variation in the shade and extent of the barring on the feathers of the under parts: in some examples the bands are light chestnut with dark, smoky brown borders, while in others they are a deep, burnt sienna. There is, however, nothing in the series at present available to suggest that these differences are due to age, or to give any indication of the plumage acquired at the first moult. A large juvenile male (total length 407 mm.) has a plumage very similar to that of the smallest example taken. The soft parts in immature birds are the same colour as in adults.

1. A detailed description of this plumage is given by J. J. Lister in the Proc. Zoo. Soc., 1888, p. 524.

Ninox forbesi natalis Lister

Christmas Island Hawk-Owl.

The Christmas Island owl is secretive and shy, but not rare. It appears to be fairly evenly distributed over the whole island, frequenting the thick jungle and its fringes on both the plateau and the shore terrace. It occasionally comes out into the open at dusk, and at such times it may stray onto the verandas of the bungalows.

It is generally silent by day, even when disturbed, though when very frightened it may emit a soft, throaty whine. During the evening and the first half of the night the birds often call to each other, producing a peculiar sound closely resembling the bark of a dog, but with an added hollow, muffled quality, as though the animal were shut away in a thick-walled room. They usually begin with a low, scarcely audible *chuk-chuk*, which is continued at intervals, with gathering intensity, until it finally develops into a full, short bark. This is repeated a number of times, and the calling, with one bird answering another, may go on for a considerable period. It normally ends by fading gently, as though the whole chorus were moving away, but occasionally the birds stop suddenly. The Chinese coolies sometimes refer to the owl as "the dog which no man feeds."

Seven stomachs were examined. From their contents it would appear that the owl feeds chiefly on large insects, and to a lesser extent on lizards and white-eyes. The insect remains included the elytra of several beetles, and recognisable fragments of a number of orthoptera, including the large cricket, *Gryllacris rufovaria*, the mantid, *Hierodula dispar*, *Locusta migratoides* and a *Euconocephalus* sp. The reptiles were the gecko, *Gymnodactylus marmoratus*, and the skink, *Lygosoma atrocostatum*. Bird remains were present in only two of the seven stomachs examined.

There is a limited individual variation in the plumage, especially in the intensity of the white on the lower breast and belly: in some examples the mantle is faintly spotted. There are not, however, any consistent differences between the sexes in plumage, size or the colouring of the soft parts, which are discernible in the field.[1] The iris is lemon yellow; the eyelids light bluish grey, edged with black; the beak and cere light bluish grey; and the feet pale yellow to straw yellow.

1. Chasen (Bull. Raff. Mus., 1933, p. 81) recording a series of seven specimens (3 ♂, 4 ♀) taken by Mr. Tweedie in 1932, gives the females as slightly longer in the wing than the males: 196–198 mm. against 188–192 mm. My own measurements (for 2 ♀ and 5 ♂) run 195–199 mm. for the females and 189–194 mm. for the males, and thus support this point, but the differences are small.

There is no direct evidence of the season of nidification[1]. The majority of the birds appear to undergo a full moult between May and August. It one specimen this had not been completed by October 10, while another taken on January 11 was just beginning to moult. It was a fairly large bird (total length 284 mm., tail 123 mm., wing 192 mm., culmen without cere 16 mm., and tarsus 36 mm.) with small, quiescent testes. A second male caught a few weeks later showed no sign of any recent change in plumage.

The specimens at present available for examination do not suggest the occurrence of a distinct juvenile plumage.

Collocalia esculenta natalis Lister.

Christmas Island Swiftlet.

The swiftlet exists in large numbers, spread over the whole island; it normally frequents the edges of clearings and the paths and natural alleys through the jungle itself. It is commoner on the shore terrace than on the inland plateau. It is most plentiful along the west side of South Point and least numerous along the coast from Egeria Point to West White Beach.

The adult bird makes no sound except when frightened, or when two arrive at the nest together. Then it utters a shrill squeak, much like a young rat. The chicks make a low twittering when disturbed or when expecting their parents. As they grow older the note becomes hoarser. By the time that they are ready to leave the nest they can produce a tolerable imitation of the adult bird.

The food consists of small insects which are taken on the wing.

The plumage of the two sexes is similar. They do not differ appreciably in size, although on the series examined the males are a little longer in the tail and a little shorter in the body (♀ tail, 45 mm., body, 54 mm.; ♂ tail, 46.5 mm., body, 52 mm.: figures obtained from an average of ten specimens of each sex), but the difference is almost negligible. The colouring of the soft parts is the same in both sexes (iris dark brown; eyelids black; bill dark brown, almost black; and the legs and feet dark red-brown).

The breeding season is from the beginning of September to the end of March, and there are two peak periods starting in October and January. Very few eggs are laid in November or

1. The only record of a nest is C. W. Andrews's statement (*Monograph of Christmas Island*, 1900, p. 47) that Hugh Ross told him that "it is usually placed in a screw-pine and made of twigs". I was never able to find a nest, or to obtain direct information of one, though I had a Dayak searching suitable jungle and pandanus areas for about a week in November 1940. Ross also suggested that the Emerald Dove nests in *Pandanus:* he may have had a sense of humour.

early December and there are more breeding couples in January and February than in October. It is possible that the species is partially double-brooded as many of the early nests, or sites, are used twice. The earliest eggs found were seen on October 3rd; the latest sign of activity was a nest with two chicks, almost ready to fly, on April 14th.

