CHAPTER 2

DIABLOTIN (*PTERODROMA HASITATA*): A BIOGRAPHY OF THE ENDANGERED BLACK-CAPPED PETREL

David S. Lee and J. Christopher Haney

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ABSTRACT

The Black-capped Petrel (*Pterodroma hasitata*) is the only extant gadfly petrel known to breed in the wider West Indies region. Now seriously threatened or endangered, current breeding populations occur on only one, possibly two, of the six islands mentioned historically as breeding sites. Earlier accounts of breeding on Cuba apparently resulted from erroneous assumptions that birds observed at sea just offshore of that island were local breeders. A related form (probably full species) once bred but is now apparently extinct on Jamaica. Breeding populations on the large island of Hispaniola (Dominican Republic and Haiti) are small, fragmented, and currently believed to be declining, although the exact sizes, locations, and detailed chronologies of all petrel breeding colonies remain poorly-studied. Nesting sites are limited to cliff faces in open-canopy highland forest, but in the past the species may have used open sites maintained by fires, hurricanes, earthquakes, and volcanism. In addition to direct exploitation by colonists in previous centuries and recent declines in breeding habitat due to deforestation, introduced predators (mongoose, feral cats, dogs, and pigs, opposums) may have played a role in the species' decline. Presently, there is insufficient information available for ascertaining population and morphological variation, or genetic differentiation, of Black-capped Petrels. Unlike the majority of currently-threatened seabird species, considerably more is known about the petrel's marine ecology than its breeding biology. The Gulf Stream current system is a principal factor influencing the marine distribution of Black-capped Petrels: the primary foraging

range of the species is waters offshore of the southeastern United States between Cape Canaveral, Florida and Cape Hatteras, North Carolina. Populations at sea are at risk from anticipated exploration and development of offshore oil and gas resources. Black-capped Petrel tissue from North Carolina has the highest mercury concentrations of any seabird species tested in that region. As conservation measures, we recommend that 1) this species be considered for protection under the Endangered Species Act by the U.S. Fish and Wildlife Service, 2) genetic studies be initiated so that genetic variability of the species can be determined, 3) one or more long-term monitoring sites be designated at breeding colonies, 4) satellite imagery be used to ascertain the amount of suitable breeding habitat remaining in Caribbean mountain forests, and 5) attempts be made to use remote sensing methods (e.g., bioacoustic tomogaphy) for counting breeding populations of this secretive, nocturnal species.

INTRODUCTION

The Black-capped Petrel (*Pterodroma hasitata*) is the only gadfly petrel (Procellariidae) known to still breed in the West Indies. Once thought to be extinct, the species is extant on only one, possibly two, of the five islands upon which breeding was documented historically. Breeding populations are small, fragmented, and currently believed to be declining, although the exact sizes, locations, and chronologies of petrel breeding colonies are poorly known. Nesting sites appear to be currently tied to open canopy habitats on cliff faces, but in the past the species may have used less precipitous sites. This petrel has been observed infrequently during the last century. It was not until the late 1970s that the primary foraging range of the Black-capped Petrel was recognized as the offshore zones of the southeastern United States. The Gulf Stream current system is thought to be a principal factor influencing the marine distribution of this seabird.

The Jamaican Petrel, *Pterodroma* (*h*.) *caribbeae*, was historically considered a race of the Black-capped Petrel endemic to Jamaica. Although most authors now regard it as a distinct species, we also summarize what is known about this taxon.

Sub-fossil and bone remains of *Pterodroma* which are established as, or believed to be, *hasitata* are known from Haiti (FSM uncatalogued), Martinique (USNM 428289 Wetmore 1952), St. Croix in the Virgin Islands (USNM 225842, Wetmore 1918) and Crooked Island in the Bahamas (Wetmore 1938; originally given as *P. cahow* but Storrs Olson [pers. comm.], based on size and geographic probability, believes that this series represents in part *P. hasitata*). *P. cahow* is also known from pre-Columbian middens on Crooked Island. The Florida State Museum has numerous sub-fossil *P. hasitata* from at least four different caves in Haiti. All sites are from the southern peninsula, several of the caves are deep sink holes. Although none of the material collected from these caves has been radio carbon dated, the faunal assemblage suggests a late Pleistocene age to recent (David Steadman, pers. comm.).

SYSTEMATICS

The genus *Pterodroma* comprises approximately 30 widely-distributed species (Bourne 1972, Jouanin and Mougin 1979, Imber 1985). All are believed to be highly pelagic and fundamentally nocturnal. After fledging, the birds probably spend at least 4-6 years at sea prior to returning to nesting islands

Before the mid-1800s, gadfly petrels were placed in the genus *Procellaria*. In 1856, Bonaparte proposed the genus *Pterodroma* (Greek for 'winged runner', or 'fast on the wing') for the all dark species, and *Aestrelata* for some of the ventrally-white forms such as *hasitata* (designated as the type for this genus by Coues 1866). Imber (1985) provided a thorough recent review of the taxonomy of the gadfly petrels.

In the original description of the Black-capped Petrel, Kuhl (1820) chose the specific name *hasitata*. The origin of this name is from the Latin 'haesito,' which means to be perplexed and is the root of the English word hesitate, indicating the uncertainty Kuhl had concerning the recognition of this species. This is a fitting name considering the lack of agreement on the taxonomic relationships of the Black-capped Petrel, uncertainty that continues to some extent to this day.

Lawrence (1853), for example, assigned *hasitata* to a specimen of *Procellaria cinereus* from the Nicolas Pike collection. For many years, this specimen was regarded as the only justification for the occurrence of the Grey Petrel in North America. (Re-examination of the bird, as well as several other specimens and their accompanying labels from off Monterey California, indicates that the locality information was almost certainly in error.) The correct identification of the 'California' *P. cinereus* (AMNH 45967) was provided by Coues, but see Lawrence (1853) for an appreciation of the taxonomic confusion surrounding *hasitata* in the mid-1800s.

Murphy (1936) considered *phaeopygia*, *externa*, *cahow*, and *hasitata* to be of close affinity. Palmer (1962) considered many forms of *Pterodroma* to be a subspecies of *hasitata*. These include not only *caribbaea* (see below) and *cahow* of the North Atlantic, but four Pacific birds that get progressively larger and grayer with a reduction in dark pigmentation from north to south. These include *sandwichensis* of Hawaii, *phaeopygia* of the Galapagos, *cervicalis* from the Kermadec Islands, and the large *externa* breeding on the Juan Fernandez islands. Imber (1985) placed *P. hasitata* in the subgenus *Pterodroma*, one of four subgenera. The eleven members of this subgenus include the largest in size, have the deepest, strongest bills, and have helicoidal intestines with 93-100% counterclockwise twist. (Seven, including *hasitata*, are winter breeders.) The intestinal structure of *P. hasitata* is virtually identical to that of *incerta* which may be a sibling species of *lessonii* (Murphy and Pennoyer 1952).

Imber (1985) notes that the North Atlantic may have been colonized twice by *Pterodroma*, once by summer breeding species, and once by winter breeding ones (*hasitata, cahow*). Several authors (e.g., Palmer 1962) have stated that the Bermuda Petrel *P. cahow* is a form of *hasitata*. Helicoidal twist counts of intestines indicate that the Black-capped Petrel and the Bermuda Petrel are clearly distinct (Imber 1985).

Timmermann (1965) noted that there were two very distinct species-groups of *Halipeurus* (Mallophaga) on gadfly petrels. Accordingly, he considered *Pterodroma* to be polyphyletic and proposed classifying gadfly petrels into two genera - *Pterodroma* for those hosting '*procellariae*' group lice and *Aestrelata* for those hosting '*marquesanus*' group lice (see discussion below).

We point out these studies primarily to illustrate that the systematics of gadfly petrels have been unclear even at the generic level. For the Black-capped Petrel, similar uncertainty exists. Preliminary electrophoretic studies on *Pterodroma hasitata* ($n = 7$) collected off North Carolina do not have clear cut differences, although one specimen exhibited slight frequency differences (J. Gerwin, pers. comm.). Electrophoresis, however, will probably be of little value below the generic level (Buth 1984), and we do not expect that additional electrophoretic data will contribute much information to our understanding of *hasitata*.

Examination of skins reveals considerable variation in size and coloration, and historical accounts describe two types of petrels nesting on Guadeloupe (see below). All of these sources of information indicate the need for detailed systematic review. Unfortunately, limited museum material and the loss of key specimens in European museums during World War II make such an undertaking difficult and probably inconclusive. Type specimens appear to be lacking. Recent wildlife laws make importation of birds through museum loans time-consuming. Delays and inspections by customs agents makes it unlikely that curators will allow overseas loans of rare bird specimens in the future. The widely scattered museum specimens (see Appendix I) would

make visitation to museums housing small numbers of specimens of *Pterodroma hasitata* quite costly. The rarity of many species makes collection of specimens for DNA analysis unwise.

A dark form, *Pterodroma caribbaea* (now considered a separate species; Imber 1985), bred in the Blue Mountains of Jamaica where at least 26 specimens were obtained between 1825 and 1879 (Benson 1972; Bourne 1965). The few measurements available show this form to be smaller than *P. hasitata*. Murphy (1936) assessed the relationship of the bird as follows:

> The question has arisen many times as to the relationship of the Diablotin to the black petrel or 'Blue Mountain Duck' (*Pterodroma caribbaea*) of Jamaica. It has been pointed out by Loomis (1918) and others that *hasitata* and *caribbaea* may represent dichromatic phases of the same species, a condition familiar enough among petrels of this group. Dr. G. K. Noble has informed me that the two specimens of the Diablotin preserved in the museum at Guadeloupe are both light-colored, black-capped birds. Pere Labat's observations were, however, made at this island, and Bangs and Penard (1919) have called attention to the fact that Labat's plate and text both refer to a bird of uniformly dark plumage. But only a quarter of a century before Father Labat's visit to Guadeloupe, du Tertre (1667), who had visited that island and apparently had witnessed the hunting and tasted the delicate flesh of the petrels, states with all clearness that the plumage of the birds was "a mixed black and white." A still further taxonomic complication is introduced by information advanced by Lafresnaye (1844) and Noble (1916), namely, that two different sorts of closely related white-breasted petrels formerly bred at Guadeloupe, the respective birds coming to nest at different seasons, and choosing quite different altitudes on the island for the sites of their colonies. Lafresnaye states that the inhabitants distinguished one as the 'high petrel,' the other as the 'low petrel,' and that the two kinds were of different sizes. Although such a distinction is not currently recognized, there seems to be a wide range in the dimensions of existing specimens of the Black-capped Petrel, and it is unlikely that the last word upon the subject has been said.

Returning to the question of identity of the dark, Jamaican Petrel, Murphy (1936) went on to state: "I consider it highly probable that this bird and the Black-capped were color phases of the same species." Complete or prevailing segregation of two phases in distinct though adjacent breeding grounds is a phenomenon known among other Procellariiformes, such as *Pterodroma neglecta* and *Puffinus pacificus*. It is likely that even in a single locality there is also a secular succession or alternation of prevailing plumage-types, as one genetic factor or another gains ascendancy in a breeding population. This might explain why du Tertre found white-breasted

Diablotins at Guadeloupe during one generation, and Labat black petrels in a subsequent period. It is likely furthermore, that the probably dichromatic petrel discussed in this biography was abundant and widespread in the West Indies, becoming exterminated in most places soon after the importation of large numbers of negro slaves and domestic animals. Our only knowledge of the dark phase, aside from the figures and text of Labat, is based upon the Jamaican representative, commonly known as *Pterodroma caribbaea*. M. J. Imber (pers. comm.) believes that *caribbaea* is a distinct species most closely related to *P. feae* of the North Atlantic. The second type of Diablotin on Guadeloupe may have been nesting Audubon's Shearwaters, *Puffinus lherminieri*. The name Diablotin was also used for it (see below).

All specimens obtained in North America are of *hasitata* (i.e., the nominate form), but considerable variations in size and markings (Lee 1984) suggest that birds occurring off North Carolina may be from several geographically distinguishable populations. No dark forms (*caribbaea*) were ever noted in the multi-year studies of Lee or Haney conducted off the southeastern United States. The type locality of *hasitata* was never stated and has since been designated as Dominica. No detailed comparisons of recent specimens obtained at sea to the birds collected from nesting colonies have yet been made.

The Black-capped Petrel is known by several other names throughout the West Indies. In North America and in the English-speaking islands, it also goes by 'Capped Petrel' and 'West Indian Petrel.' The all-dark *caribbaea* race has been called the 'Jamaican Petrel,' and the bird was also known as the 'dry land booby' and 'Blue Mountain duck' on that island. In the creole-, French-, and Spanish-speaking islands, the bird is usually referred to as 'diablotin,' or more rarely 'diablotine.' Translated into English, 'diablotin' means little devil, a name also used occasionally for Audubon's Shearwater (*Puffinus lherminieri*). This name spread throughout the Greater and Lesser Antillies as agriculture expanded and slaves were traded throughout the region. In Haiti,

and possibly other islands where French is spoken, 'chathuant' is also used. This common name is frequently used for other nocturnal birds, including owls and caprimulgids. In Cuba, the bird is known as 'bruja' or witch. In historical times, young birds savored for eating were referred to as 'cottons,' the name obviously referring to their down feathers.

