

## THE BREEDING ECOLOGY OF SEA BIRDS ON MONITO ISLAND, PUERTO RICO

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Although much has been written about the birds of Puerto Rico, their status on its numerous outlying islands is poorly known. This is especially true of Monito, Puerto Rico's most isolated and inaccessible island. Although Monito has long been known as a haven for sea birds (Percy 1607, Hübener 1898, Bond 1946), it has rarely been visited by a scientific party (Beatty *in* Bond 1946, Rolle et al. 1964). For this reason, my associates and I included Monito in a study of the species composition, population size, and breeding phenology of sea birds on islands in Puerto Rican waters. We found three breeding species that had not been reported from the island, and our data, together with those from Culebra (Kepler and Kepler, *in press*), provide a reasonably clear understanding of the distribution and breeding seasons of Puerto Rican sea birds.

### MONITO ISLAND

Monito (18°10'N, 67°57'W) (Fig. 1) lies 4.7 km NW of Mona Island, the nearest land, and is roughly halfway between Puerto Rico (75 km E) and the Dominican Republic (50 km W). It is composed of jagged up-raised limestone, with vertical cliffs up to 66 m high around the entire island (Fig. 2). There are no beaches, and the encircling cliffs, roughly 2100 m in length, have been undercut two to five meters by wave action on all sides. A cave, ascending from sea level nearly to the top, cuts deeply into the west coast, and numerous smaller caves penetrate the cliff faces, especially on the north and northwest. In calm weather the top can be reached by climbing the west cliff from a projecting limestone knob, although in the best of conditions this is difficult. Percy's (1607:29) description is still appropriate: "... we had a terrible landing, and a troublesome time getting to the top of the Mountaine or Ile; (it) being a high firme Rocke, steep, with many terrible sharpe stones." A diverse and thriving sea bird colony undoubtedly owes its presence in part to these "sharpe" cliffs.

Flat land is limited to a large plateau approximately 300 m by 500 m (15 ha), and to several shelves one to several meters wide

near the tops of the cliffs (Fig. 3), especially on the west, north, and east sides of the island; these are generally separated from the plateau by vertical or near-vertical limestone escarpments. The plateau slopes gently from northeast (66 m) to southwest (25 m), and is partly bounded on the north by a broad swale with several limestone escarpments and small caves. A limestone prominence (Castle Rock) rises 10 m on the east, and an impassable cleft extends roughly 100 m inland from the south cliff, dividing the island into lower western and higher eastern sections.

The U.S. Air Force used Monito as an aerial bombing target after World War II (Wadsworth 1973), and many large impact craters and bomb fragments remain on the plateau. Several cliffs and shelves have been cracked or shattered by impact, making passage difficult and treacherous.

### CLIMATE

Weather on Monito is probably similar to that on Mona, which has been summarized by Calvesbert (1973). The average annual rainfall on Mona is 809 mm, with a dry sea-

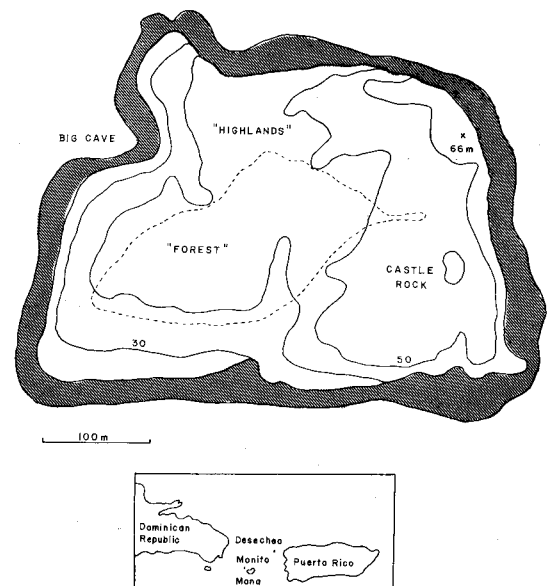


FIGURE 1. Monito Island, Puerto Rico, showing prominent physical features. Solid lines are 10 m contours, dotted lines delineate forest boundary, hatching indicates cliff faces.



FIGURE 2. Monito Island. The southeast point, precipitous eastern cliffs (right), and tapering southern cliffs (left), 8 December 1973. Note the gradual slope from the plateau's highest (extreme right) to lowest (extreme left) points.

son from January to April, and a wet season from August to December, with October and November the wettest months (mean monthly rainfall in mm, Jan.–Dec., is 39.6, 28.2, 31.2, 51.8, 80.8, 72.4, 66.0, 81.5, 80.3, 110.7, 86.9, and 79.5). No temperature data exist for Mona, so estimates are based on records from eastern Dominican Republic and southwestern Puerto Rico; monthly low and high means probably vary from about 21° and 29°C in January to 24° and 32°C in August, the extreme months. Mona lies on the southern edge of the Bermuda high pressure cell, thus experiencing eastern trade winds nearly continuously—80% of all wind has some easterly component.

#### VEGETATION

The interaction of topography and climate has strongly affected plant distribution and stat-

ure, and thus had a significant impact on Monito's sea bird distribution. Subtropic dry forest (Ewel and Whitmore 1973) covers most of its surface, except for soilless areas of exposed limestone; 36 plant species have been found by R. Woodbury (Woodbury et al., in press). Because the island is 40 m higher in the east than in the west, wind velocity is substantially reduced over the western (leeward) half of the island. A dense grove of trees, primarily *Ficus citrifolia* and *Guapira discolor*, extends northeastward about 300 m from the southwestern tip, terminating abruptly at the cleft on the southern coast, and gradually as it follows the lower edge of the northern escarpment towards the east. This small forest, approximately 4–5 m high, is bordered on all sides by lower vegetation more exposed to the prevailing wind. Trees



FIGURE 3. Monito Island's plateau, 20 June 1973. Sooty Terns nest on the central grassy limestone patch and under adjacent brushy vegetation.

characteristic of the forest also occur sparingly on the cliff shelves, but are smaller. The exposed northern escarpment is grassy (*Paspalum laxum*), with clumps of trees in protected areas. Thick shrubs (*Lantana involucrata*) predominate on the eastern cliffs and southeastern third of the island, and are seldom used by sea birds. Open grassy patches are scattered over the island, including some small openings in the forest.

Cacti grow throughout the island. A dense patch of tree cactus (*Consolea rubescens*) borders the forest on the southwest. Prickly pear (*Opuntia dillenii*) formerly covered large areas of the plateau, making walking difficult and usurping much potential sea bird habitat. The cactus moth (*Cactoblastis cactorum*), spreading from the northern Lesser Antilles, where it was introduced in 1957 (Garcia et al. 1971), invaded the island between our June 1969 and 1973 visits. In June 1973, very few patches of *Opuntia dillenii* remained, and extensive open areas covered with cactus spines occurred throughout the plateau. By December 1973 the cactus was rapidly recovering, and can be expected to reach its former abundance unless *Cactoblastis* has survived or reinvades the island.

#### REPTILES

Four species of small lizards occur on Monito, *Anolis monensis*, *Mabuya sloanii*, and *Ameiva alboguttata* (Schwartz and Thomas 1976), and an undescribed species of *Sphaerodactylus* discovered in 1974 (H. Campbell, pers. comm.). No interactions between them and sea birds have yet been noted. No amphibians have been found.