The nests are built on the walls, usually high up and frequently sheltering behind stalactites, of the limestone caves and grottos in the inland cliff. The sites chosen are frequently so far inside the cave that they are in almost complete darkness. The nests are constructed of a pale green lichen, which grows fairly freely on the jungle trees, interwoven with dried fibres of sago palm. The interior is hemispherical and often neatly lined with palm: a few feathers may be included, but this is not usual. The rim is somewhat flattened along one side, depending in extent on the situation chosen, and the nest is attached, at the two ends, to the wall by dried saliva so that it projects from the surface in the manner of a holy water stoup. Saliva is not conspicuous anywhere else in its construction.

The nest takes about three weeks to build. It is begun simultaneously at the two points of attachment. From them fibres are woven across to make a sagging sling. The hollow of this is then partially filled, and the cup finally formed by adding a rim along the outer edge. The nest usually begins to disintegrate before the young are quite ready to fly, and very few are still in place by April.

Normally the eggs are laid at the beginning of October or in January. Two make a full clutch and I never found a nest with more. They are about 15·5–16 mm. long and 10 mm. broad, (the size being remarkably constant), and almost symmetrical in shape. The shell is very thin. It is pure white in colour, with a faint gloss. Newly laid eggs are slightly translucent. The eggs hatch between the twenty-second and twenty-fifth day. The young chicks are the colour of raw-meat, without down, and with the eyes showing through the skin of the closed lids, like two large, bluish haematomas. The primaries, in sheath, begin to appear about the fifty day. They are followed, fairly quickly, by a line of feathers down the back and on the top of the head. By the ninth day the first contour feathers have appeared on the crown, breast and back; the primaries, still in their sheathes, are about 3 mm. long. At this stage the neck is bare and the head is still disproportionately large. The eyes remain closed. The chicks are fed every fifteen to twenty minutes.

By the fifteenth day the chicks are covered with contour feathers except for a line down the angles between the flank and the back. The rectrices have appeared and are projecting about

1 mm. beyond their sheathes. The head is in better proportion to the body, and is approximating more to the adult shape. The total length of the chick is about 43 mm. By the twentieth day feathering is complete except that the primaries and rectrices have not grown to their full length. The eyes are open. The chick now measures 63 mm. By the twenty-fifth day this has increased to 71 mm., and by the thirtieth to 81 mm. Most of this increase is covered by the growth of the tail feathers.

Up to the middle of the fifth week the wing, pressed flat, measures less than the body plus the tail, but by the thirty-fifth day the wing is slightly longer. At this point the total length is about 86 mm. of which 36 mm. are tail (this means that the body is practically fully-grown), and the wing is about 87 mm. Birds at this stage are capable of fluttering and planing downwards, but they do not seem to be able to fly up. They are very active and very querulous. Most of the observed chicks were still in the nest on the fortieth day, when they had an average total length of about 94 mm. and a wing measurement of 97 mm. All had flown by the forty-fifth day, at the latest. It would thus appear that the young do not leave the nest voluntarily until both wing and tail feathers are fully developed.

The juvenile birds are indistinguishable from the adult in plumage, but there is a slight difference, lessening with age, in the coloration of the soft parts. The bill is black; the iris brown, but not quite as dark as in the adult; and the feet pink with dark-brown to black claws.

Turdus javanicus erythropleurus Sharpe.

Christmas Island Ground-Thrush.

The thrush is very plentiful, especially in the open jungle on the shore terrace. It is least numerous in the more thickly covered portions of the inland plateau, particularily towards the west of the island. In these parts, though not strictly gregarious, it appears to be distributed in small scattered groups. On the coast, where the birds are more evenly spaced, the ground is divided up, during the breeding season, into territories which the males defend against each other with considerable pugnacity.

In the breeding season the male produces a song not unlike that of the English thrush, but it is more monotonous and with the final note harsher and less mellow: it is as though he were still learning. When a sitting bird is frightened off the nest it complains bitterly, beginning with a soft *chowack, chowack,* repeated rapidly a number of times, and finishing with a harsh squawk. This may be answered by the mate, or by a sympathiser, often from a considerable distance. If the second bird approaches the two perch together, some fifteen feet away, and converse in

soft, hoarse notes, as if whispering. When a single bird is startled it rises with a little chink of alarm, not unlike the English blackbird but less "silvery". The usual call of the sub-adult is a husky *chuck-chuck*.

The thrush is omnivorous, but it has a special affection for insects and their larvae. It usually searches among fallen leaves, but it will, occasionally, pick over the bark of dead trees, especially the cabbage-tree. It is always much interested in any entomological investigations, and when I was examining fallen wood for any length of time I always found one or two birds watching me. At such moments it is very tame, approaching to within a few feet and even coming forward to take insects which have been overlooked or ignored. It will also eat seeds, and the coolies manage to catch it, for food, in traps bated with cooked rice.