DESCRIPTION

The original description by Kuhl (1820) is quite vague. It is reprinted here in its entirety:

> 11. *Proc. hasitata* Forster.
> Forster tab. 97.
> --- tab. 98, sub nomine *Procellariae leucocephalae*.
> c) Cauda cuneiformi.
> 2. Remige primo longissimo.
> Unguibus falculatis, altitudine latitudinem superanti. Hallu-
> ce mediocri.
> Alis caudam aequantibus, a flexura ad apicem usque 11 1/8 poll. longis. Cauda cuneiformi, acuta, 6 poll. longa; rostro robustiori, valde deflexo, ab angulo oris ad apicem 19 lin. longo. Pedibus humilibus, tarsis 17 lin., digito medio 25 lin. longis. --- Longitudo corporis 16 1/3 poll. --- Alba sunt: latus inferius, frons, facies, nucha caudaeque tectrices superiores et inferiores. Brunescente-ni-gra sunt: alae, cauda, dorsum, uropygium et vertex me-dius, interscapulium autem brunescente-cinereum. Rostro et membranae natatoriae parte antica nigris, pedum parte reliqua flava.
> In Museo Bullokiano, nuc in Temminkiano.

Black-capped Petrels encountered off the southeastern U.S. coast display remarkable variation in size and markings. This variation is not related to age, sex, or molt sequence (Lee unpubl. data). Based on the study of a substantial series of specimens, it is apparent that Black-capped Petrels are extremely polymorphic or that the birds off the North Carolina coast are possibly recruited from a number of distinct breeding populations. Black-capped Petrels range from large (590+ g) birds with classic black caps, wide, distinctive collars, and conspicuous white "rump" patches to ones of 300 g with reduced areas of white. Thus, the smallest and darkest would approach a Bermuda Petrel in both size and, from a distance, in appearance.

HISTORICAL AND RECENT DISTRIBUTIONS OF NESTING POPULATIONS

It is worthwhile to examine the current distribution of breeding Black-capped Petrels in view of Antillean geological and biogeographical interpretations. Like most *Pterodroma*, nesting populations of *P. hasitata* are along the edges of oceanic fault plates. The species is not only endemic to the Caribbean, but nesting colonies are confined to islands on the northern and eastern edge of the Caribbean plate, Jamaica being the exception. Earlier schools of thought regarding Caribbean insular biogeography emphasized land-bridges (Spencer 1895, Barbour 1916, Rivas 1958, 1986). This hypothesis was rejected by Briggs (1984, 1987), and more recently by Burgess and Franz (1989), because of the lack of confirmatory geologic evidence. In addition, the minimal exchange of species between the islands and the mainland suggests that had a land bridge existed, its life span would have been improbably short. Briggs (1984, 1987) believed terrestrial organisms were dispersed by fortuitous sea transport over long periods of time. Current plate-tectonic theory suggests that migrating islands, in some cases with nearly intact biotas, were primarily responsible for much of the current biogeographic assemblage in the Antillean region. Burgess and Franz (1989) illustrated that certain large islands (Cuba and northern Hispaniola) were sufficiently well-emerged during the Tertiary to have accepted and retained biotic elements. These in turn provided the stock and dispersal routes for subsequent colonization and recolonization of the smaller islands that emerged or re-emerged at later times.

The role of plate tectonics in the Caribbean was first presented by Malfait and Dinkelman (1972) and Redford (1974) with a number of subsequent studies. Although the exact sequence and timing of the placement of land masses is not clear, the consensus of opinion is summarized by Burgess and Franz (1989):

> The Greater Antilles arose in the area currently occupied by lower Central America, either attached to the continental land mass or (more likely) as a series of subduction-derived islands. Cuba, Puerto Rico and northern Hispaniola are the oldest permanently exposed insular land masses; Jamaica and southern Hispaniola are younger in age (relative to continuous land emergence).

Subsequent eastward and northeastward movements brought these islands to their current positions. Southern Hispaniola, of independent origin from northern Hispaniola, has collided with northern Hispaniola (which may itself represent the merger of two islands of similar origin and geologic history).

Eustatic sea level changes and localized uplift and subsidence have greatly influenced the relative vertical positions of the islands. Jamaica may only have been continuously emergent since the early Miocene, and with southern Hispaniola has exhibited the greatest recent uplift.

The Lesser Antilles are more recently derived as a volcanic island arc with no past continental connections.

The early geologic histories of Jamaica and southern Hispaniola are not as clear. They are believed to have once been a part of a primitive island arc along with Cuba, northern Hispaniola and Puerto Rico. One hypothesis has Jamaica and southern Hispaniola arising close to the southern shore of Cuba in the late Cretaceous or Paleocene (Stephan 1982, Thierry 1983). Another school of thought has Jamaica originating further west than other major islands in the Greater Antilies, and in the passage of Paleocene and mid-Eocene Middle Seas (Guyer and Savage 1986). At any rate, the long history of exposed major land masses in the Greater Antilles and the recent emergence of the Lesser Antilles is evidenced by, among other biotic elements, the relatively complex native freshwater fish fauna of the former and its complete absence in the latter (Lee et al. 1983, Burgess and Franz 1989).

We propose that the distribution of the Black-capped Petrels is related to the geological history of the Antillean region. Winter-breeding, non-migrating *Pterodroma*, of the *Aestrelata* of Bonaparte (1856) and the subgenus *Pterodroma* of Imber (1985), colonized one or more of the larger Caribbean Islands during the Pleistocene or earlier. The presence of an open tropical middle sea (Pan-Tethyan) through a period of up to 65 million years ago could have allowed the original colonization to come from Pacific stock. Such a scenario would explain the close affinity of *hasitata* to some of the Pacific members of the subgenus *Pterodroma* such as *incerta* (see above). However, the evidence strongly suggests that this colonization came from the South

Atlantic after the closure of the Panama isthmus (Imber 1985). (Note: *incerta* is a South Atlantic species not to be confused with *externa*).

Once established, the Caribbean stock colonized other Antillean islands. The apparent separate evolutionary history of Jamaica may in part explain the distinct appearance of the petrel of that island in that this form may have arrived at a different time. Although marine birds are certainty not as limited in dispersal abilities as terrestrial animals with an intolerance for salt water, *Pterodroma* may not disperse easily or widely from ancestral breeding grounds to establish new colonies. This is a result of strong philopatry, not poor dispersal *per se*. This is evidenced by the complex taxonomic and geographic mosaic of the genus, as well as evolution of highly endemic forms such as *P. cahow* which have been shown to exhibit extreme fidelity to specific nesting areas.

In the Greater Antilles today the species is distributed primarily along the suture zone of the North and South Island of Hispaniolia and formerly to mountains in Jamaica. The latter two sites are younger in age than Cuba, Puerto Rico and northern Hispaniola. We suggest that *hasitata* or its ancestors colonized the older islands but were largely extirpated from them as a result of ecological incompatibility with maturing biotas. Aside from the current and historic conservation problems, it may be that *hasitata* was already on the decline on the younger Greater Antillean islands due to vegetative changes. Eventually Black-capped Petrels became restricted, or nearly so, to high cliffs which were not dominated by dense vegetation protruding above forest canopies and which, in historic times, were restrictive to man and other predators.

The relationship of *caribbaea* to *hasitata* is problematic but based on both its smaller size and all dark coloration, it may indeed not be closely related to *hasitata* or other Atlantic *Pterodroma*. The proposed separate geological history of Jamaica adds intrigue but not evidence to this thought.

The Lesser Antilles are younger than the Greater Antilles and have less diverse fauna. Hurricanes, earthquakes and volcanic eruptions could intermittently restrict dense vegetation and predators locally and for varying periods of time. We believe that *P. hasitata* colonized and re-colonized the Lesser Antilles initially from stocks in Greater Antilles, and then later from within and across the Lesser Antilles. Thus, different islands in the chain could have been colonized whereas others were not, and the entire system would have remained in a state of flux.

Natural disasters commonly influence populations of island plants and animals. Hurricanes can create vast areas with reduced vegetation. Location (including origin), frequency, strength, and track length of Caribbean hurricanes are all cyclic climatic phenomena that exhibit considerable variability through time (UNEP 1990, Gray 1990, Kerr 1990). After two decades of relatively quiescent activity, Caribbean hurricanes are expected to increase in frequency and strength (Gray 1990). Vegetative changes associated with periods of increased hurricane activity could have periodically affected the suitability of highland forest sites used by breeding populations of Black-capped Petrels. Because hurricanes typically occur in summer and fall (May-November), breeding activity by petrels would not be affected directly. Hurricane damage to forests could effect the accessibility of nesting sites, however, by opening the canopy or covering burrow openings or by loss of soil needed for burrow construction through erosion. On Dominica, much of the interior forests have remained undisturbed by man, yet Hurricane David in 1979 caused the most severe damage ever reported to forests on that island. Montane rainforest on Dominica is expected to take 50 years or more to regain climax conditions (Lugo et al. 1983). Extensive damage to forests occurred even on the leeward slopes of Morne Diablotin (at least formerly a petrel nesting site), probably the most sheltered region of the island (Evans 1986).

Even heavy rains often create mud slides which can deforest many acres. We believe these and similar natural openings in high elevation areas historically would have been beneficial to nesting petrels. The 1847 earthquake on Guadeloupe is credited with the disappearance of *hasitata* from that island. Although earthquakes during the nesting season might be detrimental initially to breeding populations, long range effects may be quite beneficial. As another example, the central mountains of Martinique are now covered with remnant rain forest and have no active Black-capped Petrel breeding colonies. Yet the volcanic eruption of Mt. Pelee in 1902, which destroyed the coastal city of St. Pierre, would have created considerable potential habitat on Martinique for many decades, (the fact that it apparently did not is probably due to introduced predators and the presence of man by this period). Storms regularly maintain successional stages crucial for the nesting sites of a number of coastal colonial seabird species, and it is probably that they are important to inland breeding species as well.

To some extent storms may also affect the size of predator populations. Allen (1942) discussed fluctuations of predators on nesting Roseate Spoonbills, *Ajaia ajaia*, and illustrated the theoretical relationship between raccoons, *Procyon lotor*, and hurricane activity in Florida Bay between 1870 and 1940. While the situation Allen described may have little direct bearing on nesting situations of Caribbean *Petrodroma*, the principle of tropical storms influencing terrestrial predator populations is an important consideration. We believe catastrophic events in the past could have played a major role in the colonization of *hasitata*. The unstable mosaic of available nesting habitats may have caused colonies to move and reform; this in turn may have favored the polymorphism presently exhibited by the species. On the other hand, stable forest systems seem critical to the survival of Pacific petrels. Many *Pterodroma* habitually climb trees to exit colonies (Warham 1996).

An island by island summary of breeding localities follows:

Lesser Antilles

Martinique. Most authors (e.g. Pinchon 1967, van Halewyn and Norton 1984) concur that on Martinique the Black-capped Petrel was apparently extirpated in pre-Columbian times by the Carib Indians who used the bird as a source of food. However, Wetmore (1952), in his report of a humerus of this petrel from Martinique (USNM 428289), points out another record from the early 1800's when L'Herminier (1879) included it in a list of species without data other than the name (observed between 1827 and 1844). Wetmore concluded that the bone specimen is verification of this early report. The volcanic eruption of 1902 in Mt. Pelee is of speculative interest in that it may relate to the disappearance of *Pterodroma* on this island. Today this island is largely deforested, with most of the available land converted to agriculture.

Guadeloupe. Bent (1922) and Pinchon (1967) reported rapid declines in the population as a result of an earthquake in 1847, the use of the adult birds for food, and exploitation of the greasy young birds for fuel. Nesting birds disappeared around 1850.

> Labat's (1724) account is accompanied by an illustration of the 'Montagne des Diables,' showing negroes at work with their bird-poles in the treeless Soufriere of Guadeloupe. He states that in spite of the fatigues of the hunt, his curiosity led him to take part in one which lasted for more than 24 hours. The party followed the bed of a running stream inland as far as was possible, then climbed the steep slopes of the mountain and camped for the night. Next morning the burrows were searched out, the occupied homes being determined through the aid of dogs with well-trained noses. The birds, for the most part, were dragged out by being teased into seizing with their bills the end of a pole thrust into the burrows. Before noon of the second day, the party of six men had captured 213 petrels, with which they returned to the coast. 'One has to admit,' writes Pere Labat, 'that a Diable right from the spit is a delicacy. I had thought that one bird would well satisfy my appetite but, whether it was due to the cold mountain air, the strenuous trip, or to the fact that the Diables of this island are more tempting and digestible than those of other regions, I felt constrained to do as my companions did and to eat a second.' (Murphy 1936)
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> 'Pere Labat evidently had the instinct of a conservationist, for he wrote in his notes for the year 1696 that the reprehensible habits of the French settlers had nearly wiped out the Diablotins in the accessible regions of Guadeloupe. This, however, did not prevent him from recording that the birds are a sort of manna which God had sent the inhabitants of the island for an annual period of gourmandising. The "cottons" he describes as particularly tasty, and he gives detailed recipes for cooking both these and

> adult birds in several different ways.' (Murphy 1936, Bent 1922 cites Labats entire account of this species)

The most recent information for the island was presented by Noble (1916) who provided the following information which was repeated in Bent (1922):

> One of the chief reasons of my visit to Guadeloupe was to obtain information about the black-capped petrels. A few days after landing I had the good fortune to meet Monsieur C. Thionville, president of the Club des Montagnards. The name diablotin was associated in his mind with the past history and early colonization of the French in Guadeloupe. He immediately began to make inquiries about Basse Terre but without much success. Finally we made a trip together high up into the hills of Matouba to visit an old Negro called Pere Lownisky living on the slopes of the Soufrier. This old man in his early youth had often hunted Diablotins and had joined several of the large parties which had camped on the Nez Casse to dig out the diablotins from their burrows. Since Pere Lownisky had spent his entire life in Matouba he knew all the old breeding grounds of the black-capped petrels. He told us that the diablotins formerly bred on the north and northeast slope of the Nez Casse. The birds arrived in late September and the period of incubation for the colony as a whole extended through November and December. The young birds remained in the nest until March. He asserted positively, however, that no diablotins had been heard or seen since the great earthquake of 1847. The old Negro remembered that earthquake for during it the whole side of Nez Casse, on which the petrels bred, had collapsed and fallen into the valley. Pere Lownisky ended his exposition by dramatically raising his withered hand, exclaiming again in his 'creole' French that the diablotins had not been heard of for nearly seventy years, 'Jamais! Jamais!' (Murphy 1936).