#### MAMMALS

The only mammal recorded from Monito is the roof rat (*Rattus rattus*), which we discovered in large numbers in June 1969, and collected (USNM 349996) on our second trip. The likely sources of introduction were ships involved in guano-extracting operations in the early 1850's (Wadsworth 1973). Rats were active over the entire island at all hours during our first four visits. We saw no predation on sea birds, such as has been recorded for *R. norvegicus* in the U.S. (Austin 1948, Hagar 1937, Howard 1968) and *R. exulans* in the Pacific (Kepler 1967), but their presence could account for the apparent absence of Audubon's Shearwaters (*Puffinus lherminieri*) which formerly occurred on Mona (Barnes 1946).

#### METHODS

My associates and I determined the status, distribution, population size, and breeding phenology of Monito's sea birds during 9 days and 4 nights on the island, as follows: 5-6 June 1969, 19-20 June and 7-8 December 1973, 19-20 May 1974, and 10 August 1974. In June 1973 we divided the island into 16 areas, each of which we censused thoroughly. Only selected areas or species were covered fully on other trips: the June 1973 census provided comparative information for extrapolation to uncensused areas on other visits. We evaluated breeding phenology and population sizes for all species by describing adult activity, counting and plotting nests, analyzing the contents of each nest and, where chicks were present, assigning each chick to one of several age classes (see species accounts). The range of probable egg-laying dates for each age class can be derived from these data by counting back the requisite number of days preceding each visit (histograms, Figs. 6-9). We have also calculated the average number of clutches begun per day by dividing the number of active nests (eggs or young) in each stage by its duration in days (line graphs, Figs. 6-9). This technique provides information for surviving young only; early egg or chick losses can not be detected. We observed nine species of land birds (Kepler, unpubl. data) and collected plants in 1969 and June 1973.

#### SPECIES ACCOUNTS

##### PHAETHON LEPTURUS. WHITE-TAILED TROPICBIRD

Casual in summer, possibly breeds. Rolle et al. (1964) saw two birds approximately 100 m off Monito on 31 May 1963, the only published Monito record. We saw and heard two groups, of three and five birds, calling and circling within 200 m of the big cave (Fig. 1) on 5 June 1969, and saw one in the same area the next day. Raffaele saw four birds attempting to land in the cliffs at southeast point on 20 May 1974, but did not see them enter any of the available holes. This species may breed or attempt to breed in small numbers, although tropicbirds are vulnerable to rats (Fleet 1972, Murphy 1936:807, pers. observ.), and could have been eliminated by them.

This species nests throughout the West Indies (Bond 1956). It breeds locally on mainland Puerto Rico (Wetmore 1927) and on three islets off Culebra (pers. observ.), but is most abundant (hundreds) at Mona, nesting in numerous caves in the extensive cliffs from February through August (Cory 1892, Struthers 1927, Bond 1946, Raffaele 1973).

##### SULA DACTYLATRA. BLUE-FACED BOOBY.

Permanent resident. We found this species breeding on Monito on each trip to the island. The total population is 50 to 60 pairs.

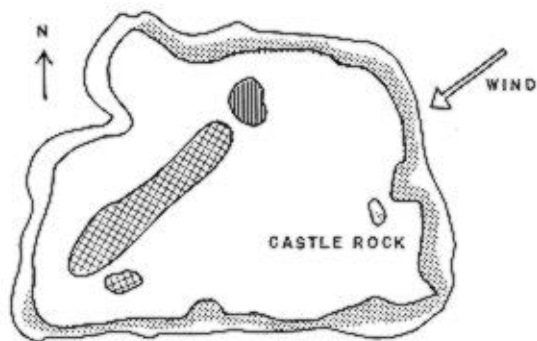


FIGURE 4. Breeding distribution of the Blue-faced Booby (dots), Magnificent Frigatebird (cross hatching), and Sooty Tern (hatching), Monito Island.

*Monito distribution.* Blue-faced Boobies are restricted to cliff shelves and, on the east coast, the edge of the plateau and Castle Rock (one pair, December 1973, May 1974). They do not occur inland on the plateau, and are absent as breeding or roosting birds from the shelves of the west (leeward) cliffs, including those above the big cave and south of the northwest point (Fig. 4). Their distribution suggests dependence on wind; the trades provide nearly constant updrafts even on the southwest point, but not on the west cliffs. Nests, as in other colonies, are merely scrapes on the ground holding a few twigs; they occur in flat pockets of soil among bare limestone and cactus, from the very edge of the cliff (Fig. 5) to flat areas several meters inland. The nests on the eastern plateau (three in June 1973, two in May 1974) were surrounded by shrubs (*Lantana involucrata*) up to 1 m high, one pair nesting 5 m from the cliff edge. Most nests were 10–20 m from each other, although in 1969 three nests on the southwest point were all within 3 m and in sight of each other. Seven pairs were in the same area at dusk on 7 December 1973, suggesting that the point regularly supports a greater density than other parts of the island.

*Population.* In our most complete count (June 1973) we found 45 adult pairs, and an additional 10 flying juveniles. There were 38 pairs in 1969, 40 in December 1973, and 35 in May 1974 in less complete censuses. As we could not visit all areas at dusk or dawn, when maximum numbers are in the colony (Kepler 1969), we undoubtedly missed birds that were at sea; we estimate that between 50 and 60 pairs nest on Monito.

*Breeding season.* On the first four Monito visits we described the contents of every accessible nest, and tallied every pair in one of



FIGURE 5. Nesting Blue-faced Boobies with downy young, Monito Island, 20 June 1973.

the following eight stages. The approximate age of young (in days from laying) is based upon descriptions in Dorward (1962) and Kepler (1969).

1. Pair on territory—one or both members of a pair standing at or near a nest scrape lacking eggs or young.
2. Eggs—adult incubating one or two eggs, mate may or may not be present (incubation takes 44 days).
3. Naked chick—chick naked or covered with a light mantle of down, skin visible (45–54 days).
4. Downy chick—chick entirely or nearly covered with thick white down, no contour feathers erupting (55–88 days).
5. Remiges—remiges and rectrices erupting visibly. Body downy, no contour feathers across back (89–114 days).
6. "Scapulars"—appearance of feathers in the interscapular region, forming a bridge between the scapulars. The chick is still basically downy, and may begin to show development of contour feathers ventrally (115–144 days).
7. Juvenal plumage—essentially a chick with contour feathers nearly fully grown. Traces of down still cling to body, and head and neck may be downy or show traces of down (145–164 days).
8. Flying juvenile (fledglings)—juvenal plumage completed, bird capable of flight (165–225 days). Often we did not determine if birds could fly because of difficult access to some nests, or fear of scaring juveniles from the cliff before they could fly. Thus juveniles (Table 1) are not plotted in Figure 6, for some may have been older birds.