There is a definite difference between the plumage of the two sexes, in addition to a certain amount of individual variation. The rufous colouring of the belly is much richer in the male, especially in freshly moulted birds. In the female there is more pale brown and less grey in the shade of the breast, and the throat is much lighter. In the male the colour is usually uniform from just below the angle of the bill to the middle of the breast, and if there is a pale area on the throat it is confined to some half dozen feathers. The males are a little larger than the females (♂ total length, 224 mm., ♀ total length, 214 mm.; figures obtained from an average of ten specimens of each sex) and frequently plumper. The colouring of the soft parts, except the bill, is the same in both sexes, the iris being dark-brown, the eyelids yellow, and the feet orange-yellow. The bill is a rather dull yellow, almost brownish in the female, and a rich orange-yellow in the male. In the breeding season the bill of the male becomes a bright waxy orange.

The thrush has a definite, though wide, breeding season stretching from the beginning of October to the middle of March. The earliest signs found were a newly built nest at the end of October and an egg early in November. Towards the west of the island I discovered a nest with freshly hatched chicks as late as February 20th. Some birds breed outside the season, but I think that they represent a very small proportion of the total population. I found a nest with eggs at the end of July, and saw two young birds, with half-grown rectrices, early in August.

The nest, which is fairly large, is usually built on an untidy pile of dead leaves and coarse vegetable fibres, giving it a very bulky appearance. The whole is placed in the vertical fork of a young sapling, or among the horizontal branches of a medium sized bush. It is generally between six and fifteen feet from the ground. The commonest alternative site is above a tree-fern, or

in the pocket of a creeper, growing on the trunk of a larger tree. The nest itself is built of thin twigs and fibres, finer than those in the base, and is relatively tightly woven. The outside is frequently decorated with bright green moss; in one case narrow strips of paper-shaving were used instead. The cup, which is about 75 mm. across and 60 mm. deep, is lined with sago-palm. Neither feathers nor mud appear in its construction.

By far the largest number of nests are built during November. The time required varies considerably, but the average is about three weeks. The eggs are not laid immediately, and one nest remained empty for eighteen days. A full clutch normally contains two or three eggs, but rarely a bird may go broody on one. Ten ranged from 25·5 to 28 mm. in length and 17·5 to 20 mm. in breadth, with an average of 27·1 mm. by 18 mm.: the larger measurements usually occur in the smaller clutches. The surface is a fine matt, and the colour a dull pale blue, with a hint of green, coarsely blotched, most thickly at the rounded end, with rufous-brown and, occasionally, a watery mauve-brown.

Only the hen incubates, but the cock bird may remain in the vicinity, and keep fairly close to the nest while she is away feeding. The eggs hatch after eighteen days. The young chick has a bright yellow skin, and appears red-yellow with blue-grey bars along the back and wings where the feathers in their sheathes are preparing to sprout. There is a little scanty down, very fine in texture, along the midline of the back, the line of the primaries and two sagittal lines, diverging anteriorly, over the crown. The gape is yellow, the bill and claws straw-coloured, and the feet pinkish.

Growth is fairly rapid, and the chick reaches a relatively large size before the feathers develop. By the fourth day, when the primaries are just beginning to appear, it has attained a length of about 68 mm. with the bill, measured to the gape, 18 mm. The eyes open two days later, when the gape measures 20 mm. and the total length 86 mm. By the ninth day the total length is 104 mm. of which 6 mm. are covered by the rectrices which are just reaching the ends of their sheathes. The bill is now 24 mm. long (eighty per cent of the average adult figure). The wing pressed flat is 47 mm. with the longest primary, free for about two-thirds of its length, 27 mm. At this stage fragments of down are still present on the head and shoulders. Contour feathers, most of them still half in their sheathes, have appeared in one strip down the spine, two down the flanks, one down the external surface of the thigh, and one along the wing. Other feathers form a triangular area over the crown, and there is a row above the tail.

At the tenth day the iris is grey-brown, the mouth flanges or gape a very pale yellow, the legs off-pink and the beak a purplish bone-brown except at the tip, which is yellow. As development proceeds these colours grow darker. By the fifteenth day the iris has lost its grey tone, and by the time that the chick leaves the nest it has become a strong brown, almost as dark as in the adult. The gape and eyelids gain in intensity and the bill loses its purplish shade, becoming straw-brown at the tip merging to a smoky bone-brown at the base. In some birds, presumably males, this grows to an orange-yellow after a few months. In immature birds which have just left the nest the legs are straw-coloured, only slightly tinged with pink.

The chick leaves the nest between the seventeenth and ninteenth day. At this stage it has a total length of about 142 mm. of which 26 mm. are accounted for by the tail (in the full-grown bird the tail is about 84 mm.). The wing flat is only 74 mm. between two-thirds and three-quarters of the adult size. The bird is, nevertheless, quite capable of good and sustained flight, although it usually does not travel more than thirty or forty feet at a time. The bill is interesting. It still measures only 25 mm. from the tip to the gape, which means that it has grown very little since the tenth day. It has, however, approximated more to the adult shape although it is still deficient in front of the nostril, where it measures only 10 mm. against the average for a fully developed adult of just over 15 mm.