The fact that historical information suggests the existence of two separate and distinct populations of petrels on this island has already been discussed under Systematics. Guadeloupe too has suffered heavy deforestation.

Dominica. The species was numerous on Dominica (the designate type locality) in the early 1800's, and although its numbers certainly have been decimated, it is possible that a portion of the population is still extant. It appears that historically the largest portion of the population nested here. Murphy (1936) states:

> During the West Indian work of the Brewster-Sanford Expedition, Beck hunted for the breeding grounds of the Black-capped Petrel in late April, 1917. They are known to have been abundant at Dominica as late as the year 1858, coming from sea each year in October (Lawrence 1878). A native guide, whose parent had dug the birds out of their

> holes in the forest a half century before, accompanied Beck, and together they combed over the ground on the steep ridge below the crest of Morne Diablotin. They also spent the whole of one night and parts of others in the woodland, listening for calls of the birds, but without result. The only warm-blooded animal found in burrows of the forest floor, or in undermined recesses among the roots of trees on steep slopes, was an unidentified, rat-like mammal, which may possibly represent the species of opossum which, according to Nicoll (1904), was introduced from Grenada or Tobago into Dominica some time since the latter part of the seventeenth century. Nicoll infers that this animal may well have wiped out most of the petrels at their nesting sites. Ober (1881) also scaled the precipitous sides of Morne Diablotin in vain, investigating traces of the petrels' burrows at a date when many natives asserted that they well remembered the bird. Other unproductive searches are referred to by Godman (1908).

Murphy (1936) further notes:

> That the Black-capped Petrel was not collected during the course of the Brewster-Sanford Expedition is due to no lack of effort on the part of Mr. Beck. The species is still in existence and has been identified in the field by competent observers many times during the last twenty years. Not long since, Bond (1928) warned against placing too much credence in the commonly accepted story of the complete extirpation of this petrel at Dominica. He called attention to the facts that large areas of the mountain known as Morne Diablotin were still unexplored, and that the mongoose, charged with the wiping out of certain West Indian birds, had, fortunately, never been introduced into the island. Proof that the Black-capped Petrel is, indeed, not extinct in the Lesser Antillean region, and that it almost certainly still breeds at Dominica, has since been forthcoming through the capture of an exhausted adult female in the streets of Roseau on May 2, 1932, as recorded by Hobley (1932), who has published three excellent photographs of the living bird.

Petrels collected on Dominica in 1932 and heard as recently as 1977 (van Halewyn and Norton 1984) provide no positive indication that the species is still nesting. Although the last confirmed date of nesting is 1862 (Smith 1959), a recent specimen record from the island (Adolphus Christian pers. comm. 1990) provides further promise that the birds continue to exist.

Wingate (1964) visited Dominica between 16 October and 10 November 1961. Conditions for field work were extremely difficult. In addition to the steep terrain and impenetrable nature of the rain forests, it was also the rainy season. Nights were spent on or near the summits of the two highest peaks, Trois Pitons and Diablotin, where as much as 4 inches of rain fell each night and progress was possible only by climbing through the top of a matted dwarf forest. Western

slopes of Morne Diablotin were watched on several clear and moonlit nights in early November, all with negative results. It was possible only to check a small proportion of potential breeding sites by night watches. Many parts of the island, including all climatic zones and some offshore rocks, were, however, visited in daylight hours.

Examination of the terrain suggested that the original breeding population occupied only a narrow zone at about 1,200 m elevation on leeward and 1,000 m on windward slopes of one or more of the higher peaks. Excessive rainfall and ground saturation might be a limiting factor at higher altitudes, and continuity of tall forest cover might be a limiting factor at lower altitudes. Many potential sites within these limits are probably above the reach of the introduced opossum (*Didelphis marsupialis*) which, according to plantation owners, does not occur much above 800 m. These sites are probably also too steep to be reached by pigs, which may have roamed wild in the interior for more than three centuries. Wingate (1964) found tracks of pigs on more level areas up to 1,200 m, but never on the near-vertical slopes. The black rat (*Rattus rattus)* probably occurs throughout the island.

During his excursions, Wingate questioned many local inhabitants about the petrel. Although some of the older people knew the tradition of the "Diablotin" as it was locally called, they unanimously agreed that it disappeared before their time. It should be pointed out, however, that more than 150 square miles of the interior of Dominica still remains uninhabited and is rarely, if ever, visited at night. Investigations, including those of Wingate (1964), indicate that the mid- October to mid-November period during which the island was surveyed may not be an appropriate time to hear or see these birds.

Greater Antilles

Hispaniola, Haiti. Wingate (1964) summarized recent specimens and records of *Pterodroma hasitata* in Haiti as follows:

1. Sight record; found apparently exhausted on the waterfront of Port-au-Prince; 1951 (month uncertain); identified by Mr. Leonce Bonnefil; age and sex undetermined; subsequently recovered and released.
2. Mounted specimen; shot in the Gulf of Gonave, south of Gonave Island; 1953 or 1954; private collection of Mrs. Celeste Jean-Charles; adult, sex undetermined.
3. Mounted specimen; shot in the Bay of Port-au-Prince near the city; 1954 or 1955; biological collection of the school of St. Martial in Port-au-Prince; adult, sex undetermined.
4. Mounted specimen; flew against window in the logging camp at Foret de Pins near Mont des Commissaires in the Massif de la Selle; summer, 1957; preserved by Mr. Leonce Bonnefil; collection of the Agricultural Institute at Damien, Port-au-Prince; fledgling bearing traces of down on underparts, sex undetermined.
5. Sight record; found alive near Port-au-Prince; June, 1961; identified by Mr. Richard Frisell; fledgling with traces of down, sex undetermined; subsequently died but not preserved.
6. Mounted specimen; struck mango tree and fell into streets of Port-au-Prince; 0630 hours, 1 July 1961; preserved by Mr. Hughes Whiteman; collection of the Bermuda Government Aquarium; fledgling with traces of down on the crown, sex undetermined.
7. Study skin; found alive with damaged right wing at Canadian Embassy in Port-au-Prince; 31 January 1963; preserved by Mr. Hughes Whiteman; American Museum of Natural History; adult, sex undetermined.
8. Skeleton; collected (by "sen sel") 2 km east of Morne Cabaio, 23 February 1963, by David Wingate; collection of the Bermuda Government Aquarium; adult male, testes 6 X 3 mm, moderately fat.

Hispaniola, Dominican Republic. A small population of Black-capped Petrels was discovered in the Sierra de Baoruco in 1981 (van Halewyn and Norton 1984), although their presence was suspected here prior to 1979 (Ottenwalder and Vargas 1979). This site is immediately adjacent to the location of the Haitian population. The population was surveyed in 1981 (Woods and Ottenwalder 1983), and 1989 and 1990 (pers. obs.). The breeding colony is apparently quite small and rather extensive searches indicate that the birds are limited to a single, steep 400-foot cliff about 7,200 feet in elevation. Most records of calling birds are from the winter period (11, 12, and 16 January, pers. obs.) although Haney (pers. obs.) heard individual calling birds on 14 August 1989.

The high ridge tops, where Black-capped Petrels are believed to currently limit their nesting activities, are dominated by the pine *Pinus occidentalis*. This pine, the only species in Hispaniola (Mirov 1967), occupies a large area in the north-central Dominican Republic, but is also found in the southwestern part of this country and in Haiti where *Pterodroma* have been

heard calling. The forest in the Baoruco Mountains of the Dominican Republic was logged regularly through the early 1960's, but since the political assassination of Trujillo, the area has remained a national park with its forests generally protected from human disturbance. In Haiti, the cutting of these pines is so extensive that some mountains in Morne la Selle range support only isolated trees (pers. obs. 1989, 1990).

Holdridge (1942) describes the distribution of the *Pinus occidentalis* forest in the portion of Haiti where *Pterodroma* breed as follows:

> Of the five species of pines in the Caribbean region *P. occidentalis* is the only high elevation species. Generally the species grows at elevations from about 900 to over 2700 meters. In Haiti, the range of the species includes most of the country, although in most sections it occurs only as scattered specimens. In the southern ranges of mountains, good stands of pine are found in large blocks. At the eastern end of the Morne la Selle range, in the section called Mornes des Commissaires is located a stand estimated to cover approximately 10,000 acres [a little over 4000 ha]. This is contiguous with the pine forest across the border in the Bahoruco Mountains of the Dominican Republic. The Haitian tract is located on a plateau at an elevation of about 5000 feet [1500 m] above sea-level, although scattered patches of pine to the north and south grow down to 2000 feet [about 610 m]. This is the only forest in Haiti which is traversed by a public road and when "leforet de pins" is mentioned in the capital, it is almost invariably with reference to this unit.
>
> Only a few miles to the west of this area La Selle Peak, the highest point of land in the Republic, attains an elevation of over 9000 feet [over 2700 m]. It is covered to the very peak with a pine forest which has an area probably greater than 25,000 acres [about 10,000 ha.]. West of La Selle on the main plateau and on the various ridges extending therefrom scattered individuals and patches are encountered to slightly beyond Furcy and Kenscoff.

It is also possible that a breeding colony occurs on cliffs on Isla Beata off the southwestern Dominican Republic. Ottenwalder (pers. comm.) reported seeing birds at sea in the vicinity of this island. On 28 January 1990, Lee flew over the island, which measures about 5 miles by 5 miles. Steep cliffs with caves meet the sea on the south side of Isla Beata and the same cliff face raises to a central plateau on the west side of the island. These inland cliffs rise out of a low coastal forest. The cliff-faces are sparsely vegetated and are similar to the cliff-faces on the main island that support colonies of *Petrodroma hasitata*. The island has limited access, because it is controlled by the Dominican Republic Navy, and therefore it is essentially protected. Other

species of seabirds are known to breed on the island (*Phaethon lepturus*, *Sula leucogaster*, *Pelecanus occidentalis*, *Sterna fuscata*, and *Sterna antillarum*, Ottenwalder pers. comm.), but the island has not been extensively surveyed. Even though the island is only five miles from the coast of the Dominican Republic, its long isolation from mainland Hispaniola is indicated by a large number of endemic reptiles (Cochran 1931, Noble 1923).

Cuba. Small colonies were believed to occur in high elevations in the Sierra Maestra in eastern Cuba in 1977 (Bond 1978), but very little additional information is available to evaluate these records. Recent discussions with Cuban ornithologists affiliated with the Havana National Museum of Natural History indicated that six specimens were collected as they came in from the sea. The birds are believed to have followed a river system into the mountains (Lee 1990). Local people appear to have been aware of these birds because the breeding locality in the Sierra Maestra reported by Bond (1978) is Monte La Bruja, bruga being the local name for this bird (but also other nocturnal bird species). However, Monte La Bruja and a town of the same name are inland sites named after an adjacent point of land also named La Bruja where the petrels feed at night.

The relict pine forests of *P. occidentalis*, with which *Pterodroma* is associated in Hispaniola, also grow in the mountains of eastern Cuba where they are found from 300 to 1500 meters (Smith 1954). A closely-related species of pine, *P. cubensis*, which some authors (e.g., Shaw 1914) consider a synonym of *occidentalis*, is found on the eastern portion of the island (Oriente), in the mountains of La Sierra de Nipe, Sierra de Moa, and Cuchillas de Toa. The altitudinal range is much lower, however, extending from sea level to about 820 meters (Smith 1954).

Jamaica. An endemic race, *Pterodroma h. caribbaea*, considered by some authors a distinct species, is known from the John Crow and Blue Mountains of Jamaica (Bond 1967). This is the easternmost island upon which *Pterodroma* nest(ed), and the one deepest in the interior of the Caribbean. Specimens obtained in the mid-1800's are darker and smaller than the nominate. This form may have survived in the John Crow Mountains in northeast Jamaica until recent times (Scott 1891, van Halewyn and Norton 1984) but this has not been confirmed.