The results of these censuses appear in Table 1, and probable egg-laying dates are plotted in Figure 6. It is clear that in May and June of all 3 years the boobies were nearing the end of their breeding season; only two (8%), five (16%), and two (7%) nests contained eggs in 1969, 1973, and 1974, respectively. The chick data (Fig. 6) showed spring laying peaks in March and April in all 3 years. In June 1973 the large number of juveniles (10) and fledglings (10) indicated a major egg-laying period late in 1972—fledglings normally remain in the colony about 2 months (Nelson 1967). Fall–winter laying occurred again in December 1973, when the Blue-faced

TABLE 1. Stages in the breeding cycle of the Blue-faced Booby, Monito Island, Puerto Rico, 1969, 1973, and 1974.

Census date	Nest stage/Age in days from laying						Pair on territory
	Juvenile 145-164	Scapulars 115-144	Remiges 89-114	Downy 55-88	Naked 45-54	Eggs 0-44	
5-6 June 1969	2	2	5	10	3	2	14
19-20 June 1973	10	2	6	5	3	5	14
7-8 Dec. 1973 <sup>a</sup>	0	0	1	9	1	9	12
19-20 May 1974	5	4	3	12	4	2	5

<sup>a</sup> Contents of an additional 8 nests could not be determined.

Boobies were clearly beginning a new cycle; 19 nests (95%) contained eggs, or naked or downy young, and no young in juvenal plumage. There was no (successful) nesting in the hot weeks of July and early August 1973, and it is probable that late nests from the previous season (eggs in June) failed to produce fledged young, for we should have seen them in December had they survived. The data indicate that nesting is normally from September to June, and may be bimodal, with an "autumn-early winter" peak, a "mid-winter" dip, and a second peak in March-April. Colonies near the U.S. mainland have eggs from "late fall to spring" (Palmer 1962), and Monito fits this pattern. Palmer (1962) stated that egg-laying occurs in the dry season in other colonies. Egg-laying on Monito in 1972 and 1973 peaked in the wettest months

(fall), as well as in the dry season (spring); October-November 1973 were exceptionally rainy on Mona (Tom Wiewandt, pers. comm.).

In most Blue-faced Booby colonies the normal clutch is two eggs, yet only one young is raised (Dorward 1962, Nelson 1967, Kepler 1969). In 14 nests in which we counted eggs, six held one, and eight held two; some of the former could have been incomplete clutches. In only one of 11 nests with naked chicks were two nestlings present, and in this instance the youngest chick was very small, certainly less than five days old. Only one young was present in all other nests ( $n = 59$ ). Two-egg clutches are more successful than those with one egg, for second eggs effectively buffer against loss of one egg or early death of the first chick (Kepler 1969).

*West Indian distribution.* The Blue-faced Booby is the rarest booby in the Antilles, previously reported in small numbers only on Pedro and Serranilla cays (Jamaica), Cockroach Cay (St. Thomas), and three islets in the Grenadines (Bond 1956). A colony in the Bahamas is apparently extirpated (Palmer 1962). The only previous records for Puerto Rico were sightings of single birds, one by Catesby Jones in 1958 near Desecheo Island, 55 km NW of Monito (Leopold 1963), and another by Erdman (Raffaele 1973) off Monito.

#### *SULA LEUCOGASTER.* BROWN BOOBY.

Permanent resident. We found Brown Boobies with eggs or young on every trip to the island, although there was a distinct breeding season every year. The population varied from about 150 pairs in the non-breeding season (summer) to  $500 \pm$  pairs during the breeding season (fall-spring).

*Monito distribution.* This is the most widely distributed breeding bird on Monito. It built its nests on every level, open spot, including caves and notches in the vertical cliff faces, cliff shelves, and the plateau in exposed grassy

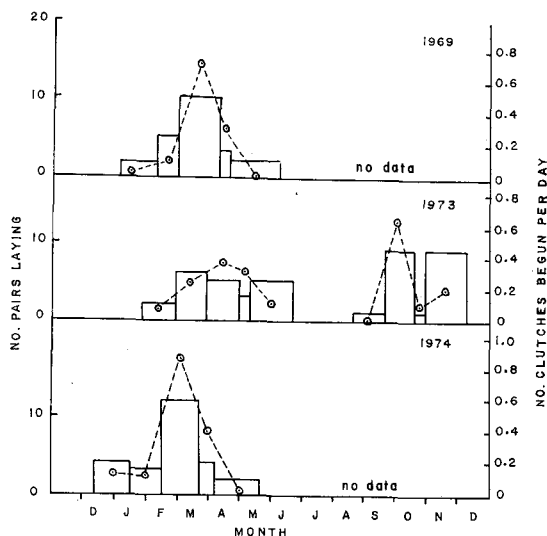


FIGURE 6. Breeding phenology of the Blue-faced Booby, Monito Island. In this and the following three figures the number of pairs laying during a given period prior to our visits (histograms) was determined by tallying each nest into one of several mutually-exclusive age classes; histogram widths indicate length in days for each class. Line graphs show mean number of clutches begun per day for each age class (see Methods).

TABLE 2. Distribution of Brown Booby nests on Monito Island during three censuses, 1969 and 1973.

Census date	Total breeding pairs <sup>a</sup>	East (windward)	West (leeward)	Plateau	Cliff <sup>b</sup>
5-6 June 1969	109	52	57	83	26
19-20 June 1973	94	42	52	68	26
7-8 Dec. 1973	204	not censused	204	72	132

<sup>a</sup> Does not include flying juveniles (43 in June 1973, 15 in Dec. 1973).

<sup>b</sup> Not well covered in 1969, and includes only nests on or visible from cliff shelves in 1973.

patches, including openings in the forest and cactus thickets, and under trees if accessible openings are within a few meters. Birds nest with equal frequency on the windward and leeward sides of the island (Table 2). Our census data show no clear preference for cliffs or plateau, as we found more nests on the plateau in June 1969 (end of laying) and June 1973 (beginning of laying), though more were on the cliffs in December 1973 (middle of laying). From the ship we noted extensive cliff areas containing Brown Boobies that could not be censused from the island, so the major breeding effort may be on cliffs. Of the 72 nests found on the plateau in December 1973, most (45) were in breezy areas of grass and low bush, with only 27 in grassy openings in the forest, where surrounding trees nearly eliminated any trace of wind, creating very hot, humid conditions. On each trip, birds in all stages of breeding were dispersed throughout the island; we found no indication of sub-populations breeding out of synchrony with other areas in the colony. Adults not associated with nest sites roosted inside the big cave penetrating the western cliff, where we found 30 birds in June, and about 50 in December 1973; a few individuals roosted on the cliffs bordering the cave mouth to the north. We found no other major roosts on the island.

**Population.** Estimating the population size is difficult because the widely dispersed nests are often hidden or inaccessible, and the number of adults changes with the breeding season. Our two most thorough censuses, both in 1973, hit a population peak in December and a dip in June (Fig. 7); together with our other data (Table 3) they allow a reasonable projection of the population fluctuations. Estimates are based on the number of nests found; equal numbers nest on the east and west sides of the island (Table 2). In December 1973 we found 204 pairs, plus 15 flying juveniles, on the western half of the island (Table 2), giving a minimum population of about 450 pairs. This figure does not include an unknown but possibly significant number nesting unobserved on cliff faces. We

covered less than half the plateau and a small part of the cliffs in June 1969, and estimated  $500 \pm$  pairs, a figure that appears consistent with our subsequent data.