The plumage in which the young bird leaves the nest differs considerably from that of the adult. The belly is almost white, and the feathers of the breast and flank ochreous, strongly tipped with smoky brown. This latter reaches its maximum on the foreneck and breast, and is paler again between the mandibles. The remaining feathers are olive-brown, but the wing coverts and those in the mantle area have ochraceous shafts. On the wing coverts this broadens at the tip of the feather to form a yellowish frill, giving, the very young bird a highly speckled appearance. As it grows older the tips of the feathers wear away, and the effect is slowly lost.

Zosterops natalis Lister

Christmas Island White-eye.

This bird is very plentiful, and very conspicuous, on Christmas Island. It is gregarious and collects in small flocks which abound round the settlements and the outlying camps. It does not, as a general rule, penetrate far into the jungle itself, though it may be met with in any areas where there are natural clearings of half an acre or more. It is interesting to note that it was liberated on one of the islands in the Cocos-Keeling group between forty and fifty years ago, and though it is now numerous on that island it has not spread to any of the others.

The White-eye is a lively, querulous, little bird. Its usual call is a short, rather high twittering note. When two birds are disputing, as they frequently do, it becomes even shorter and harsher. In the presence of the hawk or owl, or when other danger threatens, a flock gives rise to an indignant clamour of considerable volume, which soon fades into a drier, chittering sound. This is continued until the danger passes.

It occasionally takes insects, but the diet consists largely of fruit and, to a lesser extent, seeds. It is fond of bananas, mangos, sour-sops (*Anona muricata*), custard-apples (*A. squamosa*) and papayas. It is particularly troublesome over the latter, and unless the fruit is well protected it is inevitably attacked as soon as it begins to ripen. The White-eye also feeds on the wild passion-flower (*Passiflora* sp.) and the drying seeds of the various cannas. The coolies sometimes catch it in traps baited with sun-dried boiled rice.

There is no difference between the sexes in size, plumage or the colouring of the soft parts, and they cannot be separated in the field. The iris is a rich chestnut brown, the bill black, with the base of the lower mandible grey, and the legs and feet greenish grey.

Occasional individuals may be found nesting at any time of the year, but there is certainly a peak period running from the beginning of September to the end of January, or slightly later. A fair proportion of the birds appear to moult in the early part of the year.

The nests are usually built in the fork of a very thin branch (between five and fifteen feet from the ground) in a medium-sized bush; but they may, especially on the slope of the inland cliff, be constructed much higher up, in large trees. The nest is firmly attached to the arms of the fork from which it is suspended, and they may even be built into the rim. The cup, which is about 55 mm. in diameter and 20 to 25 mm. deep, is carefully lined with dried strands of the local "sago-palm" (*Arenga listeri*). The outer portion of the nest, which is fairly neat and compact, is normally woven of dried grass and other slightly coarser vegetable fibres, and *Arenga* is rarely used for it. A few feathers or even dried leaves, may be incorporated in this section, but their presence is unusual.

The eggs are a uniform, pale, rather watery, blue in colour, with a fine matt surface. Their shape is a pointed oval. Ten average 17·8 mm. by 12·4 mm., with a range of 16·5 to 18·5 mm. in length and 12 to 13 mm. in breadth. A completed clutch contains two or, less frequently, three eggs: one nest was found with four in it. The eggs hatch after fifteen to sixteen days incubation.

The chicks emerge naked, except for a little fine down on the head, mantle and back. Development is fairly rapid. By the end of the fourth day the sheathes of the primaries and of the feathers of the crown and back have thrust their way through the skin. The rectrices follow during the course of the fifth day. By the eighth day the primaries, scapulars and crown feathers have pressed 1·5 to 2 mm. beyond the ends of their sheathes, and feathers have appeared on the flanks and thighs. At this stage the chicks have a total body length, subtracting the length of the rectrices, of about 45 to 50 mm., and almost fill the nest.

By the twelfth day the chicks are well feathered, and over two-thirds of the adult length. By the fifteenth day the plumage appears to be complete, except that the rectrices and remiges are short and the feathers barely spread across the belly. The total length, without the tail, is now about 73 mm., against the 80 mm. of the adult. The tail itself is about 16 mm., compared with the adult range of 46 to 49 mm. The primaries are in better proportion, and by the sixteenth day the wing when pressed flat measures over 40 mm. In this condition the young bird is capable of a short, limited flight, and it may leave the nest at any time after the seventeenth day. It does not usually move far away for at least a week, and during this period it is still fed regularly by the parents. The juvenile plumage does not differ materially from that of the adults.

Padda oryzivora oryzivora (Linn.)

Java Sparrow.

The Java Sparrow was liberated in the neighbourhood of the north coast settlement between Dr. Hanitsch's visit in 1904 and that of the Dayak collectors from the Raffles Museum in 1923. It is, apparently, a most unenterprising little bird. By 1940 it had extended its range no further than the whole length of the north coast road (a distance of six miles), and two miles along the railway line towards South Point. Within, this area, the short strip of shore terrace and the clearing on either side of the track, it was very plentiful.