Nevertheless, its continued survival cannot be completely ruled out (see discussion in van Halewyn and Norton 1984). The demise of this population appears to be a direct result of the mongoose, *Herpestes auropunctatus*, which was first brought to the island in 1872. This represents the earliest introduction of this species in the West Indies. Murphy (1936) summarized Scott's (1891) report:

> ...in February, 1891, a black man named William King made a trip into the hills of Jamaica in search of a bird which he knew as the "dry land booby" or Blue Mountain Duck. This bird dwelt in holes in the cliffs, and had formerly been extensively hunted by the mountain people. King, himself, had eaten a pair not long before, and had been impressed by the sounds made by the birds in their holes at night. After a six days' search, on the trip referred to, King reported that he had found the old breeding places, had dug out not less than 25 of the burrows, and had found a mongoose in some and nothing in the others. We need go no further in seeking an explanation of the disappearance of the petrel from Jamaica.

Murphy (1936) noted that the American Museum's single Black-capped Petrel specimen was obtained by Governor Newton, of Jamaica, during either April or November, 1879. Bond (1936) recorded a sighting of the black phase of *hasitata* at sea, west of the Bimini group of the Bahama Islands. Recent records of the dark phase of *Pterodroma arminjoniana* from the North Atlantic (Lee 1979, 1984, Gochfield et al. 1988) suggest to us that the bird in question may have been that or some other dark procellariiform species rather than *P. h. caribbaea*.

Although there is little additional information, we believe it is informative to outline subsequent field efforts to locate populations. This information is primarily from a series of articles which appeared in a newsletter of the Gosse Bird Club (Jamaica WI). Whenever possible it is presented in its entirety:

> It may be of interest, too, to see that on the visit we made to the summit of Blue Mountain Peak, we were unable to find any evidence or information that the "Blue Mountain Duck" resorts regularly to this locality, though such is said to be the case (Field 1894).
>
> In 'Broadsheet No. 2' of the Gosse Bird Club appeared the first account of the recent discovery by David Wingate of Bermuda of the breeding grounds of the Black-capped Petrel in Haiti under the title 'Does the Blue Mountain Duck of Jamaica survive?' Here is a project that should be undertaken in January or February. Probably the best locality for a search would be high in the John Crow Mountain, for these seabirds nest in burrows where they can take off against the wind. I must say that I do not believe any petrels nest

in the Blue Mountains. I certainly never heard any of these highly vociferous birds when I spent a week or so near Portland Gap during the month of December (Bond 1965).

BLACK-CAPPED PETREL. (*Pterodroma hasitata*). Unfortunately we cannot report the finding of the extinct(?) species in Jamaica. We made a preliminary look for petrels on a high cliff (Judgement Cliff in the Yallaks Valley), the top of which is some 1,400 feet above sea level. We reached the top of the cliff before dusk and remained until about 8 p.m., walking and listening for signs of birds. All was silent on the return journey, however, we met an old farmer who lives in the area, and, during a conversation about birds in general (with numerous digressions during which he related stories of ghosts or buried spanish treasure), the old gentleman volunteered without propping on our part, the information that the Blue Mountain Duck regularly flies in from the ocean to the south, and over the top of the Blue Mountain at night. The birds, he said were large, and could be seen against the pale night sky, and flew very fast with a loud rushing noise. Perhaps the old man has hallucinations, or on the other hand the Blue Mountain Duck may indeed be still extant. A night spent on the ridge of Blue Mountain may well be profitable. Why not try? (Smith and Gochfield 1965)

JAMAICAN BLACK-CAPPED PETREL: James Bond reports that a museum in Cambridge, England, possesses eight specimens of this bird, collected at Cinchona, Jamaica, December 12th 1879. These must be among the last records of this probably extinct bird. In Dr. Bond's opinion the specimens that he examined were at least subspecifically different from *Pterodroma hasitata* which occurs in Haiti (Anon. 1967). Our main purpose in coming was to begin a search for the Jamaica Petrel, believed by many to be extinct for 50 years. Operating on the optimistic assumption that a small population exists which has escaped the notice of man and introduced predators alike, we hoped to hear them calling at night in the Blue Mountains, which was their custom in the past. Although we spent one night each on Blue Mountain Peak and East Peak, we heard no calls. We plan to return next winter to renew the search, this time further to the east near Sugarloaf or Stoddats Peaks.

Our observations began on 22nd March...After passing the night on Blue Mountain Peak, we set off for East Peak in the fog on a foot trail… Our goal was Sugarloaf several miles to the east and invisible to us in the fog. After clearing our own trail for 6 hours on a compass course we came upon the old trail to Surgarloaf which was somewhat overgrown but not difficult to follow if one took pains to look for old blazes on trees on the way. Since we had to retrieve our packs which we had carried only part way down our trail we were unable to continue on to the summit of Sugarloaf Peak, so we returned to East Peak for the night. From the summit we watched a Barn Owl hunting along the summit ridge in the light of the full moon (King and Fenn 1967).

It was while lunching off a delicious roast duck in a charming house on a banana property in St. Mary, gazing at the misty outlines of the Blue Mountains...that the following story was told me. One of the luncheon guests was a lady, Mrs. K., who before the war lived in the Blue Mountains where she farmed a small property and also took in paying guests. One of the "regulars" was an American ornithologist who collected birds for the Smithsonian Institute. Sometime around 1930, a few days before the ornithologist was due to arrive for his winter holiday, the headman brought in a strange duck-like bird that he had shot. Mrs. K. decided to add a little variety to the menu and have it for lunch. "It must have been very old because after trying to roast it, we had to stew it before it was tender enough to eat..." When the ornithologist arrived and she described this bird to him

he became very over-excited and told her that the Smithsonian would have gladly given here two thousand dollars for a specimen of this bird, and proportionate sums for any eggs that could be found. (The headman told her that this kind of bird laid its eggs in a hole in the ground). I too became excited as she continued to describe the bird to me... "a little, dark, duck-like bird with webbed feet - dark brown with light colored underparts...a funny beak (Hart 1965)."

The dark phase (or sub-species?) *P. h. caribbeae* was known only from Jamaica, and it was last reported breeding in the Blue Mountains in 1890 (Scott 1891). The last specimens were collected at Newcastle and Cinchona during the decade 1880-90, and one of these is now a mounted specimen in the Natural History Museum at the Institute of Jamaica. Following Wingate's discovery of the Haitian birds, several attempts have been made to determine whether the Blue Mountain duck still survives here, but so far these have proved fruitless. The attempts include those of Trimble, Gochfield, and King.

Because of the introduction of the mongoose into Jamaica, any surviving breeding colonies must be located on very steep cliffs, safe from this animal. The birds breed in shallow burrows which they excavate, and therefore colonies must be in areas where some soil clings to the cliff faces, and is held in position by the roots of trees.

These conditions do occur in Jamaica, principally on the north side of the Blue Mountain ridge, and in particular on the north side of Sugarloaf and Stoddart's peaks, and the narrow ridge which links the two. Cliffs also occur on the west side of Abraham's ridge, a long buttress stretching north from Stoddart's Peak, and the east side of a similar buttress stretching north from Sugarloaf peak to Two Claw Peak. Between these buttresses the Stoney River rises, its tributaries falling down steep cliffs forming waterfalls up to 200 feet high, leading down to Nanny Town, and on to the confluence with the Back Rio Grande, and so to the Rio Grande itself. Few people know these mountain ridges and mountain rivers: this is truly the wildest and most beautiful part of Jamaica. Access into the area is, furthermore, becoming increasingly difficult, for in the past trails were kept open by wild-hog hunters, and these days only the older men, mainly maroons from Seaman's Valley and Windsor, still hunt hogs: the life is too hard for the young of today.

The well-organized search for the site of Nanny Town, planned and successfully executed by one of our previous members, Alan Teulon, and reported in the Daily Gleaner, provided an excellent opportunity for flights in a helicopter of the Jamaica Defense Force over the north side of the Blue mountains. Very good photographs by David Lee (now at the Scientific Research Council) clearly showed the cliffs to the N of Sugarloaf and Stoddart's peaks, and expeditions by foot from Windsor to Nanny Town, provided first hand views of the cliffs from the upper reaches of the Stoney River, but access to the top of the cliffs from this north coast route would obviously be very difficult if not impossible.

In May, 1968, therefore, Mike Ashcroft and I decided to attempt to reach the summit of Stoddart's Peak from the south side, following the route of the long lost and overgrown Trelawny's Path, from Island Head in St. Thomas. Early on Saturday morning, at first light we set out from Island Head, and found the route to Stoddarts surprisingly easy, though a little steep at times. There was no marked path once we left the cultivated lands and entered the wet mountain forest. The first land-mark is the hill called half-a-bottle: and shortly after reaching it the mist descended, and the rain fell. On Stoddart's peak it was very cold, so cold we couldn't stop our teeth chattering, and had to keep moving,

stamping our feet to keep warm, whilst we hurriedly ate some bun and cheese, half a chocolate bar and drank some condensed milk. It was 11:00 a.m.

On Stoddart's peak the forest floor is free of undergrowth, the tall trees with sodden moss covered trunks stand among moss covered rocks. The earth is wet, muddy, and on the very summit there were two muddy, rain-filled holes where wild pigs had recently been wallowing.

We had to keep moving, and had set out prepared to spend the night at Stoddarts. No point in going back so soon, so we went on, taking the ridge to the north, out towards Abraham's Peak where 200 years ago Trelawny's men mounted a swivel gun and based their attack on the maroons who were holding out down the valley at Nanny Town. The ridge to Abraham was difficult, the top getting narrower and narrower, forming a knife edge falling away on both sides down steep hills to the rivers below. From Abraham's Peak, away to our left we caught a view of the great fall, a strip of silver marking a 200 foot vertical line down the steep cliff face, and we saw the inaccessible cliffs, wooded and ideal for the breeding colonies of the Blue Mountain Ducks. Last spring, and all the springs before, had the petrels come speeding in from the ocean and laid their eggs on these cliffs, or, long ago had the mongoose, or some other undetermined ecological factor caused the birds to depart from these hillsides. Perhaps next spring we would find out. After detours around rock faces, we eventually dropped down the west side of the ridge, reaching the top of the steep gully through which the upper stoney river was flowing, but night fell, and forced us to camp on a 45˚ slope, to wait for morning light before we dare risk finding a way into the river valley.

Our camp site was close by Nanny Town, we were in fact further up stream than the actual site of the town discovered by Teulon, and on the opposite side of the river. We fully agree with Thomas in his description of the spot written in 1890, when he said "I do not suppose that there is to be found throughout the length and breadth of Jamaica any spot to surpass, or even approach this one in wild and picturesque loveliness". Ever since Captain Stoddart captured Nanny Town in 1734, the spot has been a place of superstitions, and as recorded by Gardner:

> The spirits of those slain in battle linger there, while it is a fact that men whose personal courage is unquestionable have been bewildered by the strange, mysterious noises they hear when camping down for a night. The fears of the Maroons have affected their own spirits, for the falling stones are no doubt occasioned by the wild hogs rooting among the hills, and the flapping of the wings of strange low flying creatures is occasioned by sea-going birds who roost among these mighty heights and were dawn hasten away to the ocean below.

To cut a long story short, dawn came at last the following morning, casting its warm glow on the roof of our polythene tent, and driving the endless fireflies of the night away. The Brown owl, left its hunting perch in the tree over our heads, and the doctor birds began to call. We scrambled down to the river, and spent the hardest day of our lives making our way along the river, now swimming the deep, clear pools, now clambering over the rapids or jumping down the waterfalls, but always wet, mostly warm in the water, but cold when the clouds obscured the sun, and the showers passed. By dusk, we arrived at Durham, stiff and cold, and very tired, but with a great sense of achievement in having crossed the Blue Mountains, followed Trelawny's path, and in two days achieved what many had failed to do in more than a week. We had seen the cliffs, and were

optimistic that if the petrels still survived, then we had seen the most likely place. Next spring would tell.

Next spring is now this spring: and Operation "Mountain Duck" took place on the weekend of January 25th. This time, Mike Ashcroft, Dave Romney and I would go again to Stoddart's Peak, but turn west at the top, and try to reach the top of Sugar Loaf peak, where we would camp the night listening for the sound of the birds. This we did, a beautiful day, no rain this time, and we reached the mossy Stoddart's peak again around 11:00 a.m. Lunch break, and on to Sugar Loaf. Soon after leaving Stoddart's, on a trail partly marked, often obscure, we reached the water-hole and filled our bottles: knowing that we would not see water again till we reached the west peak of Blue Mountain. A long day, checking compass, reading maps, we eventually reached the foot of the last climb up to Sugar Loaf, and at 5:00 p.m. we were within 10 minutes of the peak, and made camp under a gnarled and leaning tree, just to the south of the ridge, out of the wind.

The plodding day had been monotonous, the views were limited and sometimes we found a sort of trail, made by pigs or other animals: perhaps by the dogs we met, strange, shy yet friendly creatures, running wild in the hills miles from the nearest man. Other times we moved slowly, cutting through dense ferns, swearing at the bamboo grass which clawed at our packs, tripped our feet, deliberately impeding our progress. The bamboo grass we felt was the guardian of the hills, doing everything to stop our progress: we hit it with the machetes, and it yielded at last.