Breeding was just beginning in June 1973, when, in a thorough census, we found only 94 nesting pairs, plus an additional 43 flying juveniles and about 100 non-breeding adults. The population was probably between 150 and 200 pairs, or less than half the total present in December. On 20 May 1974, Sansom noted far fewer birds than in the previous December, and Beatty (*in* Bond 1946) found about 200 adults in August 1944, both observations occurring during non-laying seasons. Similar drops in the number of resident Brown Boobies have been found in some but not all colonies (Palmer 1962), even on the same island (Dorward 1962, Simmons 1967). Brown Boobies are primarily inshore feeders (Dorward 1962, Nelson 1970, pers. observ.); there is no shallow water at Monito, and only

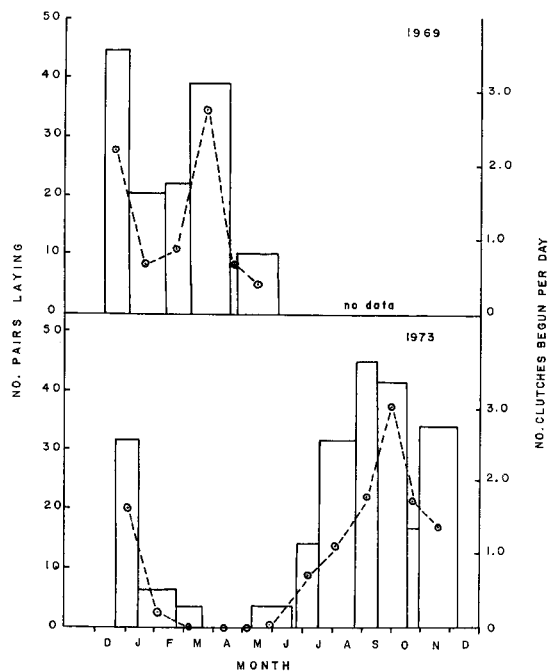


FIGURE 7. Breeding phenology of the Brown Booby, Monito Island.

TABLE 3. Stages in the breeding cycle of the Brown Booby, Monito Island, 1969, 1973, and 1974.

Census date	Nest stage/Age in days from laying							
	Flying juvenile >164	Juvenile 144-164	Scapulars 114-144	Remiges 88-114	Downy 54-88	Naked 44-54	Eggs 0-44	Pair on territory
5-6 June 1969	-	44	20	22	38	8	10	0
19-20 June 1973	43	32	6	3	0	0	3	50
7-8 Dec. 1973	15	14	33	45	41	17	34	3
19-20 May 1974 (no census)		old chicks present		0	0	0	0	-
10 Aug. 1974 (no census)	0	0	0	0	0	0	all nests with 2 eggs	

a limited inshore zone at Mona, where this species also breeds. There are scores of islands with extensive inshore zones in the Dominican Republic, Puerto Rico, and the Virgin Islands where birds could congregate away from Monito near locally available food supplies during their non-breeding season. It could be advantageous for birds to forage and roost there when they are not caring for eggs or young on Monito.

*Breeding season.* Brown Boobies have a flexible breeding season throughout their range, some colonies breeding seasonally, others aseasonally (Nelson 1970). Palmer (1962) noted that West Indian populations tend to show fall-spring breeding peaks, although this is variable, as some colonies show prolonged breeding seasons or temporally different peaks in different years. This is true of the colonies in the Mona passage; although breeding is seasonal and annual, with egg-laying occurring through at least 8 months each year, the laying peaks may shift 3 to 4 months in different years, obscuring the underlying phenology. For this reason, periods when no eggs are laid best define the breeding season. Fortunately, past observations and the current data provide a reasonably clear understanding of the breeding cycle.

*March through May non-breeding seasons.* On our first three trips to Monito, we censused and tallied Brown Booby nests by category, as described for the Blue-faced Booby; incubation time and development of the young are nearly identical in both species (Dorward 1962). The data reveal annual breeding cycles on Monito, with variations in the timing of the main breeding effort (Fig. 7). In June 1969 the population was completing one season; the 10 (9%) nests with eggs were clutches trailing a peak laying in late March or early April. The large number of non-flying juveniles indicated a previous peak in December-January (Table 3). In contrast, the 1973 winter-spring peak ended in March,

not June, and a new cycle began in June; we found only three clutches in a thorough census (probably the first eggs in over 2 months) and no naked or downy chicks. The December data show that laying increased steadily from June to September, then decreased again through early December. Raffaele and Sansom saw large chicks on 20 May 1974, but no eggs or young, and Wiewandt (pers. comm.) found no young, but several nests with two eggs on 10 August 1974 (Table 3), observations that indicate a 1974 laying season substantially the same as in 1973. On 31 May 1963, Rolle et al. (1964) found Brown Boobies the most common birds on Monito, with "numerous breeding adults and immature individuals," and noted that adults "immediately" flew when their "breeding areas" were disturbed. The presence of immatures could suggest a winter laying peak. Rolle did not mention eggs, and probably saw none, for incubating adults defend their territories by pecking at intruders. However, pairs on territories before breeding, and roosting adults, do fly readily when disturbed, so Rolle's records probably refer to a non-laying period similar to that of 1973-74. Danforth (1931) found a breeding hiatus on Desecheo in May 1927. On 15 September 1972, Wiewandt (pers. comm.) found 22 nests (19 with eggs, 2 with naked chicks, 1 with a large downy chick) in a colony on Mona's north coast. The first egg must have been laid in the period mid-June to early July; most eggs were laid in August or September, while none (that survived) were laid from April to June, a pattern resembling the 1973 breeding season on Monito.

*June through August non-breeding seasons.* In 1969 laying peaked in March-April, when laying was at its lowest in 1973. If new clutches declined in 1969 as they did in 1973, then the distinct period without new clutches would have occurred in July-August. Beatty (Bond 1946) found "some 200 adults and a

few immature individuals" in August 1944, but did not report any nests with eggs, a pattern described for Mona Island in June–July 1926, July 1921, and August 1901 (Bowdish 1902, Struthers 1923, 1927), and for Desecheo in June 1912 (Wetmore 1918). On Mona, Wiewandt found that 14 pairs in a colony of about 25 pairs had eggs on 10 March 1975.

Brown Boobies in the Mona Passage have long egg-laying seasons each year, interspersed with short periods without eggs, probably 2 to 4 months long, when many adults leave the island, returning gradually to reestablish nest sites, court, and begin laying again. The availability of food, either locally or distant, probably determines when the new cycle begins or when the old cycle ends, within seasonal limits. More research is needed to explain variations in the timing of the laying peak, bimodal patterns, and late spring nestings (as in 1969), all factors that could account for the past absence of new clutches scattered in the months from March through August. The larger population in December also suggests that the "fall" breeding season is the major one, and that "spring" breeders could in part consist of birds whose first attempts had failed. In bad years, large re-nesting in the spring would result in the June–August hiatus, a good fall season could produce the March–May hiatus.

Brown Boobies normally lay two eggs and rear one chick. In 47 nests found with eggs, 35 (74%) held two eggs when found. We found 290 nests with chicks; all but three contained a single chick, and in those the second chick was less than one week old.