It is a mixed vegetable feeder, taking a number of small seeds, including those from a degenerate *Passiflora sp.*, which is very plentiful on the island. It is also partial to grains of cooked as well as uncooked rice, and frequently enters the runs in the settlement in search of the hens' food. At such times it often feeds in company with the indigenous white-eye, producing an attractive, though rather noisy, mixed flock.

There are no differences between the sexes in size, plumage or the colouring of the soft parts, and they cannot be distinguished in the field. Adults have the iris reddish chestnut; the eyelids blue grey, with the free border varying from very pale pink to

a full mauve pink; the bill purplish pink or mauve pink, paler almost white along the free edge and at the tip; and the legs and feet pale pink.

An examination of a number of skins suggested a fairly general moult between August or September and November, with the birds in fresh plumage by the end of the year. The colours of the soft parts, except the iris, appear to brighten to some extent between December and May, reaching their greatest intensity between March and June. This is most noticable in the bill which ranges from a pale, watery, purplish pink to a strong, mauve pink. Birds with pale bills usually have the legs and feet paler, and the free border of the eyelids lighter, than the others.

Six nests were found, four between May and July, and two in August. The site varied considerably. One was between the top of the wall and the roof of an old lavatory, a second in the trunk of a dead tree, another in a cleft between a rock face and the wall of a corrugated iron shed, one in a creeper on the trunk of a large tree, and two in low bushes. All were between five and fifteen feet from the ground. They were built of dried grass stems, and strips of fibre from coconut palm fronds and the island "sago-palm", *Arenga listeri*. The inside was smoother and softer than the outside, but there was no definite lining of material different from that of the body of the nest. The four in crevices or similar situations had the sides and back built up, but were not finished across the top. The two in bushes were globular in shape, with an entrance at one side. In all cases at least the greater part of the nest was fairly well woven, and held tightly together, though the outside appeared rather untidy.

The completed clutches contained three to five eggs, with an average of just over four. They are a regular oval in shape, and pure white in colour, with a smooth, matt surface. Ten average 19·9 mm. by 15·3 mm., with a range of 19 to 21 mm. in length, and 14·5 to 16 mm. in breadth. They hatch in fourteen and a half to fifteen days after the last egg is laid.

The chicks presented no abnormal features, and no detailed observations were made on them. They left the nest, fully fledged but with very short tails and wings, between the fifteenth and seventeenth day, depending, it seemed, on the amount of interference to which they were subjected. The young remained in a fairly loose group in the neighbourhood for at least a further fortnight, during which they were fed by the parents. They were very noisy at this stage, and called to each other frequently. They did not seem very alert at avoiding danger, and a number of immature birds were brought in by our cats which only once, to our knowledge, succeeded in catching a young white-eye.

The juvenile plumage is much duller than the adult. The crown of the head is dark grey instead of black, and the sides of the face and throat a uniform greyish white (without any darker colouring on the chin). The chest is vinous grey, and the breast and belly buffy white. The feathers of the back and wings are grey, as in the adult, but they are edged with warm, buffish brown, giving the area a lighter, browner appearance. The rump is the same colour as the remainder of the back, not black as in the adult. The iris is dusky grey, the bill brownish black and the feet a greyish, watery pink.

As the bird approaches its first moult the iris becomes browner, and the bill fleshy pink, washed with dusky grey. When the moult begins the black feathers appear first on the nape, the midline of the throat and the rump. On the ventral surface the grey appears first on the lower breast, and works forward patchily: on the dorsal surface the adult feathers appear first on the rump and wings coverts, working forwards and medially towards the mantle and scapulars. Towards the end of the moult the iris is greyish chestnut, and the bill pink, with a faint greyish wash. Birds in juvenile plumage were not recorded during the first five months of the year.

CHECKLIST of the Birds of Christmas Island

This list is based primarily on personal observations over the period from September 1938 to November 1940. In the case of the vagrants it has been supplemented by an examination of the skins in the Raffles Museum collection, the lists published by Bowdler Sharpe (*Monograph of Christmas Island*, 1900, pp. 37–50 & 319), Chasen and Boden Kloss (J.M.B.R.A.S., 1924, pp. 65–68) and Chasen (Bull. Raff. Mus., 1933, pp. 85–87), and some additional data. Bowdler Sharpe accepts 31 species, Chasen and Boden Kloss 38, Chasen 39 and the present list 46. The last three totals include three species, *Padda o. oryzivora*, *Aethiopsar grandis javanicus* and *Gracula r. religiosa*, which have arrived as caged birds. The first of these, *Padda o. oryzivora*, has now established itself and is breeding freely in the neighbourhood of the settlement on the north coast: the other two have so far failed to do so.

The birds on this list can be divided into three groups. The first, marked by a double asterisk, comprises those which are now breeding on the island. These consist of eight land birds (seven of which are indigenous to Christmas Island) and nine sea or coastal birds. The second group, described as visitors, consists

of those species which arrive regularly, though in small numbers, at certain times of the year. The last group, described as vagrants, comprises those species which have only been taken once or twice: it is possible that more extensive collecting might reveal that certain of these, particularly *Crocethia alba, Glareola pratincola maldivarum,* any of the herons, *Chalcites basalis* and the wagtails, are arriving more regularly and should be classified as visitors. Birds in the last two groups which I collected or observed myself are marked with a single asterisk.