It is obvious that our path, the same, but in the opposite direction, to that taken by Thomas in October, 1890, had changed little over the intervening 80 years. Thomas describes the difficult places in the following words "....crawling in the mud on all fours under fallen trees, and carving a road through a species of creeping bamboo, very interesting no doubt from a botanical point of view, but not conducive to fast traveling, the stems, like time, have no beginning and no end; they are exceedingly tough, and closely matted together, and by no means innocent of small prickles. They catch you across the mouth and throat, and when you think you have cleared yourself they raise off your hat, and when you pick that up you find yourself hitched by the knapsack or the butt of your gun, and when you have disentangled these you find one hitched over your ankle".

The night was still: not a breath of wind, but the air was cool. Our fire tried to burn, the tree fern fronds, dry yet wet provided a kindling, but the wood merely sizzled as the rain soaked fibers would not dry. What was that? Tree frogs whistling? Yes, but no petrels. Can we hear the faint noise as a swarm of bees or the rushing of wings? Our imagination taunted us: Again a noise - this time far below at Palisades a jet taxied along the runway, and in seconds was higher than we, on its way to Miami, or South America. But still no petrels.

Intermittently we slept, and woke, during the night: the cold wind from the north livened, rustling through the trees over the narrow ridge, and creeping through our blankets and clothes. We waited, and listened: but still only tree frogs and airplanes. Waited until the sky became light in the east, and the sun rose over St. Thomas.

After a hurried breakfast, we soon reached the summit of Sugar Loaf: easily identified by the small clearing in the center of which still stands an old and gnarled Yacca tree: no doubt the same tree described by Thomas: standing with its arms all gnarled and knotted and bent, on the very apex. About the root of this, and in natural hollow in the trunk I

saw a number of broken bottles. Today, many bottles were still there, some no doubt old, and others more recent, containing written records of earlier assaults on the summit. Thomas left his record, written on paper in a bottle, but the only clear message we found was the name of Ron Read (of the U.W.I.) dated 1959.

From the Yacca tree, we descended a most steep and difficult drop of about 1,000 feet to the ridge, narrow and curving, which stretches to the three peaks of blue mountain. The mist descended, and the early morning view of the peaks from just below Sugar Loaf was our last view, until we reached well below West Peak on the way to Whitfield Hall. The day's journey was land-marked by several peaks - first the small 'False' sugar loaf, then the true East Peak. East Peak is in fact a sharply pointed peak to the east of what is commonly called East Peak but is actually Middle Peak, the mountain on which an iron survey point similar to that on Blue Mountain (West) peak has been erected. Between East and Middle Peaks there is a deep drop, with a steep climb up to Middle Peak, but between Middle and West Peaks we reached the cleared path, along which the more adventurous climbers of Blue Mountain often pass.

Operation Mountain Duck was a two-pronged search for the petrels. On the Sunday morning, Warren B. King and Cameron Kepler, from the Smithsonian Institute, Washington D.C. and the U.S. Department of the Interior respectively, left Whitfield Hall, hoping to meet our party, and then trace our path eastwards towards Stoddart's Peak. We met them at the top of Jacob's Ladder: described our route, and our failure of finding the petrels - and on their way they went, whilst we returned to Whitfield Hall, and back to Kingston.

King's party were very unfortunate in the weather, as the rain and cold winds prevented much progress. They spent a night on West and Middle Peaks, and a second night back down at Portland Gap, but the noise of the wind prevented any real listening for petrel sounds.

Our failure to hear Petrels does not mean that they are extinct, our hearing range, both in distance and time, was limited. The Blue Mountain Duck may yet survive in the mountains, or on the steep West side of the John Crows. We will try again (Smith 1969).

Ann Sutton (Jamacia WI) kindly provided the following place names in Jamaica which appear to be named for the Jamaican Petrel and are believed to represent former nesting colonies: Devil's River, near Above Rocks, St. Catherine; Devil's River, near Sprink Bank, Bath, St. Thomas; Egg Hill, near Washington, Portland; and Mount Diablo, St. Ann.

BIOLOGY OF NESTING POPULATIONS

Most of the early information relating to the life history of the Black-capped Petrel is from the single report of Pere Labat (1724). This is quoted in entirety by Bent (1922), although at the time Bent had some misgivings about the identity of the bird. Murphy (1936) states:

> We learn from him that the Diablotins nested high on the mountains, perhaps altogether on volcanic ridges above the zone of dense forests. There the birds burrowed in the earth like rabbits, and remained concealed throughout the hours of daylight in the customary petrel manner. Labat says that the Diablotins are goggle-eyed birds which can neither stand the light nor discern objects in it. They are, therefore, clumsy and helpless when pulled forth from the burrows. Yet such observations take no account of the obvious ability of these birds to fly about over the sea during the day; it is probably the sudden change from darkness to light which discommodes their eyes. At night in the mountains they could be heard crying continuously, as though calling and answering one another with mournful voices while in flight. The annual mating season began after the end of September, and eggs were probably laid during January, for the young were hatched by March. These were covered with thick yellow down, and were known to the blacks of the islands as 'cottons.' By the end of May the fledglings made their way to sea, and thereafter no Diablotins were seen in the neighborhood of the nesting grounds until the following September.

Subsequent reports are of second-hand historical accounts, or from persons locating nesting colonies but not the nest themselves. The eggs of this species have never been described and the only mention of them at all is of a single egg, one-third incubated, taken on Dominica on 1 February 1862 (Smith 1959). Lloyd Kiff (pers. comm.) is not aware of any eggs of this species in any collection.

Most of the current information on the breeding habitat of this species is from Wingate's (1964) discovery of this species in Haiti. He states:

> At present the breeding habitat is confined to areas so steep as to be virtually inaccessible. This is in contrast to the historic accounts, which imply clearly that burrows occurred on slopes negotiable by men and dogs. The 11 colonies located were in forested cliffs 500 m or more in height and above 1,300 m altitude. Most were located between 1,500 m and 2,000 m above sea level. Proximity to the sea did not appear to be necessary. All but one of the colonies were on the north or inland side of La Selle Ridge, presumably because the most suitable habitat occurred there. One of these, near Pic la Selle, was 20 km from the sea. The mountains of the Massif de la Selle are composed primarily of dolomitic limestone. Where this rock is exposed as bare cliffs, mainly on east-facing slopes, there are no caves or crevices to provide a foothold for petrels. Colonies occurred only where a sufficient soil cover existed for burrowing--hence the association with forested cliffs where the vegetation held in place a steep talus of boulders, soil, and humus at a high level of stability. I reached such an area, where petrels had been burrowing, on one occasion and found loose feathers and soil kicked out from under boulders, but no occupied burrows. There were sufficient gaps in the horizontally growing forest cover here to give the petrels direct access to the ground.

In the Greater Antilles, Black-capped Petrels are associated with open park-like pine savannas, and all known nesting cliffs are in such habitats. Lower elevations are dominated by dense tropical cloud forest through which it may be difficult for the birds to maneuver. In Puerto Rico, for example, Pregill and Olson (1981) documented changes in the avifauna that were associated with Pleistocene climatic changes. Increasing amounts of rainfall resulted in the loss of savanna habitats and several bird species believed to be specific to this habitat. Today, there are no species of *Pinus* in Puerto Rico. It is interesting to note that Puerto Rico is the only major island in the Greater Antillies from which *hasitata* has not been reported. The habitat of the Jamaican petrel has never been described, but natural pines are totally lacking there as well as throughout the Lesser Antilles. *Pinus caribaea* occurs in the Bahama and Caicos Islands, both to the north and south of Crooked Islands, a possible former breeding site of the petrel.

The apparently limited altitudinal zone of former breeding sites on Dominica may have been due to the petrel's requiring areas of open or short vegetation to maneuver. The high peaks of Morne Trois Piton and Diablotin are covered with elfin woods, shrubs and protruding rocks and banks. As previously discussed, other natural open areas may have been available to nesting birds as a result of fire, hurricanes, mud slides, earthquakes and/or volcanoes. A pine sub-climax savannah provides suitable open areas on two of the three islands in the Greater Antilles inhabited by this species and early-aged successional communities are suggested to be of major significance to birds nesting in the Lesser Antilles. Such a pattern would tend to concentrate birds into temporarily formed open communities, and this in turn may have an important role in allowing early settlers to collect large numbers of birds and decimate populations in a relatively short period.

Although it is well established that Black-capped Petrels nesting localities are currently restricted to steep cliff faces, it is unclear whether this is a result of predation by man and

introduced predators, or a necessity. Also, it may be that on land this *Pterodroma* needs to launch itself from high cliffs in order to become airborne.

POPULATION ESTIMATES

Actual population size of this species is unknown, but it is believed to be quite small. Based on the 1961 survey of LaSelle in Haiti, Wingate estimated a minimum of 4,000 birds. Van Halewyn and Norton (1984), apparently based mostly on Wingate's calculations, stated that the population size ranged between 2,000 and 25,000 pairs. The colony in the Sierra de Baoruco in the Dominican Republic was estimated to be 65 pairs in 1981 (Woods and Ottenwalder 1983). By 1990, Haney and Lee (pers. obs.) believed that only five pairs were present at this site. Populations are particularly hard to locate and monitor because of their secretive, nocturnal nesting on inaccessible cliffs.

For Haiti, Wingate (1964) noted:

> It was exceedingly difficult to estimate the population when the nest sites were inaccessible and visited by petrels only at night. Flying birds could not be seen to be counted and individual calls could not be discriminated from the total chorus. The volume of chorus was, however, arbitrarily measured and some advantage was derived from the fact that the ratio of chorus volume to total breeding population is known for the Cahow (Wingate, unpubl. data). On this basis I judged that each colony of *P. hasitata* contained at least 50 pairs and probably many more.
>
> Estimating the number of colonies on Hispaniola was somewhat easier. This was done by calculating the ratio of occupied to unoccupied potential sites as determined on La Selle Ridge and relating this to the approximate number of potential sites on the island, as deduced from maps. Assuming, on authority of Wetmore (1932), that mountain ranges in the Dominican Republic are occupied, something in the order of 40 colonies may exist. Correlating these estimates gives a minimum breeding population of 4,000 birds. The actual population is probably much higher.

In any event, the species has been extirpated from a large portion of its former breeding range and former population sizes on any of the islands are unknown. It is clear from historical accounts that the species was once quite common at least on Guadeloupe and Dominica. The abundance of sub-fossil bones in caves in Haiti suggest it was also common in portions of

Hispaniola. Despite ample montane habitat on the other side of Hispaniola, there is no evidence to indicate that the species was ever common or widespread in the Dominican Republic.

Relatively large numbers can be seen off the Outer Banks of North Carolina, the Georgia Embayment, and other portions of the South Atlantic Bight (Cape Hatteras, NC, to Cape Canaveral, FL). This is the only marine zone where consistent or regular concentrations of this seabird are known to occur. If the most conservative estimates of breeding population size are correct, the majority of the world's population forages off the coast of the southeastern U.S. If the higher estimates are correct, a significant portion of the population occurs off this region in all seasons. In either case, these offshore waters appear vital to the survival of the species. Because of their mobility, high flight speeds, and the regular occurrence during the breeding season, it seems likely that birds nesting in the Caribbean could actually commute to these waters to feed. The concept of such long-range foraging is not far-fetched. Jouventin and Weimerskirch (1990), through satellite tracking, showed that adult Wandering Albatrosses (*Diomedea exulans*) covered 3,600 to 15,000 km on a single foraging trip between incubation shifts.

Information derived from at-sea counts provides inexact estimates of population size that are similar to ones made at nesting colonies. Our marine censuses and the distributional limits suggested by others (Rowlett 1980, Powers 1983) indicate that the bulk of the marine population occurs between latitudes 28˚-36˚ N. Furthermore, the birds are distributed primarily along the narrow corridor of the Gulf Stream. Within this corridor, the distribution is not random or even. Although estimates of bird density, which are expressed in mean number of birds per km^2, could be misleading (e.g. Haney 1985, Tasker et al., 1984), we have attempted to calculate population size based on estimated densities. A total estimate of 17,500 individual birds was obtained. If the exceptionally high abundances from the region of 32˚-33˚ N (which could easily result from

sampling error) are discarded and the remaining data are averaged, the population estimate is 12,000. Using students t-distribution for small sample sizes, we obtained 95% confidence limits for this estimate: 5,000 to 19,000 individuals (0.16 to 0.59 birds/km^2). Because the birds are known to circle boats and individuals could be recounted, the initial counts could easily be inflated 2 to 4 times higher than the actual number of birds.

Seasonal abundance curves suggest uneven population flux within the prescribed area, a factor which could indicate that the estimate of 5,000 to 19,000 birds is still too high. It is important to point out that in spite of all the potential variables and biases, we see that at best there is a known population of Black-capped Petrels numbering in the thousands. All estimates differ only by factors, not by orders of magnitude. Our estimates are similar to the lower estimates obtained from the breeding colonies. This would be expected in view of the pressures that continue to be placed on the nesting populations in Haiti and the differences of 2 to 3 decades between the timing of the estimates at breeding sites and those made at sea. Nevertheless, we should point out that because the regular marine occurrence of Black-capped Petrels was not known prior to the late 1970's, additional foraging areas of major importance could conceivably occur elsewhere in the western North Atlantic. Based on knowledge of productivity of tropical marine systems, however, this is not likely.