*West Indian distribution.* The Brown Booby is the most widely distributed sulid in the West Indies, breeding on small islands from the Bahamas south through the Greater and Lesser Antilles (Bond 1956). In Puerto Rico it breeds on Mona, Desecheo, La Cordillera E of Puerto Rico (pers. observ.) and on Cayos Geniqui E of Culebra (Kepler and Kepler, in press).

#### SULA SULA. RED-FOOTED BOOBY.

Permanent resident. Lays eggs in most months, from late June through April. The total breeding population varies widely, although 2000 to 3000 birds regularly roost on the island.

*Monito distribution.* Red-footed Boobies are found on Monito wherever there are trees and shrubs; they roost and nest primarily above 2 m in *Ficus citrifolia*. Some nests were found 1–2 m high in dense growths of *Caparis flexuosa* intertwined with *Pithecellobium*

*aculeata*. In June 1973 we found 163 active nests (Table 4), 126 (77%) of them in the forest on the leeward plateau, including its outlying trees. The other nests were in sheltered trees and shrubs on the rocky shelves of the north (6) and west (3) cliffs, the southeast point (17), or scattered elsewhere on the island (11). Most nest trees were adjacent to open areas, thus facilitating landing and takeoff; few nests occurred in the denser parts of the forest or in trees exposed to the full force of the northeast trades. The primary roosting areas were near or within nest trees. Although all areas were not thoroughly covered in December, the distribution was similar, with perhaps higher numbers using the shelves in the northern and western cliffs.

*Population.* Although only six nests were found in June 1969, and the colony was nearly deserted during the day, large numbers of birds roosted at night. We counted 398 adults arriving before dusk in three sample counts to determine the frequency of color morphs in the population, and easily 4 to 5 times that number arrived; the total population was roughly estimated at 2500 individuals. In three similar sample counts of arriving birds in June 1973, we counted 400 adults, suggesting a total population similar to that in 1969, although far more birds had nests (163) or held territories. In December 1973, we found 459 nests with eggs, chicks, or non-flying juveniles, 34 flying juveniles, and seven pairs on territories. We censused half the island, but covered areas that held 60% of the breeding birds in June. Thus we estimated 800 to 850 breeding pairs; including non-breeders, the total adult population would again range between 2000 and 3000 birds. The population appears to have remained stable between 1969 and 1974, even though the number of birds with eggs or chicks varied widely.

*Breeding season.* We described the contents of accessible Red-footed Booby nests in the same manner as for the other sulids. However, development is slightly different in this species: the approximate ages of young, given below, are based on descriptions in Verner (1961) and Palmer (1962) for Caribbean populations of this species.

1. Pair on territory—one or both members of a pair standing at or near stick-nest lacking egg. Nest-building precedes egg-laying by 11–35 days (Nelson 1969a).
2. Egg—adult incubating single egg (incubation takes 44 days).
3. Naked chick (45–53 days).
4. Downy chick (54–74 days).
5. Remiges—remiges and rectrices visible. Body



TABLE 4. Stages in the breeding cycle of the Red-footed Booby, Monito Island, 1969, 1973, and 1974.

Census date	Nest stage/Age in days from laying						Pair on territory
	Juvenile >150	Scapulars 111-150	Remiges 75-110	Downy 54-74	Naked 45-53	Eggs 0-45	
5-6 June 1969	0	1	4	1	0	0	—
19-20 June 1973	128 <sup>a</sup>	39	93	8	0	1	36
7-8 Dec. 1973	104 <sup>b</sup>	145	130	46	4	64	7
19-20 May 1974	mostly old chicks		—	—	0	0	—
10 Aug. 1974	0	0	0	0	0	50%	50%

<sup>a</sup> 106 flying.

<sup>b</sup> 34 flying.

still downy, contour feathers absent or thinly developed across back. Primaries (chord) of 34 Monito chicks measured 100-310 mm ( $\bar{x}$  = 220,  $\sigma$  = 59) (75-110 days).

6. "Scapulars"—extensive development of scapular feathers across back, contour feathers of entire body surface developing, but not completely in. Primaries of 25 Monito chicks measured 290-360 mm ( $\bar{x}$  = 321,  $\sigma$  = 19) (111-150 days).

7. Juvenal plumage—contour feathers nearly fully developed, traces of down clinging to head. May or may not fly with down on head. Primaries of two flying juveniles measured 360 mm (over 150 days).

The growth of Red-footed Booby chicks is sensitive to the available food supply (Nelson 1969a), so these age categories are approximate and assume that food supply was optimal. They also reflect only eggs that hatched, so extrapolations to the breeding phenology are made with caution, given that in bad years a majority of nests may fail during incubation (Nelson 1969a reported a 70% egg loss in a Galapagos colony).

The Monito Red-footed Boobies have an annual breeding season with major laying from mid-summer to fall (Fig. 8), and in the spring, with a short non-laying period from

mid-April through mid-June (Table 4). In 1969 few birds were breeding, but laying for those surviving chicks had centered in Feb.-March. The June 1973 data show the same peak far more dramatically, but again we were in a non-breeding period, with only one egg found in a thorough census of the island. However, 36 pairs were on territories, and a new breeding season was beginning. We saw many "V" flight-circuits, much stick-carrying, presentation of leaves, and active nest-building (see Nelson 1969b). The large number of active nests and flying juveniles (493) found in December 1973 indicated that laying had developed quickly in late June and July, after our departure, and carried on well into December, since we found 64 nests with eggs and seven pairs on territory. Breeding activity in summer-fall 1973 was the greatest we recorded during our five trips to the island. Sansom found mostly old chicks in 19-20 May 1974, but no eggs or naked young, and Wiewandt found no older chicks in August 1974, but noted that half the breeding birds had eggs, the other half had territories. These observations again indicate a breeding hiatus from April through June.

Other data from the area fit this pattern. Rolle et al. (1964) found only small groups of Red-footed Boobies on Monito in May 1963. In a large (>3000 birds) colony on Mona Island, Raffaele (1973) reported 500-700 nests in all stages in December 1971, but only 10-15 nests and 10 adults carrying sticks in July 1972. In the same colony Wiewandt (pers. comm.) found 500+ nests with eggs or naked chicks on 15 September 1972, eggs but no young on 12 July 1973, and mostly eggs, with a few large chicks, on 10 March 1975; these observations all indicate a breeding season substantially the same as that on Monito in 1973 (Fig. 8). Other Caribbean data (Verner 1961) suggest that on Half Moon Cay, Belize, these boobies lay from November to April.