The nomenclature of this list follows Chasen's *Handlist of Malaysian Birds* (Bull. Raff. Mus., 1935,). Trivial names have been added for the benefit of residents on the island, or anyone paying a short visit, who might possibly be inspired to collect further and so add to our knowledge of the less common species.

Two unsubstantiated records are omitted from this list. G. M. Mathews (*Systema Avium Australasianum,* 1927, p. 232) includes Christmas Island in the range of *Sula dactylatra bedouti,* and Dr. P. R. Lowe (Nov. Zool., Vol. 31, 1924, p. 310) refers to a specimen of *Fregata ariel* from the island. These were not accepted by Chasen in 1933, and only the former in 1935. Neither species breeds on the island, and no strays were seen during my stay there. It seems most likely that the supposed occurrence of the frigate-bird is based on an incorrectly labelled specimen, and of the booby on an error in compiling the locality list. I found both species breeding on North Keeling, though Mathews omits the Cocos-Keeling Islands from his range of *Sula dactylatra.*

Several additional birds are said to have been seen on the island, but no examples have been taken and accordingly they are not included in the following list. In the Monograph Andrews refers to a second rail (p. 301), a "fishing-hawk" and "a number of whiteheaded swifts" (p. 302), none of which can, or should, be identified from these descriptions. A resident also described a pigeon to Chasen which the latter thought might have been the Nicobar Pigeon, *Caloenas nicobarica:* personally I am of the opinion that it was a mutant of the Christmas Island Imperial Pigeon, of which two, more advanced, examples were taken by a woodcutter while I was there. Nevertheless there can be no doubt that there are a number of vagrants still to be recorded. It is significant that every collector who has visited the island has added to the list of strays, sometimes with surprising specimens, and when on the much more isolated Cocos-Keeling Islands in 1941 I took examples of over fifteen casual visitors (including an albatross), nearly half of which have not yet turned up from Christmas Island.

SPECIES	STATUS
COLUMBIDAE	
** *Ducula rosacea whartoni* (Sharpe), Christmas Island Imperial Pigeon.	Resident, widely but locally distributed over the inland plateau.
Myristicivora bicolor bicolor (Scop.), Pied Imperial Pigeon.	Vagrant (Hugh Ross, ♂ Feb., 1899).
** *Chalcophaps indica natalis* Lister, Christmas Island Emerald Dove.	Resident, widely distributed but less plentiful towards the west end of the island.
RALLIDAE	
* *Porzana fusca fusca* (Linn.), Malayan Ruddy Crake.	Vagrant (Andrews, ♀ Aug., 1897, Gibson-Hill, ♂ Sept., 1940).
CHARADRIIDAE	
* *Charadrius apricarius fulvus* Gmel., Eastern Golden Plover.	Regular visitor, small numbers north coast between Sept. and April.
* *Charadrius leschenaultii leschenaultii* Less., Large Sand-Plover.	Regular visitor, in very small numbers, Sept.–Nov. and March–May.
* *Numenius phaeopus variegatus* (Scop), Eastern Whimbrel.	Probably a regular visitor, in very small numbers, between Sept. and May.
Capella stenura (Bp.), Pintail Snipe.	Vagrant (Andrews, ♂ Dec., 1897).
Crocethia alba (Pall.), Sanderling.	Vagrant (Andrews, an adult, no other data).
* *Erolia ruficollis* (Pall.), Rednecked Stint.	Probably a regular visitor, in very small numbers, Sept.–Nov., possibly also March–May.
* *Erolia minutilla subminuta* (Middend.), Longtoed Stint.	Vagrant (Gibson-Hill, two ♂ Sept., 1940).
* *Tringa totanus eurhinus* (Oberh.), Eastern Redshank.	Vagrant (Gibson-Hill, ♂ Sept., 1939).
Tringa incana brevipes (Vieill.), Greyrumped Tattler.	Vagrant (Hugh Ross, ♀ Sept., 1898).
Tringa nebularia (Gunn.), Greenshank.	Vagrant (Hanitsch, 1904).

SPECIES	STATUS
* *Tringa glareola* Linn., Wood Sandpiper.	Vagrant (Gibson-Hill, ♀ Nov., 1940).
* *Actitis hypoleucos* (Linn.), Common Sandpiper.	Regular visitor, small numbers, Sept.–April.
GLAREOLIDAE	
Glareola pratincola maldivarum Forst., Collared Pratincole.	Vagrant (Andrews, ♀ imm. Oct., 1897).
LARIDAE	
** *Anous stolidus pileatus* (Scop.), Noddy.	Mostly a breeding visitor April–Nov.: some birds present throughout the year.
ARDEIDAE	
Egretta eulophotes (Swinh.), Chinese Egret.	Vagrant (Maclear, ♀ Jan., 1887).
Egretta intermedia plumifera (*Gould*), Plumed Egret.	Vagrant (Andrews).[1]
* *Egretta garzetta nigripes* (Temm.), Little Egret.	Vagrant (Gibson-Hill, ♂ April, 1940).
** *Demigretta sacra sacra* (Gmel.), Reef Heron.	Resident, small numbers north and east coast beaches: breeds near Dolly Beach.
* *Notophoyx novaehollandiae* (Latham), White faced Heron.	Vagrant (Gibson-Hill, two ♂ Nov., 1940).
* *Nycticorax caledonicus hilli* Mathews, Nankeen Night Heron.	Vagrant (Gibson-Hill, ♂ Aug., 1939).