MARINE DISTRIBUTION

As opposed to almost every other seabird species, considerably more is known about the Black-capped Petrel's marine ecology than its terrestrial breeding biology. Black-capped Petrels are confined to tropical and subtropical water masses in the western North Atlantic Ocean between 10˚ and 40˚ N latitude. At sea, almost all Black-capped Petrels have been seen near breeding colonies or along the Gulf Stream in the South Atlantic Bight off the coast of the southeastern United States (Lee 1977, 1984; Clapp et al. 1982; Haney 1983). In winter and

spring, petrels occur north and south of Hispaniola, and near Puerto Rico and the Virgin Islands (Morzer Bruijns 1967a; Norton 1983, 1984). There are also records from the central eastern Caribbean and near the leeward Netherlands Antilles, but apparently no reliable observations from the western North Atlantic Ocean east of the West Indies (Voous 1983; R. van Halewyn, pers. comm.). Some syntheses of pelagic observations from the Gulf of Mexico indicate that no records exist there (Clapp et al. 1982), although unsubstantiated sight records are nevertheless still made intermittently. An old record of the Black-capped Petrel off Brazil (AOU 1983) is apparently not substantiated with details (R. van Halewyn, pers. comm.).

Black-capped Petrels occur at least occasionally north or east of the South Atlantic Bight. Single birds and small groups have been seen off Virginia and Maryland (Rowlett 1977, Harrison 1983), north to about 40˚-45˚ in the northwest Atlantic off New England and southern Canada (Brown 1973; Lambert 1977, pers. obs.). These areas are still directly or indirectly influenced by the Gulf Stream. Black-capped Petrels may also occur east of the Gulf Stream in the western Sargasso Sea (Nieboer 1966, Morzer Bruijns 1967b), but Haney saw none during two weeks of daily observations in the Sargasso Sea in August 1984. The species is accidental in the northeast Atlantic. A single specimen record (1852) exists for Norfolk England, and there is a recent sight record from the Rockall Bank (Cramp and Simmons 1977, Bourne 1983). The Norfolk specimen is the only accepted Palearctic record (Cramp and Simmons 1977).

Early records of the Black-capped Petrel at sea were given by Wetmore (1927), who observed a number of the birds along the steamship course between New York and Rio de Janeiro, at a point southeast of Bermuda, during early June, 1920. Unlike the smaller storm-petrels, he states:

> The Black-caps paid no attention to the wake of the vessel, although at times they approached within a distance of 10 meters before veering far out to one side. Their gliding flight was near the water, with frequent changes of course. Those seen at close

> range showed the dark crown, with a white line behind it, the more or less grayish cast to the back, the white rump, and a dusky tinge along the sides. The lower surface of the wings was white, outlined in black, with the dark margin heavier in front. It was in approximately these same latitudes that Nichols (1913) observed a Black-capped Petrel at the opposite season of the year, namely on January 25. He states that the flight and appearance of the bird reminded him of the Greater Shearwater (*Puffinus gravis*), from which the Black-capped Petrel can readily be distinguished by the large patch of white above the tail.

The first report of Black-capped Petrels in North Carolina's waters, and the first indication that the species occurred regularly off the North American coast, was not until 1972 (Lee 1977). Since then the species has been regarded as regular and relatively common off the coast of the southeast in general, and off North Carolina in particular. Counts of thirty to a hundred birds in a single day are not unusual in offshore waters, and one tally of over 300 birds is available.

Black-capped Petrels are generally restricted to relatively deep water (200-2,000 m [100-1000 fathoms]) and they are most common in waters over 1000 m (500 fathoms) in depth. These birds occur with greatest regularity in a small area southeast of Oregon Inlet (Fig. 1; Lee pers obs.). Haney (1987a) indicates that south of Cape Hatteras the distribution of Black-capped Petrels is most influenced by the position of the Gulf Stream, a major current system that is highly dynamic in its position. Petrels generally were not common over the outer continental shelf, and were absent from the inner shelf. In twenty days of monitoring shelf waters (30-40 m) during the summer, Lee did not record a single *Pterodroma*. In Lee's study area, the shelf break, continental shelf-slope, and the inner edge of the Gulf Stream are all close together, and it was difficult to determine which of these factors affected conditions responsible for the local petrel distribution. Recent research, however, indicates that petrels track the location of the Gulf Stream's inner (western) edge in this region as well (Hass 1997).

Haney (1987a) further noted:

> Petrels occurred almost exclusively within the cross-shelf interval of Gulf Stream frontal meandering in the South Atlantic Bight.. Gulf Stream position relative to the shelf

changes during 2- to 14-day periods as a consequence of wave-like propagations along the current boundary (Lee and Brooks 1979, Lee et al. 1981, Lee and Atkinson 1983, Olson et al. 1983). Petrel affinities for the Gulf Stream current boundary resulted in changes in the species' distribution with respect to depth and distance offshore. Off Florida, Black-capped Petrels occurred over shallower depths and closer to land than farther north off Georgia and South Carolina. Broader cross-shelf distributions of Black-capped Petrels at higher latitudes also corresponded to this increase in the cross-shelf range of frontal meandering. East of the western Gulf Stream frontal boundary, Black-capped Petrels were observed only over seamounts, submarine ridges, and mesas on the Blake Plateau. Small numbers of the petrels were seen feeding over and downstream of the Stetson Mesa (30˚30'N, 79˚30'W) and Hoyt Hills (32˚00'N, 78˚30'W). Petrels at these locations were primarily observed in or near internal wave crests resulting from topographic turbulence created by the current over steep undersea ridges and peaks (Haney 1987b).

One hundred to 1000-km scale changes in petrel abundance were correlated with increases in the amplitude of Gulf Stream meandering at higher latitudes. Unstable meanders induce upwelling (Lee et al. 1981) and cause local increases in the biomasses of marine organisms in the South Atlantic Bight (Yoder et al. 1981, Atkinson and Targett 1983, Paffenhofer et al. 1984, Deibel 1985). Significantly, south of Cape Hatteras Black-capped Petrels were most abundant off northern Georgia and southern South Carolina where upwelling is most frequent, persistent, and extensive (Brooks and Bane 1978, Legeckis 1979, Bane 1983). Food biomasses may also be higher in this region because of downstream transport and accumulation of marine organisms from upstream upwelling sites (cf. Yoder et al. 1981, Haney 1986a). There appears to be a progressive increase in abundance from south to north, peaking and abruptly terminating off the Hatteras area of North Carolina.

During shorter time scales (days) and at smaller spatial scales (10-100 km), Black-capped Petrels were unequally distributed along the Gulf Stream frontal boundary and within the stream itself. Peak abundances occurred at temporary and kinetic frontal eddies and upwelling features with elevated productivity (Yoder et al. 1981). Petrels were more abundant in the immediate frontal region at eddies (e.g., at the 28˚ and 29˚ C isotherms), and in the resident Gulf Stream water itself (Haney 1986b). A few Black-capped Petrels, however, were occasionally observed in the adjacent upwelled eddy cold-core between the Gulf Stream and shelf waters (see also Lee 1984).

Sea surface temperature and depth did not characterize the Black-capped Petrel's marine habitat over large geographic areas and long time spans. However, at all seasons they were found to be in waters warmer than mean sea surface temperatures recorded for a particular day or season (Lee, per obs.). In the South Atlantic Bight, petrels were always observed in the relatively warmer offshore waters at or near the Gulf Stream; however, the absolute sea surface temperatures where petrels were observed varied extensively (20.5˚-29.0˚C), in part because of seasonal and latitudinal changes in the Gulf Stream (Atkinson et al. 1983).

We do not believe that these birds respond to water temperatures *per se* but that the birds restrict their activity to areas that are influenced by the Gulf Stream. For example, Black-capped

Petrels did not occur during summer in shelf waters where sea surface temperature may equal or exceed those in the Gulf Stream (Atkinson et al. 1983, pers. obs.). The influence of depth or bathymetry on petrel distribution was indirect, and was primarily exerted through steering effects of bottom topography on the position of the western frontal boundary of the Gulf Stream (Brooks and Bane 1978, Legeckis 1979, Bane 1983).

This is the only locally occurring seabird found during all seasons off North Carolina (Lee 1986a), but it is most common in May, August, and late December through early January (Fig. 1). Haney (1987) also noted year round occurrence with a maximum occurrence of Black-capped Petrels south of Cape Hatteras in April and November which indicates that major segments of the population of these birds may be foraging in different areas at different seasons.

BEHAVIOR AT SEA

Haney (1987) reported on the marine habitat and behavior of Black-capped Petrels off Georgia. Petrels usually flew in rapid "roller coaster" flight on bowed and angled wings that produced a distinctive bounding or rising and falling progression (Harrison 1983). Occasionally, they rose to 20-25 m above the sea at the peaks of the arcs. The extent of wing-flapping in this flight mode was inversely related to wind speed. At wind speeds less than or equal to about six knots, petrels used a very slow and labored flight with many deep, rapid wing-beats, particularly when taking off from the ocean surface. Gull-like soaring on horizontal wings from 50-100 m above the ocean surface was observed very rarely during moderate wind conditions (6-15 knots). In higher winds, Black-capped Petrels may spring directly into the air from the water surface (Harrison 1983). In low winds ($\leq$6 knots), they run along the ocean surface for 2-4 m before taking flight (Haney 1983).

Relative petrel abundances increased from Beaufort force 2 to a peak at force 5 (17-21 knots). Individuals were not observed by Haney in winds $\leq$ 4 knots, except when sitting birds

were flushed from the ocean surface by passing ships. The majority (72%; *n* = 19) of all sitting birds observed during transit, as well as 100% (*n* = 13) of nonfeeding sitting petrels, were recorded at wind velocities $\leq$4 knots. Unless petrels are more difficult to detect when sitting on the ocean surface under conditions of low wind velocity, this information suggests that petrels are dependent upon higher wind velocities for foraging and dispersal (Jouventin and Weimerskirsh 1990).

Haney found that Black-capped Petrels were active during all daylight hours, with an apparent peak in activity from 07:00-09:00 and a less pronounced peak from 17:00-19:00. Lee's offshore survey methods did not allow for much information in activity period to be recorded. Survey boats were seldom in areas where Black-capped Petrels occurred prior to 09:00. A marked decline in activity occurred after 11:00, but by mid-afternoon survey boats were again out of areas where the species occurred. Petrels were seen flying in the ship's high-beam search lights at night, although no feeding was observed during these limited observations. All eight natural feeding aggregations reported by Haney (1987) occurred before 09:00 or after 15:00. All aggregations that resulted from artificial, chum-feeding experiments (*n* = 6) occurred after 15:00. Lee found that petrels exploit mostly diel, vertically-migrating, mesopelagic nekton (Imber 1985), prey types that strongly suggest an adaptation for crepuscular or nocturnal feeding.

Although petrels were generally silent, individuals at chum slicks occasionally uttered single bleating or croaking notes, "waaahh" or "aaa-aw", when feeding (Wingate 1964, Imber 1985, Lee, pers. obs.). On one occasion in December Lee noted that a large number of petrels he saw at sea were vocal. Collection of birds showed most to be adult males.

The majority (96%) of petrel feeding bouts reported by Haney (*n* = 25) occurred in flocks, 88% of which included other species. Petrels fed with twelve other species (x = 4.3 species/flock; range = 2-8) at 'baitfish' or invertebrate swarms; most frequently with Cory's

Shearwaters (*Calonectris diomedea*), Greater Shearwaters (*Puffinus gravis*), Audubon's Shearwaters (*P. lherminier*i), and Pomarine Jaegers (*Stercorarius pomarinus*) in summer, and with Herring Gulls (*Larus argentatus*) and Black-legged Kittiwakes (*Rissa tridactyla*) during winter. Petrels fed with ten seabird species (x = 3.8 species/flock; range = 3-6) at chum slicks, including Greater Shearwaters, Wilson's Storm-Petrels (*Oceanites oceanicus*), and Pomarine Jaegers in summer and Herring and Laughing Gulls (*L. atricilla*) in winter. Lee found other less common feeding associates to include South Polar Skua (*Catharacta maccormicki*) and Common (*Sterna hirundo*), Bridled (*S. anaethetus*), and Sooty terns (*S. fuscata*). Both Parasitic (*Sterecorarius parasiticus*) and Pomarine Jaegers attempted to parasitize nonflying feeding petrels (Haney 1987). Lee (pers obs.) watched a Bridled Tern repeatedly attack a Black-capped Petrel that was trying to feed on the wing. The pursuit continued for some period with the Black-capped Petrel eventually leaving the area. This was the only such incidence observed during fifteen years of study.

With one exception, Black-capped Petrels were not seen in association with marine mammals, despite ample opportunity to make such observations during Lee's long study period. On 1 April 1987 a single petrel was seen foraging around a finbacked whale, *Balaenoptera physalus*, the only record of this petrel in shallow (<15 fathoms) shelf waters.