*Color morphs.* There are two major Red-footed Booby color morphs, brown and white, and their proportions vary widely from colony

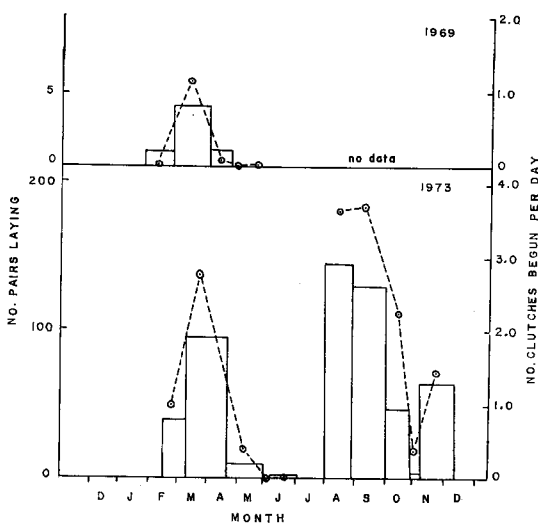


FIGURE 8. Breeding phenology of the Red-footed Booby, Monito Island.

to colony. White morphs are the less variable of the two; typically, and on Monito, adults are white, with black primaries and secondaries. Brown morphs range from entirely brown, as in the Galapagos (Nelson 1969b), to brown and white, the extent and pattern of white varying among and within colonies. The "typical" brown morph on Monito is light brown on the head, neck, breast, belly, flanks, and thighs, slightly darker brown on the wings and back, and white on the tail, upper and under tail coverts, and vent. However, the white on some brown morphs extends forward to the interscapulars dorsally, and the mid-belly ventrally; in these birds the thighs and intervening flanks are also white. In breeding adults of both morphs the feet are bright red, the bill and orbital skin pale blue, and the base of the bill pink. Sub-adults are entirely dark brown with dark bills, and are easily told from brown morph adults under most field conditions. The function of these plumages is not understood, although it has been the subject of much speculation (Nelson 1968); like Nelson, we saw both morphs returning to the island late at night. We found a brown-to-white ratio of 4:1 while counting returning adult Red-footed Boobies at three locations prior to dusk in June 1969 and June 1973 (Table 5).

*Oiled feathers.* The Mona Passage is heavily used by ships passing to and from the Panama Canal, and by oil tankers passing between Venezuela and the U.S., so we were interested in possible pollution of nearby waters. We found three oiled Red-footed Boobies in 1969 and four in June 1973. Heavily-oiled birds, however, could never fly back to the colony. Wiewandt (pers. comm.) has seen many oiled boobies on Mona's southern coast, and an oiled Blue-faced Booby on Monito.

*West Indian distribution.* The Red-footed Booby nests on a few scattered islands from Little Swan Island in the west to two islets in the Grenadines, although it is far less common than the Brown Booby, and is known from fewer than 12 islands (Bond 1956) within this range.

In Puerto Rico, the Red-footed Booby breeds only on Monito, Mona and Desecheo. On the latter island introduced rhesus macaques (*Macaca mulatta*) have been observed disrupting the colony, and it may not survive unless the monkey colony is removed.

*FREGATA MAGNIFICENS.* MAGNIFICENT FRIGATEBIRD.

Permanent resident. Although some pairs

TABLE 5. Proportion of white and brown morph adult Red-footed Boobies on Monito Island.

Date	Color phase				Total
	Brown		White		
	no.	%	no.	%	
5 June 1969	314	78.9	84	21.1	398
19 June 1973	326	81.5	74	18.5	400
Total	640	80.2	158	19.8	798

have eggs or chicks through the year, the laying peak from late October to early December is highly synchronous. The resident population numbers between 350 and 400 pairs.

*Monito distribution.* The entire frigatebird colony is on the leeward side of the island. It extends from the inner edge of the trees on the southwest point roughly 250 m north-eastward, bordering the northern edge of the forest and terminates abruptly under the lee side of several limestone escarpments near the center of the island. Most nests are placed between 0.5 and 2 m high in low shrubs (*Capparis flexuosa*) adjacent to or detached from the forest edge. Every suitable shrub contains several nests, each about frigatebird-stabbing distance from its neighbor. Several groups of birds nest in shrubs in clearings where the forest thins out near the southwest point. All nest sites have a low profile and an open area nearby. As Diamond (1973) found in Barbuda (*F. magnificens*) and Aldabra (*F. minor* and *F. ariel*), nests were in sheltered areas away from the full force of trade-winds, although light breezes are characteristic of all sites. Relatively windless areas within the forest were not used.

*Population.* We found 237 nests and an additional 115 courting males in December 1973, near the beginning of the breeding season, when the largest number of birds would be in the colony. We found fewer birds on other visits (Table 6), although we saw 251 active nests in June 1969, and 150 in June 1973; many birds had undoubtedly abandoned their nests and left the island. The maximum population probably exceeded only slightly the numbers counted in December 1973; we estimate that it lies between 350 and 400 breeding pairs.

*Breeding season.* Because the colony was compact, we could census all nests on the first three trips to the island (Table 6). We were careful to avoid disturbing the birds because of their known tendency to destroy unattended nests. All birds sitting tightly were

TABLE 6. Stages in the breeding cycle of the Magnificent Frigatebird, Monito Island, 1969, 1973, and 1974.

Census date	Nest stage/Age in days from laying						
	Flying juvenile >230	Juvenile 190-230	Remiges 101-189	Scapulars 76-100	Downy 61-75	Naked 50-60	Eggs 0-50
5-6 June 1969	-	206	20	19	3	3	0
19-20 June 1973	-	133	3	2	8	0	0
7-8 Dec. 1973	3	0	0	0	0	0	234
19-20 May 1974	11	32	1	5	2	1	1
10 Aug. 1974	-	4	0	0	0	0	0

assumed to have eggs, and we approached nests only if older, unattended young were present. Often incubating adults rose slightly off their nests, and we could determine the developmental stage with binoculars. Information on the development of young is from Stonehouse and Stonehouse (1963) for *F. aquila*, and we have followed Diamond (1973) in estimating an incubation period of 50 days for this species. Each nest was tallied in one of the following stages:

1. Eggs—adult incubating single egg, or in incubating position and very reluctant to move from the nest (incubation takes 50 days).
2. Naked chick (50-60 days).
3. Downy chick—white down with no contour feathers (61-75 days).
4. "Scapulars"—dorsal and/or scapular feathers visible, no flight feathers (76-100 days).
5. Primaries—primary, secondary, or tail feathers erupting, scapular mantle expanding, body downy (101-189 days).
6. White-head—essentially complete juvenal plumage, no down on head, bird flightless or reluctant to fly (190-230 days).

Our censuses reveal a highly synchronous annual breeding season on Monito, with a well-defined laying peak from late October to mid-December (Fig. 9). Some eggs are laid through April, a six-month period, but these late nests are a small percentage of the total. In 1969, the November nests represented 82% of those found; in June 1973, 91%. In December 1973, all 234 nests had been started within 50 days of our visit (possibly much less), and an additional 115 males were courting, their throat-pouches fully inflated. Nelson (1970) found a nearly identical situation for two populations of *F. minor* on Tower Island, Galapagos: a six-month laying season, with 65% to 90% of all eggs laid within two months. In June 1969 and June 1973, we found 206 and 133 white-headed juveniles, respectively, no eggs, three naked chicks (1969), and no courting birds. In December all nests, representing an estimated 60-70% of the total population, had eggs, and the court-

ing males provided a constant audible and visible backdrop to the incubating birds.