1. The only heron listed in the Monograph is *Demigretta sacra*, but *Mesophoyx plumifera* (Gould) (= *Egretta intermedia plumifera*) is included in a list of thirteen species collected by C. W. Andrews on Christmas Island, of which specimens were exhibited by Dr. Bowdler Sharpe at a meeting of the British Ornithologists' Club on December 15, 1897 (Bull. Brit. Orn. Club, No. 49, p. 23). The short account of the meeting states specifically that this bird and the rail *Limnobaenus fuscus* (= *Porzana f. fusca*) were additions to the list of Christmas Island birds, as published by J. J. Lister in 1888. It is scarcely likely that the specimen was shown in error, and the species is accordingly included in this check-list as a rare vagrant. The normal range of the race is given by Peters (Vol. 1, 1931, p. 112) as Buru, Ceram, New Guinea and Australia.

SPECIES	STATUS
Butorides striatus amurensis Schrenck, Little Green Heron.	Vagrant (Coll. Raff. Mus., ♂ 1923).
ANATIDAE	
Anas gibberifrons gibberifrons S. Mull. Wood-Teal.	Vagrant (Hanitsch, 1904).
SULIDAE	
** *Sula abbotti* Ridgw., Abbott's Booby.	Resident, breeds in small numbers towards the west end of the island.
** *Sula leucogaster plotus* (Forst.), Brown Booby.	Resident, widely distributed round the coast.
** *Sula sula rubripes* Gould, Redfooted Booby.	Resident, widely distributed round the coast.
FREGATIDAE	
** *Fregata andrewsi* Math., Christmas Island Frigate-bird.	Resident, widely but locally distributed round the coast.
** *Fregata minor minor* (Gmel.), Lesser Frigate-bird.	Resident, widely but locally distributed round the coast.
PHAETHONTIDAE	
** *Phaëthon rubricauda westralis* Math., Redtailed Bo'sun-bird.	Resident, widely but locally distributed round the coast.
** *Phaëthon lepturus fulvus* Brandt, Golden Bo'sun-bird.	Resident, small numbers, mostly on the north coast.
FALCONIDAE	
** *Accipiter fasciatus natalis* (Lister), Christmas Island Goshawk.	Resident, widely distributed.
STRIGIDAE	
** *Ninox forbesi natalis* Lister, Christmas Island Hawk-Owl.	Resident, widely distributed, but retiring and seldom seen.
MICROPODIDAE	
** *Collocalia esculenta natalis* Lister, Christmas Island Swiftlet.	Resident, widely distributed: breeding in limestone caves.

SPECIES	STATUS
CUCULIDAE	
Chalcites basalis (Horsf.), Bronze Cuckoo.	Vagrant (Andrews, immature female).
HIRUNDINIDAE	
* *Hirundo rustica gutturalis* Scop., Eastern Common Swallow.	Regular visitor, small numbers between Sept. and Nov.
TURDIDAE	
** *Turdus javanicus erythropleurus* Sharpe, Christmas Island Ground-Thrush.	Resident, widely distributed.
ZOSTEROPIDAE	
** *Zosterops natalis* Lister, Christmas Island White-eye.	Resident, widely distributed.
MOTACILLIDAE	
Motacilla cinerea melanope Pall., Grey Wagtail.	Vagrant (Andrews, ♂ Oct., 1897).
Motacilla flava simillima Hart., Blueheaded Wagtail.	Vagrant (Andrews, 3 imm. Oct., 1897).
Anthus campestris striolatus Blyth., Tawny Pipit.	Vagrant (Coll. Raff. Mus., ♂ 1923).
PLOCEIDAE	
** *Padda oryzivora oryzivora* (Linn.), Java Sparrow.	Introduced before 1923, and now breeding in some numbers in the neighbourhood of the settlement on the north coast.
STURNIDAE	
* *Aethiopsar grandis javanicus* (Cab.), Javan Jungle Myna.	Introduced: taken by Hanitsch in 1904, but not recorded in 1923 or 1932. An escaped bird was seen for about a week in June 1939; then it disappeared.
Gracula religiosa religiosa Linn., Grackle.	Introduced: taken Coll. Raff. Mus., 1923, but not seen in 1932 or later.

Visitors and vagrants have been collected by the following field workers, who are arranged in chronological order. The dates immediately after their names give the periods during which they were on the island. The references in brackets are the first publication of their records. These are added to establish the authority for the latter, as in some cases the specimens cannot now be found.

Maclear, Captain. January, 1887 (Sharpe, Cat. Birds Brit. Mus., vol. 26, 1898, p. 143).

Lister, J. J. October, 1887 (Lister, Proc. Zool. Soc., 1888, pp. 517–529).