Haney's (1987) observations of Black-capped Petrels feeding at chum were the first reports for this species. During his study, petrels frequently flew in to inspect fresh waste fish, and fish and chicken entrails near fishing boats. Petrels settled on the water and consumed the chum, occasionally flying off with large pieces, or attempting to steal the food items from other petrels. On 13 April 1984, 65 petrels fed on fish entrails, with 5 to 10 individuals on the ocean surface continuously. Like several other procellariiformes (Guzman and Myres 1983), Black-capped

Petrels may scavenge discarded waste only when natural foods are not abundant or reliable, such as when large numbers of migrating individuals are concentrated locally in unproductive waters.

Black-capped Petrels do not appear to rely exclusively on olfaction for locating food sources like certain procellariiform seabirds. Some procellariiforms are selectively attracted to food-related odors from downwind (Hutchinson et al. 1984). Petrels frequently flew in to inspect seabird individuals or flocks exhibiting foraging behavior from upwind, however, and these birds arrived from all compass directions.

Petrels used at least four foraging postures when feeding: (1) sitting in the ocean surface with wings outstretched and sharply angled backward; (2) aerial dipping, pattering and hydroplaning (Ashmole 1971), with their feet extended and touching the ocean surface but still remaining airborne; (3) aerial maneuvering; and (4) less commonly sitting on the ocean surface with folded wings and the head and neck submerged underwater. The last behavioral pattern appeared to be similar to the foraging behavior of the Audubon's Shearwater (Haney 1986d, Lee, pers. obs.).

On 5 May 1983, P. W. Stangel (pers. comm.) observed aerial "flushing" and chasing of flying fish by two Black-capped Petrels but did not observe successful capture. On one occasion, a petrel was seen diving 3-4 m from the air to, but not beneath, the ocean surface at an angle of 45˚-60˚. This behavior resembled "belly flop" diving or surface plunging by gulls (Ashmole 1971). Petrels were never seen diving beneath the ocean surface.

Nearly all birds collected off North Carolina birds were adults. Only three of them had bursas and these were assumed to be young birds. Males outnumbered females 43 to 20 (P=0.0056, two-tailed binomial test corrected for continuity). Male petrels were also generally larger. Weights of males ranged from 329-591 and females were 347-511.

Black-capped Petrels collected between 10 September through 29 April by Lee showed no sign of molt. Most May specimens exhibited no molt of flight feathers, but four of six collected

on 19 May 1982 were molting their inner-most primaries (1 new, 2-3 in sheaths and growing, 4 to 11 old). A single bird from 22 May had no sign of molt. All birds collected between 3 June and 21 August were molting primaries with the outermost primaries molting from 11-21 August. Body molt is most advanced toward the end of this period and tail molt occurs from May to July. The only available information previous to this study on molt is provided by Palmer (1962), who noted two birds taken in wing and body molt in August.

External parasites of Black-capped Petrels (n = 20) obtained off North Carolina include several lice (Phthiraptera). Taxonomic affinities of these lice include the family Philopteridae (*Halipeurus* [*Halipeurus*] *theresae, Trabeculus fuscocly peatus, Saemundssonia jamaicensis*, and the family Menoponidae *Austromenopon popellus* (Palma, pers. comm.). *Austromenopon popellus* is widespread on the petrel genera *Procellaria, Pseudobulweria, Lugensa and Pterodroma* (Pilgrim and Palma 1982, R. L. Palma, pers. comm.), including most of subgenus *Pterodroma* sensu (Imber 1985): *macroptera, lessonii, incerta, mollis* and *magentae*. However, this is the first record from the North Atlantic (Palma & Zonfrillo in press). *Saemundssonia* (*Puffinoecus*) spp. live on shearwaters and other petrels, but on gadfly petrels have so far been found only on several species of subgenus *Pterodroma* including *lessonii* and *caribbaea* (Pilgrim and Palma 1982). *Halipeurus theresae* belongs to the *H.* (*H.*) *procellariae* group of this genus, thus refuting Timmermann's (1965) suggestion that, if *P. hasitata* hosted a *H.* (*H.*) *marquesanuo* group louse, like *phaeopygia, cervicalis, alba* and *heraldica*, it would be the type of resurrected genus *Aestrelata*. *H. theresae* is found on other subgenus *Pterodroma* species in the North Atlantic and South Pacific Oceans (R. L. Palma, pers. comm.), as well as on two small Pacific species: *P. hypoleuca* and *P. axillaris* (Pilgrim and Palma 1982, R. L. Palma, pers. comm.).

Thus, three of the four louse species on *hasitata* are consistent with evidence from intestinal structure (Imber 1985) and from vocalizations (Wingate 1964, pers. obs.) that the Black-capped

Petrel belongs to subgenus *Pterodroma* and thereby closely related to the other extant North Atlantic *Pterodroma* species. However, *Trabeculus fuscoclypeatus* is not found on other subgenus *Pterodroma* species, but rather is hosted by numerous medium-sized tropical and subtropical gadfly petrels, mainly of the *Hallstroma* subgenus of Imber (1985) (R. L. Palmer, pers. comm.). Therefore, this louse is probably a secondary infestation from one of those species. Although carried by the Trinidade Petrel *P. arminjoniana* of the South Atlantic, this is a surface-breeder and contact between it and *hasitata* on breeding grounds seems unlikely. Rather, it is possible that the group of *Pterodroma* that radiated westwards from *P. cervicalis* in the south-west Atlantic Ocean at St. Heleana I. (now extinct, but represented among subfossil bones of gadfly petrels, e.g., Olson 1975, Meredith 1985), and possibly the Lesser Antilles. This could explain statements by Lafresnaye and Noble (in Murphy 1936) that two closely-related white-breasted petrels bred on Guadeloupe at different seasons. White-breasted *hasitata* is a winter-breeder, but the *cervicalis-baraui* group are summer-breeders. Thus up to three species should be sought among sub-fossil bones from the Antillean chain of islands: *hasitata, caribbaea*, and a lost species akin to one represented by sub-fossil bones on St. Helena I.

Little information is available on the diet of Black-capped Petrels (Clapp et al. 1982). Haney (1987) examined stomachs of three individuals collected off Georgia and found squid, fish (one a *Monocanthus hispidus*, 40 mm), and sargassum algal blades. Examination of 57 stomachs and crops of Black-capped Petrels collected off North Carolina revealed the following: squid beaks (in 86% birds), squid eyes (26%), fish (39%; including Gonatidae), fish otoliths (7%), pelagic shrimp (20%), chiroteutuidae (10 mm; 2%), pieces of *Sargassum* (16%), unidentified items (21%), feathers (5%; from preening), parasitic nematodes (2%), and empty 4%. The time of collection and degree of digestion indicate that most individuals feed at night or early in the morning, although birds were seen feeding during mid-day. Squid were certainly the most

frequently encountered food item, but beak fragments accumulate in crops and thereby may create the false impression of a preference for squid. No plastics or other unnatural items were recovered from digestive tracts of North Carolina birds. Haney (1987) recorded small pieces of petroleum residue and paper in one stomach. Weights of total stomach contents were as high as 35 g for individuals collected off North Carolina.

North of the Hatteras area of North Carolina, *Sargassum* is typically transported northward along the inner edge of the Gulf Stream and by oceanic fronts within the Gulf Stream. Black-capped Petrels have rarely been observed foraging in or near *Sargassum* lines like other pelagic seabirds (notably Audubon's Shearwaters and Bridled Terns). Presence of *Sargassum*, mostly floats, in the stomachs further nevertheless indicate that at least some foraging of the petrel probably takes place around sargassum mats, perhaps at night. The file fish *Monocanthus hispidus*, present in one stomach, is clearly a *Sargassum* associate. However, we do not believe that these petrels are as dependent on *Sargassum* faunal associates as important food sources. Platania et al. (1986) measured body temperatures of nine Black-capped Petrels and found a mean of 39.1˚ $\pm$ 0.6˚ (38.0˚ - 40.0˚) C.

CONSERVATION PROBLEMS

Nesting Areas. In former times, the French islands and Jamaica probably supported larger human populations than these islands' natural resources could physically sustain. Human populations were protein-deficient; thus, birds were considered a great delicacy. Consequently the petrels were hunted constantly during the breeding season. Often, dogs were used to locate burrows (Labat 1722). Even the difficult and dangerous cliffs were scaled in pursuit of the birds. The young in down, called "cottons" on the French Islands of Guadeloupe, were thought to be particularly succulent.

There is little doubt that the breeding population on Hispaniola has decreased since European colonization, but whether this trend still continues remains uncertain. The fact that peasants living near colonies were unaware of any change in petrel abundance during their lifetime may be significant. Some factors which obviously limit the breeding population now and which may reduce it further in the future include:

Human predation. Based on fragmentary written observations from the seventeenth and eighteenth centuries, these birds must have been consumed in considerable numbers:

> It may be said that these birds are a manna which sends every year for the Negroes and for the lowly inhabitants, who do not live on any thing else during the season. After two or three hours of hunting I returned with my Negro to rest to cook some birds for dinner. I began finally to hunt alone. We reassembled at midday. The four Negroes had 138 diablotins. Albert had 43, and I 17. Each of us ate two, and we left carrying the rest of our game. Those who read these memoirs will doubtless be surprised that we should eat birds in Lent; but the missionaries who are in these islands, and who in many matters exercise the power of bishops, after serious deliberation and a consultation of medical men, have declared that lizards and diablotins are vegetable food, and that consequently they may be eaten at all times (Labat 1722). Its flesh is so delicate that no hunter ever returns from the mountain who does not ardently desire to have a dozen of these "devils" hanging from his neck" (du Tertre 1654).

A practice of exploitation called "sen sel" continues on moonless foggy nights. Sen sel is a method for capturing petrels at breeding colonies (January through March) by lighting a moderate fire on a cliff top above a colony. Birds flying near the fire become disoriented and crash either directly into the fire or into nearby vegetation. Wingate (1964) notes that about 15 were caught using this method in February by employees of a logging camp at Casse Dent near Sequin, Haiti. Wingate (1964) tried to capture birds by sen sel on 12 nights but was successful only once when he captured four birds.

Wingate noted that the sen sel practice would seem to take an insignificant toll, but considering the small size of the colonies and the low reproductive yield of the species, it could be argued that any disturbance at the nesting area would be detrimental to the species' survival.

Unfortunately, the already dense human population on Haiti continues to increase, bringing more people in close proximity to breeding colonies. Although cliffs where Black-capped Petrels nest will continue to be inaccessible, agricultural clearings now extend close above and below these colonies. The standard practice of burning the cleared vegetation on these clearings was reported to have the same effect as sen sel.

Prior to the arrival of Europeans and slaves, seabirds were probably consumed by Native Americans. In addition to the *Pterodroma* remains from pre-Columbian middens on Crooked Island, Bahamas, Wing (1989) reports the remains of numerous Audubon's Shearwaters from a site on Antigua. The West Indies were populated rather recently, however. Casimiroid people arrived on Cuba and Hispaniola about 5,000 BP and did not migrate to central Cuba and the Bahamas until 800 and 1200 AD. Ortoroid people from South America arrived in the Lesser Antilles and Puerto Rico about 3000 BP (Rouse 1989).

Forest fires. Wingate (1964) noted that a direct development from increased human population is the higher frequency of accidental forest fires. The pine forest areas above colonies with their even ground cover of bracken (*Pteris longifolia*) are highly combustible. In recent years, ground fires have raged over vast areas of the pine forest, particularly in the Foret de Pins near La Selle in Haiti. A fire occurred 10-12 years ago in the Sierra de Baruaco in the Dominican Republic at the petrel breeding site (T. Varga, pers. comm.). Presently the pine forest of the area is a pine savannah with an open overstory. Such habitats allow for maneuverability by flying petrels. Although the forested cliffs generally escape burning because of the totally different nature of the vegetation, Wingate did record one instance where a patch of cliff face had recently been burned off adjacent to a petrel colony. Depending on the location and season, such fires could have disastrous effects on petrel colonies. Fire may, though, be important in

maintaining the open park-like savannah habitat at high elevation, similar to the role of earthquakes, hurricanes, and volcanoes in the pineless Lesser Antilles.

Deforestation. Since colonization by Europeans and Africans, most if not all West Indian islands where Black-capped Petrels bred or breed have lost a considerable amount of their original forest habitats. Direct effects of deforestation on petrels are unknown and may not always be detrimental, but the fact that deforestation has occurred most rapidly and completely in Haiti certainly bodes ill for the future long-term survival of the species. The increased presence of protein-deficient human populations so near the principal breeding population greatly increases the risk of direct exploitation through the practice of sen sel. Were it not for the fact that limited surface water restricts agricultural opportunities in the upland pine forests of Hispaniola, deforestation and occupation by humans would be even more pronounced.

On Gaudeloupe, where petrels have been extirpated for decades or centuries, little forest remains on the eastern island of Grande Terre and only 14,600 ha remains on the western island of Basse Terre (Johnson 1988). All forest habitats on Martinique have been affected by human activities (Davis et al. 1986), although remaining forest tracts on this island are among the largest remaining in the Caribbean (700-9,000 ha). Largely through government-sponsored silviculture, development of coffee plantations, illegal cultivation, and charcoal burning, forests on Jamaica are being lost at a rate of 20 km^2 per year (FAO/UNEP 1981), and all remaining areas of forest are severely threatened (Johnson, 1988).