Beatty (Bond 1946) found 20 white-headed juveniles on Monito in August 1944 who originated from mid-winter nests (Dec.-Jan.). Most young produced in a November peak would have fledged, which suggests that the breeding season has been stable on Monito for 30 years. It is significant that the median laying date found in the large Barbuda colony (2500 pairs) was late November-early December (Diamond 1973), indicating breeding synchrony between these two West Indian colonies. Early information from Desecheo (Wetmore 1918, Palmer 1962) also suggests a winter breeding season.

*West Indian distribution.* Colonies are found throughout the West Indies, from the Bahamas and Cuba south and east to the Grenadines. However, frigatebirds are very susceptible to human disturbance, and colonies in Puerto Rico have disappeared from La Parguera (due to boating activities) and Mona; they may not survive on Desecheo because of the monkeys. The Monito colony is thus the only viable population breeding in Puerto Rican waters.

#### LARUS ATRICILLA. LAUGHING GULL.

Summer resident. We found small numbers in May and June, none in August or December. The largest population (June 1973) was eight to ten pairs.

Laughing Gulls are restricted to the plateau, where they perch conspicuously on prominent limestone outcrops, or circle overhead. Two nests in June 1969 (one egg each) and one in May 1974 (two eggs) were in open areas of the plateau, adjacent to grass or low shrubs. They were loose cups of dried grasses and twigs (Fig. 10). The Monito birds lay at the same time of year as those in North American colonies (Dinsmore and Schreiber 1974), colonies on Desecheo Island (pers. observ.), and cays off Culebra (Sorrie 1975, Kepler and Kepler, in press).

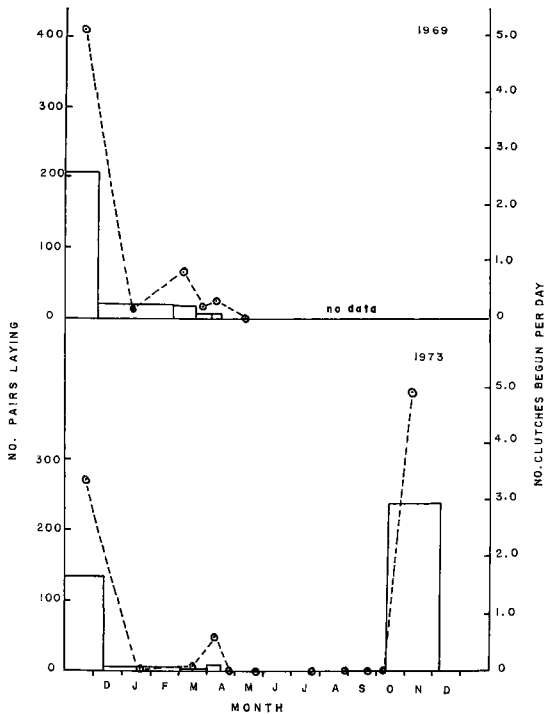


FIGURE 9. Breeding phenology of the Magnificent Frigatebird, Monito Island.

These Monito nests are the first breeding records for Puerto Rico (Danforth 1936, Biaggi 1970, Raffaele 1973). Leopold (1963) stated that Laughing Gulls "breed on small offshore islets," a statement we found to be true, although neither is substantiated in the literature (although assumed) nor documented by Leopold. This species is a common summer breeder throughout the West Indies, and regularly occurs in coastal Puerto Rico and its offshore islands from March to September (McCandless 1958, pers. observ.).

#### *STERNA ANAETHETUS*. BRIDLED TERN.

Probable summer resident. Bridled Terns were seen flying along or above the windward cliffs only on summer visits to Monito. On 5 June 1969 about 50 birds flew in the channel between Mona and Monito, and several pairs soared above the Monito cliffs. We saw only two in May 1974. In June 1973, between 15 and 20 birds flew regularly below North Point, and the Snyders saw several landing out of sight within inaccessible caves on the cliff face.

Bridled Terns are common summer residents on nearby Mona (Bowdish 1902, Barnes 1946), and breed in cliffs near Arecibo on the northern coast of Puerto Rico, in La Cordillera off Fajardo, NE Puerto Rico, and on several



FIGURE 10. Laughing Gull nest, Monito Island, 6 June 1969.

islets in the Culebra group (pers. observ.). They probably nest in small numbers on Monito.

#### *STERNA FUSCATA*. SOOTY TERN.

Spring-summer resident. The population is roughly estimated at 1500 to 3000 pairs.

*Monito distribution.* Sooty Terns nest in a single compact colony on the western edge of the elevated northern "highlands" (Figs. 3 and 4) in the area of open limestone with scattered bunches of grass; many birds also nest under adjacent vegetation. Each year breeding activities spread over the same amorphous area, that in 1973 measured 58 m × 46 m, and covered about 1675 m<sup>2</sup>.

*Population.* Estimating numbers of breeding Sooty Terns is notoriously difficult (Robertson 1964) unless accurate plot-counts of eggs are made and the colony area is known. Unfortunately our visits occurred when the colony was either empty (December) or filled with mobile chicks (June), so no accurate counts could be made. Although we found very few young in June 1973, the colony dimensions were clear and were measured. Ashmole (1963) found an average of about 45 eggs per 25 yd<sup>2</sup> (20.9 m<sup>2</sup>) in colonies at Ascension Island, although there was a tremendous range in density (less than 10 to more than 120 nests per 25 yd<sup>2</sup>). Robertson (1964) reported similar densities from the Dry Tortugas. We measured Sooty Tern densities in a large but dispersed colony on Peninsula Flamenco, Culebra (65,100 pairs), and numbers ranged from 1.9 to 20.25 eggs per 25 yd<sup>2</sup>, considerably less dense than Ascension colonies. The densest part of the Culebra colony appeared comparable to bird densities on Monito, thus we roughly esti-

mated that 20 pairs nested per 25 yd<sup>2</sup>, for about 1600 nests on Monito in June 1973. Raffaele thought that incubating Sooty Terns in May 1974 covered twice as much area as in 1973, so as many as 3000 pairs may have laid eggs. The population is thus small and sparse compared to those in other areas, and 1500 to 3000 pairs is probably close to actuality. The colony is clearly far smaller than in the past, when Percy (1607), obviously referring to this species, wrote of his climb to Monito's plateau on 9 April 1607: "After wee got to the top of the Ile, wee found it to bee a fertill and plaine ground, full of goodly grasse, and abundance of Fowles of all kindes. They flew ouer our heads as thicke as drops of Ha[i]le. Besides they made such a noise, that wee were not able to heare one another speake. Furthermore, wee were not able to set our feet on the ground, but either on Fowles or Egges which lay so thicke in the grasse. Wee laded two Boats full in the space of three houres, to our great refreshing."

*Breeding season.* Sooty Terns in Puerto Rican waters breed from late spring to early summer. Struthers (1927) found young on Mona from 23 June to 18 July 1926. We observed only eggs in May 1974, only young in June 1969 and 1973, and no birds in August 1974 or December 1973. Incubation averages 29 days and fledging 6–8 weeks (Ashmole 1963, Dinsmore 1972). Our June chicks were in juvenal plumage, but flightless, and less than 1 month old. Thus the laying period during our three years was in April, consistent with Percy's (1607) April egg records and Struthers' (1927) Mona chick records, but about four to six weeks ahead of Sooty Tern colonies from Culebra, 275 km E (Kepler and Kepler, in press).