Andrews, C. W. July, 1896, to May, 1897 (Bowdler Sharpe, *Monograph of Christmas Island,* 1900, pp. 37–50) : see also footnote on page 162.

Ross, Hugh. Period not known (*Ibid,* p. 319).

Hanitsch, Dr. R. September, 1904 (Chasen and Boden Kloss, J.M.B.R.A.S., 1924, pp. 65–68).

Coll. Raff. Mus. = two Dayak collectors from the Raffles Museum. September and October, 1923 (*Ibid*).

Tweedie, M. W. F. August and September, 1932 (Chasen, Bull. Raff. Mus., 1933, pp. 55–87).

Gibson-Hill, C. A. September, 1938, to December, 1940 (Gibson-Hill, this journal, pp. 87–89 and 159–164).

A Note on the Plates

Photographs taken by C. A. GIBSON-HILL

Plate I. Two views of the rock-pool shelf on the north coast of Christmas Island. Both pictures were taken in calm weather, and at about low tide, when the shelf is exposed. At high water it is usually covered by the sea. The shelf can be regarded as a raised portion of the fringing reef, and it is found only on those sections of the coast (marked on the map on page 8) where the reef is present. The rock-pool shelf has an interesting and characteristic fauna, which is outlined in the note on the coast, on page 11.

Plate II. Views of the fringing reef at Greta and Lily Beaches, on the east coast of Christmas Island. The reef is much broader in front of these beaches, and is exposed round low water. Its pools are rich in crustacea, and also provide a home for certain of the echinoderms occurring on the island. The distance in the upper picture shows a typical section of the normal coast-line. These beaches are discussed in more detail on page 14.

Plate III. The freshwater marsh at Anderson Dale, on the west coast, and a view of Dolly Beach, on the east coast. The marsh, which only covers about an acre, is situated on a shelf of ground about two hundred and fifty feet above sea level. Its borders and the stream flowing from it are the principal area in which the blue land crab, *Cardisoma carnifex,* occurs: the trees surrounding it are mostly *Inocarpus edulis* and *Ficus retusa.* Dolly Beach is an attractive sandy beach backed by coconut palms which were first established there about fifty-five years ago. The fallen vegetation in the fore-ground lies over a small freshwater stream, and the area is rich in certain crabs, including *Ptychognathus pusillus* and *Sesama obtusifrons.* The beach itself is visited by Green Turtles, *Chelonia mydas,* which come ashore to lay their eggs. It is the principal home, on the island, of the crabs *Ocypoda cordimana, O. kuhli* and *O. ceratophthalma,* the last of which preys heavily on the young turtles while they are on their way to the sea. The fauna of these areas is discussed on pages 14 and 43.

Plate IV. Flight studies of five of the sea birds occurring on Christmas Island. The upper pair are the Redtailed Bo'sun, *Phaëthon rubricauda westralis* coming down to alight (on the left), and an immature Lesser Frigate-bird, *Fregata m. minor,* (on the right). The middle picture is a Redfooted Booby, *Sula sula rubripes,* in gliding flight. The lower pair are a Golden

Bo'sun *P. lepturus fulvus*, (on the left), and a Brown Booby, *S. leucogaster plotus*, (on the right). It is interesting to compare the elongated centre tail feathers of the two species of *Phaëthon*, that of the Golden Bo'sun being longer, rather broader, and much more prominent when the bird is in flight.

Plate V. Six photographs of young Brown Boobies, *Sula leucogaster plotus*, taken at intervals of about three weeks: the series reads from left to right, and above downwards. The top left-hand picture shows a newly hatched chick and an egg. The next chick, standing by one of its parents, is nearly three weeks old, and well covered with down. In the middle two photographs the feathers are beginning to thrust their way through the down. In the bottom left-hand picture the latter survives in an appreciable amount only on the head, neck, flanks, thighs and among the wing coverts: this bird is about eleven weeks old. The last youngster, in the bottom right-hand corner, is in full juvenile plumage. (*See text, pages 109–115*).

Plate VI. Chicks and juveniles of three of the sea birds occurring on Christmas Island. The upper pair show a young Noddy, *Anous stolidus pileatus*, eight days old, with its parent (top left) and a juvenile bird, just able to fly. The middle pair are the downy chick and immature bird of the Christmas Island Frigate-bird, *Fregata andrewsi:* the chick, on the left, is about nine weeks old, and has the juvenile feathering showing on the mantle and scapular regions. The lower pair of pictures show a chick, eight to nine weeks old (on the left), and a fully fledged juvenile of the Redtailed Bo'sun, *Phaëthon rubricauda westralis*.

Plate VII. Photographs of some of the Christmas Island land birds. The bird in the top-left-hand picture is the island Hawk-Owl, *Ninox forbesi natalis:* that next to it, the Ground-Thrush, *Turdus javanicus erythropleurus*. The middle two photographs are of a nest, with eggs, and a sitting bird of the Christmas Island Swiftlet, *Collocalia esculenta natalis*, taken in the large limestone cave near North-east Point. The bottom pictures show, on the left, a White-eye *Zosterops natalis*, feeding from a ripe papaya, and, on the right, two chicks of the Emerald Dove, *Chalcophaps indica natalis*, about seven days old, in their nest.