Introduced mammals. The small Indian mongoose, *Herpestes auropunctatus*, has often been blamed for the decimation of *P. hasitata* and other native fauna of the West Indies. The mongoose may or may not have contributed to the extirpation of this seabird on the French Lesser Antilles. In any case, the process of extinction was well on its way by the time the mongoose was imported. The date of the first importation to the West Indies was 1872, when

four males and five females were released in Jamaica (Espeut 1882). The population expanded quickly and animals from Jamaica were introduced to 29 other Caribbean Islands. Introductions to other islands on which *Pterodroma* breed occurred by the end of the 1800's: Hispaniola (1895), Cuba (1882), Guadeloupe (1880-1885), and Martinique (1889) (Hoagland et al. 1989). Certainly, if birds were still nesting at lower altitudes then they would have been in great danger from the rapidly-expanding mongoose population. Wingate (1964) received reliable reports of the mongoose above 2,000 m on the Massif de la Selle, but it is apparently not common there as he saw none during 25 days at that altitude. It is possible that some breeding sites are inaccessible to this mammal.

Wingate (1964) set standard break-neck traps for rats above and below colonies near Morne Cabaio in Haiti in late February. These caught *Rattus norvegicus* and two distinct and sympatric races of *Rattus rattus*. The former were caught only near dwellings and farm land and thus probably do not come commonly into contact with the petrel. The latter was widespread and common even on steep cliffs, but Wingate (1964) believed they were unlikely to be a significant predator. *R. rattus* probably occurs throughout Dominica, but it is unclear if this is a major predator. Wingate (1964) concluded, unlike Murphy and Mowbray (1951), that *R. r. rattus* does not interfere much with the Cahow on Bermuda. However, *Rattus* are important nest predators on other burrowing petrels (Bourne 1981, Grant et al. 1981, Moors and Atkinson 1984).

The rat-like animal referred to by Nicoll (1904), and the introduced opossum on Dominica mentioned by Wingate (1964), are certainly the same animal. They may have been important predators of Black-capped Petrels in earlier times, when the birds may not have been restricted to mountain cliffs. The animal in question is *Didelphis marsupialis insularis*, a race described from material collected in Trinidad (Allen 1902). In addition to its introduction to Dominica in the late 1600's, this same race is established (presumably but not certainly through human

intervention) on St. Vincent, Grenada, and Martinique (Miller 1924). Although the role this mammal may have had in the extirpation or reduction of populations of Black-capped Petrels on Dominica and Martinique is unclear, the probability should be considered, as Nicoll (1904) found these animals in petrel burrows on Guadeloupe. Furthermore, its local introduction to these islands appears to be nearly two centuries earlier than the widespread introduction of the mongoose to Caribbean islands.

Haney and Lee (pers. obs.) noted the presence of feral house cats (*Felis domesticus*) at 7,000 feet in the Sierra de Baoruco in the Dominican Republic. The highest elevation at which they were observed was at the base of the petrel's nesting cliff. It is not known what potential problems, if any, these animals present to burrow-nesting petrels. Lesel and Derenne (1975) note cats eating the eggs of *Pterodroma macroptera* on Kerguelen Island. Moors and Atkinson (1984) summarize records of cat predation on seabirds, and cite a number of references to cats entering burrows and feeding on petrel-sized birds.

Lee and M. K. Clark (per obs.) found evidence that pre-Columbians living on Hispaniola had imported the coati (*Naysa naysa*) to the eastern part of that island. These were semi-domesticated and kept much like dogs. One specimen shot in the 1950's suggests that some survived in feral status. It is unknown what impact, if any, these carnivores had on nesting *Pterodroma*.

A proposed national park at Morne La Visite on the ridge of Massif de la Selle near its western terminus in Haiti, and a national park in the Sierra de Baoruco in the Dominican Republic, provide some habitat protection for part of the nesting population. However, Woods and Ottenwalder (1983) indicated that since Wingate's surveys in 1963, and their surveys in 1982, the population at Morne la Visite was reduced (although they note differences in population may be related to the season of the surveys). Likewise, it seemed to us that the small

colony in the Sierra de Baorunco had declined since its discovery in 1981. Unfortunately, the Dominican Republic colony is small and the proposed park area in Haiti covers only 2,000 hectares.

At Sea

Currently, there is a high probability that an exploratory test well will be put into operation along the edge of the continental shelf off the Outer Banks of North Carolina. Discovery of gas or oil at this site would almost certainly lead to major development of an area where major concentrations of Black-capped Petrels are known to occur (Fig.1). Because most of the birds using this area are adults, human activities would have a greater detrimental effect on the population than if it was composed mostly of younger birds. In addition, the loss of one member of a breeding pair could mean complete loss of the mate's reproductive potential for that year. Although the loss may be recouped in future generations, most populations of marine birds take years to recover from a single catastrophe.

Ford et al. (1982) developed a mathematical model that examines the effects of oil spills on breeding populations of seabirds by using Common Murre and kittiwake populations in the Bering Sea. Their model suggests that a catastrophic mortality of adults requires a longer recovery time for a population than does a similar mortality of young. They found that a loss of all young-of-the-year Common Murres in a single year would have a smaller effect on the population's recovery time than would 5% mortality of adults. A small decrease in adult survival or fecundity greatly increased the amount of time required for the affected populations to recover. Although Common Murres are highly susceptible to oil pollution, the results are probably applicable to other species with high adult survival rates. Ford et al. (1982) also pointed out that current chronic low-level pollution has stressed many bird populations to such an extent that they may not be able to recover from a single catastrophic event. In that a

significant portion of the Black-capped Petrels using North Carolina's offshore waters are males, the overall effect would certainly be more detrimental than the models produced for murres.

Lee and Socci (1989) discussed the susceptibility of the Black-capped Petrel to oil pollution at sea, but also noted that little information is available because of the apparent lack of encounters of tropical seabirds with oil spills. A Black-capped Petrel found on a Connecticut beach in 1938 was coated with oil (Holman 1952). Haney (1987) reported small pieces of petroleum residue in one stomach he examined. Clapp et al. (1982) stated that, in general, *Pterodroma* seem relatively invulnerable to spilled oil. However, little information is available to prove or disprove this assumption.

Off the North Carolina coast, the species occurs in a relatively narrow corridor. Because Black-capped Petrels are attracted to fish oil, they may be attracted to other surface-floating oils. When at rest, they collect in small rafts on the water and would be susceptible to oil contamination during such periods. Likewise, they are attracted to other individuals of the same species in distress. Thus, one polluted bird could attract large numbers to an area of pollution. Also, petrels are attracted to lights at night, especially on foggy nights. They fly at high speeds, and collisions with oil-rigging would certainly be fatal (Lee and Socci 1989). Telfer et al. (1987) reviewed and reported on the attraction of three species of Hawaiian procellariiforms to lights. One of these species was the related and endangered Dark-rumped Petrel, *Pterodroma phaeopygia sandwichensis*. An oil spill off the North Carolina coast could immediately jeopardize the global population of the Black-capped Petrel. Because large concentrations of this seabird occur at the proposed drill test site, artificial lights could heavily impact the population.

Lee (1980) reported that Black-capped Petrels had the highest concentrations of natural mercury in their tissues of any species of seabird he examined. Actually, this statement is so conservative as to be misleading. These petrels had mercury loads which were 7 to 9 times

higher than most of the 27 species examined (Whaling et al. 1980). Mean concentrations in 22 Black-capped Petrels examined were 150 µg Hg in muscle, 710 µg in liver, 124 µg in kidneys, and 1098 µg in feathers.

In a fourteen-year study of plastic ingestion in 38 species of seabirds collected off North Carolina, 21 contained plastic in their digestive tracts. The larger Procellariiforms consumed plastic most frequently. Black-capped Petrels, however, had an extremely modest frequency of occurrence (1.8% of 57 birds examined) compared to Northern Fulmars (86.4%) and locally-collected shearwaters (5 to 63.6%).

CONCLUSIONS

Pterodroma hasitata, a Caribbean endemic, currently survives only in small relict populations on Hispaniola and perhaps Dominica. No certain evidence exists that it ever bred on Cuba, despite published references that attribute breeding to that island. Historically, petrels occurred in Jamaica (*P.* (*h.*) *caribbaea*), Guadeloupe, and Martinique. Presence of *Pterodroma* in pre-Columbian middens on St. Croix and Crooked Island suggests an even wider range for this seabird taxon in earlier times. All breeding islands originally lacked large, native, predatory land mammals.

On islands currently used as nesting sites, the bird is now confined to high, inaccessible cliff faces. We assume that prior to the arrival of pre-colonial man, petrels were less habitat-specific, or at least occurred over much larger areas of the islands. Historical information indicates that petrels were not restricted to cliff faces prior to the colonial period, when Europeans and slaves greatly overpopulated many islands. A similar situation has occurred with island-nesting gadfly petrels in the eastern North Atlantic. The Gon-gon (*P. feae*) in the Cape Verde Islands and the Freira (*P. madeira*) on Maderia once bred in mountain woods, but deforestation has now largely confined these *Pterodroma* to a few inaccessible mountain ledges (Bourne 1955). Such habitats

may be marginal and not conducive to long-range survival. Introduction of various predatory mammals along with well-developed hunting techniques apparently led to reduction of Black-capped Petrels on all islands, and their complete disappearance from several.

At present, the main portion of the population occurs in Haiti where massive deforestation and continued hunting of the birds for food threatens their existence. Although it is not possible to directly compare population estimates conducted by different surveys under different field conditions and at different seasons, data suggest a decline at all sites that have been monitored since the initial discovery of the primary breeding ground in the early 1960s. At least one colony in Haiti has disappeared; in all cases field workers are estimating smaller populations than did their predecessors.

Marine waters off the southeastern United States are critical habitat for foraging Black-capped Petrels. The nonbreeding range of the Black-capped Petrel is centered in the South Atlantic Bight between North Carolina and Florida. Petrel records off Florida originate from the Cape Canaveral region northward (Clapp et al. 1982). It thus seems likely that Black-capped Petrels migrate from West Indies breeding colonies north and east of the Bahamas via the Antilles Current rather than through the Straits of Florida. The seasonal abundance patterns of petrels (Fig. 1) suggest that the species is distributed near and in the Gulf Stream to 36˚ N, and perhaps farther north to 40˚-45˚ N. Pelagic surveys in the northwest Atlantic (Brown et al. 1975, Rowlett 1980, Powers 1983) have not been extensive on the continental slope and more oceanic marine habitats of this region. Thus, while these petrels may occur regularly farther north than present records suggest, especially where Gulf Stream meanders and warm core rings occur near the shelf edge, there are little data to support this idea despite a modest amount of offshore observation.

Black-capped Petrels off the southeastern United States during the winter breeding season are reproductively-mature birds that apparently commute back and forth to nesting areas. Breeding *Pterodroma* are known to range up to several thousand kilometers from nesting sites (Warham et al. 1977), and Black-capped Petrels could disperse to the southeastern United States between incubation shifts (Clapp et al. 1982). Breeding cycles of different Black-capped Petrel populations among or within islands may not be synchronous, with part of the population breeding in winter and other subpopulations breeding at another time of the year. This is not known to occur in the subgenus *Pterodroma,* however, and we believe it highly unlikely.

Productivity in the surface waters of the Gulf Stream is very low (Yoder et al. 1983). Few seabirds occur in the Gulf Stream except near the western current boundary, where current-generated turbulence at seamounts on the Blake Plateau creates upwelling, and off the Hatteras area of North Carolina. The Black-capped Petrel is the only seabird present in the Gulf Stream all year. Behavioral and structural adaptations of gadfly petrels are such that they can exploit ocean niches where prey are widely dispersed (Imber 1985). Their low wing loadings allow efficient gliding (Warham 1977), but not sustained flapping flight. As a result, the Black-capped Petrel is dependent on wind for long-distance foraging and dispersal within this oligotrophic environment.

NEEDED STUDIES AND CONSERVATION MEASURES

All species of North Atlantic *Pterodroma* appear to be in jeopardy and their conservation status is of grave concern. We believe that because of the documented historical decrease in population by human cause, a small total current population which appears to be declining, continued and increased threats to known breeding colonies, and the potential for economic development within its major foraging area off North Carolina, the Black-capped Petrel should be regarded as Endangered. Vermeer and Rankin (1984) list *Pterodroma hasitata* as one of

seven endangered taxa of gadfly petrels. It should be officially listed as endangered, and offered the increase in protection and public awareness which accompanies such regulatory status.

As additional conservation measures, we recommend that : 1) genetic studies be initiated so that both the taxonomic status and population structure of the species can be determined, 2) one or more long-term monitoring sites be designated at breeding colonies, 3) satellite imagery be used to ascertain the amount of suitable breeding habitat remaining in Caribbean mountain forests, and 4) attempts be made to implement new technology (e.g., bioacoustic tomogaphy) for remotely counting breeding populations of this secretive, nocturnal species.

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Table 1: Measurements of *P. h. caribbaea* in mm.

N	Sex	Bill	Wing	Tail	Tarsus	Source
6	--	29-31(30)	270-281(275)	119-132(121)	35-37(35.8)	Palmer 1962
1	male	30	275	120.2	36	Murphy 1936[1]
?	--	--	274-279	125-127	35-36	Ridgway 1887[2]

[1]This bird was certainly included in the series listed by Palmer (1962).

[2]Converted from inches.