Although rats (*Rattus rattus*) are numerous on Monito, we saw no signs of predation in the colony (Austin 1948). Raffaele watched incubating birds from 20:10 to 20:45 on 19 May 1974, and although he saw two rats on the periphery of the colony, no predation was observed. Rats ran from terns defending their nests. We had the distinct impression on both June trips that there were far too few chicks for the number of adults. Therefore, we suspect that substantial mortality may occur, possibly from frigatebirds in the adjacent colony (see Ashmole 1963) or from stormy weather when the chicks are less than two weeks old. Robertson (pers. comm.) has found mortality of tern chicks during bad weather in the Tortugas.

*West Indian distribution.* Sooty Terns nest virtually throughout the West Indies (Bond

1946). Elsewhere in Puerto Rico they nest on Mona, Culebra and four of its offshore islands, and several islets in La Cordillera, east of Puerto Rico (pers. observ.). This is the first recent breeding record for Monito.

#### ANOUS STOLIDUS. BROWN NODDY.

Spring–summer resident, with a protracted breeding season extending at least from April through August. The breeding population is probably 100± pairs.

Brown Noddies nested very sparsely in small pockets or depressions on the steep cliffs on all sides of the island. We found none nesting on the plateau, the flat shelves, or in trees or shrubs, a distribution perhaps resulting from rat predation. The largest number found on any visit was 4 nests in June 1973, one with an egg, two each with a downy chick, and one with a juvenile about to fledge; another pair was on territory without eggs or young. We found two nests with eggs in June 1969. Noddies were not present in December 1973. Incubation takes 35 to 37 days (Bent 1921), and fledging 42 days (Dorward and Ashmole 1963), so the 1973 breeding season extended at least from April through August. It was impossible to estimate numbers, as nest sites were generally inaccessible, and numerous cliff pockets could have hidden dozens of pairs. In June 1973 we saw at least 12 birds below the northwest point. We estimate that 100 pairs breed.

The Brown Noddy is one of the most widespread breeding species in the West Indies. In Puerto Rico it nests from the islands of the Mona Passage through La Cordillera, and on eight islands in the Culebra group (pers. observ.).

#### DISCUSSION

Monito Island harbors the most diverse colony of nesting sea birds in Puerto Rico and the U.S. Virgin Islands. One of the outstanding colonies in the West Indies, it possesses 50% (nine) of all breeding species in the region (Table 7). It is the only Puerto Rican island supporting all three West Indian boobies and the Magnificent Frigatebird, and is the last stronghold of the latter species in Puerto Rico. This diversity depends upon the island's unique combination of isolation, inaccessibility, and habitat diversity.

Each of the nine species has different reproductive requirements, thus there is little competition for nest sites. Two species nest in trees, the Red-footed Booby primarily in *Ficus citrifolia* normally above 2 m in height,

TABLE 7. The breeding sea birds of Monito Island, Puerto Rico.

Species	Estimated breeding population (pairs)	Breeding season (eggs)
White-tailed Tropicbird <sup>a</sup>	<5 (?)	Spring-Summer (?)
Blue-faced Booby	50-60	September-May
Brown Booby	500	Variable, Fall-Spring
Red-footed Booby	1000	July-May
Magnificent Frigatebird	350-400	October-December
Laughing Gull	8-10	April-May
Bridled Tern <sup>a</sup>	<50 (?)	Summer (?)
Sooty Tern	1500-3000	April-May
Brown Noddy	100	April-July

<sup>a</sup> Breeding probable, but not verified.

and the Magnificent Frigatebird in *Capparis flexuosa*, usually below 2 m. Red-footed Boobies are found throughout the island wherever their preferred trees occur away from the denser parts of the forest. Frigatebirds are restricted to a narrow belt of vegetation north of the forest, in the lee of the eastern cliffs, and appear to depend upon reduced wind speed (Fig. 4). The two ground-nesting boobies are generally separated by habitat: Blue-faced Boobies occur sparingly on cliff tops exposed to nearly constant winds, while Brown Boobies select almost all other flat areas, and are perhaps excluded from windy cliff tops by their larger congener. Two larids appear to nest exclusively on the plateau. Sooty Terns are concentrated on and adjacent to an open, partially grassy clearing on the elevated northern highlands, while in contrast, Laughing Gull nests are dispersed widely on other open areas of the plateau. Four species use or may use the cliffs as breeding sites: Brown Boobies occupy the larger shelves and caves, while Brown Noddies nest on the smallest pockets within the cliff face. Neither the Bridled Tern nor the White-tailed Tropicbird is known to breed on Monito, but their preferred nest sites on other islands differ from the other species on Monito, the tropicbird choosing narrow cliff holes or small crevices in caves, and the Bridled Tern favoring flat pockets on the cliffs.

The three resident boobies all laid during the cooler months, and during this study showed the greatest laying effort in the fall, the wettest season. Although some boobies nested in each month, there was a distinct, although short, non-laying season each year at Monito, and they appeared to have annual cycles, in contrast to some tropical colonies elsewhere. Heavy spring laying (e.g. Brown Boobies in 1969) may result from nest failure the preceding fall. The Magnificent Frigatebird lays primarily in the wet fall months, and laying is highly synchronous.

In contrast to the permanent residents, the four larids breed in late spring and early summer, essentially having left the island when egg-laying by the pelecaniforms reaches a peak. A study of the population dynamics and availability of the various prey fish in the Mona Passage would likely help explain the breeding phenology of these species.

Monito Island has not received the protection it deserves. It has been bombed by the U.S. Air Force, and was recently considered as an aerial bomb target by the U.S. Navy. Although Monito has been preserved largely because of its isolation and difficult access, increasing numbers of tourists now visit Mona, and disturb both islands, particularly when they circle them in low-flying aircraft. Monito must be declared and protected as a wildlife reserve if it is to continue as one of the most outstanding sea bird colonies in the West Indies.

#### SUMMARY

Monito Island, a 15-ha plateau surrounded by steep undercut cliffs, lies halfway between Puerto Rico and the Dominican Republic. Seven of the nine sea birds are known to breed, and two (Blue-faced Booby and Laughing Gull) are here recorded as breeders in Puerto Rico for the first time.

The Pelecaniformes are represented by five species, the White-tailed Tropicbird, the three pan-tropical boobies, and the Magnificent Frigatebird. The boobies all have long but annual breeding seasons, from fall through spring, showing a distinct breeding hiatus in the hot summer months, although some later-nesters may care for chicks during this period. The Magnificent Frigatebird has the most synchronous breeding, with a laying peak from late October to early December, when 70% of the population lays eggs. Four larids (Laughing Gull, Bridled Tern, Sooty Tern,

and Brown Noddy) are summer residents vacating the island in August–September, and returning again in March–April. In general, they nest during the pelecaniform non-breeding season.

The sea birds show a great range in nest site preference, with little overlap among them. Their diversity results from a combination of isolation, rugged cliffs, and the structural diversity of Monito Island. Although currently one of the outstanding sea bird colonies in the West Indies, Monito is threatened, and the colonies could be lost unless they are legally protected.

#### ACKNOWLEDGMENTS

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