Petrels and storm-petrels in North Carolina's offshore waters: including species previously unrecorded for North America

. . . a review of all species and the first detailed, at-sea account of Band-rumped Storm-Petrel and Soft-plumaged Petrel

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Aside from storm-wrecked specimen records, little information exists about the marine distribution of Band-rumped Storm-Petrels (*Oceanodroma castro*) and almost none exists for Soft-plumaged Petrels (*Pterodroma mollis*) Thus, the occurrence of both of these species off the North Carolina coast is interesting, particularly since their presence does not appear to be a result of displacement by storms. This report is the first detailed, at-sea account of Band-rumped Storm-Petrels off the North American coast and the first North American record of the Soft-plumaged Petrel. Information on a probable Bermuda Petrel (*Pterodroma cahow*), and on the third and possibly a fourth North American record of the Herald Petrel (*Pterodroma arminjoniana*) is also presented. Most of these records are from deep-water zones (500-1000+ fathom contour). Current summary distributional maps (Tuck and Heinzel 1978, Harrison 1983) imply that these species should not be expected regularly in the western North Atlantic, but this is perhaps more the result of a lack of knowledge than a true reflection of the normal distributions of these Procellariiformes. In order to present these records in perspective, a review of all the species of petrels and storm-petrels found off the North Carolina coast is also provided.

STORM-PETRELS

BAND-RUMPED STORM-PETREL

Although there have been various reported instances of the occurrence of Band-rumped Storm-Petrels (synonymous with Harcourt's and Madeiran Storm-Petrel) in the United States, particularly in the Southeast, all are associated with storms and the species has been asumed to be an accidental. Peterson (1980) lists it as accidental in Florida, North Carolina, Montana, Indiana, Delaware, Pennsylvania and the District of Columbia, Ontario, and Quebec. It is also known from South Carolina (Shuler 1973), Tennessee (USNM 526349), and Texas (Oberholser 1974); there are single records for Brazil and Cuba. The northern and inland records certainly result from storm-blown casualties. In fact, Murphy (1936) cites several of the above-mentioned records as classic examples of long-range transport of birds trapped in eyes of hurricanes. The species is recognized as being highly pelagic, staying well out at sea, generally rather solitary, and an inhabitant of tropical and subtropical seas. The eleven coastal records for the Southeast are summarized by Clapp *et al.* (1982), and all appear to be storm-related. In addition, a specimen was found on the deck of a ship anchored east of Rehoboth Beach, Delaware, at 38°41'N, 73°34'W, on August 14, 1975 (USNM 567714).

To date I have accumulated over 75 sight records of Band-rumped Storm-Petrels in North Carolina waters. These range in season from May 30 through August 20. Except for two birds seen off Hatteras (May 30, 1982, *Am. Birds* 36:840) and four off of Beaufort (one on June 13, 1983 and three on August 20, 1983, Wayne Irvin *pers. comm.*), the sightings are ones I personally obtained off Oregon Inlet. With four exceptions all encounters have been in deep-water zones (500-1000+ fathoms). Three of my records (each of a single bird) are from 100-400 fathoms and Irvin's June sighting was from only 11 fathoms. The latter was encountered after nearly a week of strong east winds. The season and area of typical occurrence are consistent with the idea that this storm-petrel is a highly pelagic, warm-water species Surface sea temperatures ranged from 80.2°-83.1.°F for my 70+ records. But the species is not confined to the Gulf Stream. On a trip on July 25 into deep "green" water east of Oregon Inlet, we encountered at least six individuals. Surface water temperatures ranged from 80.2°-80.5°F. Although the seas were warm, the birds were not associated with the blue waters of the Gulf Stream. This

temperature range is certainly within what is normally recorded in areas where the Gulf Stream flows through shallow water during the summer. In that the Band-rumped Storm-Petrels were not encountered regularly in shallow Gulf Stream areas, it is evident that water depth is a key factor in the normal distribution of this species (see Fig. 1).

Observations of Band-rumped Storm-Petrels off North Carolina (arranged chronologically by month, all off Oregon Inlet unless otherwise stated) are as follows (* = specimen record): May 30, 1982, 37 miles SSE of Hatteras Inlet, two birds (*Am. Birds* 36:840) at about 1000 fathoms (Captain Alan Foreman *pers. comm.*); June 13, 1983, off Beaufort, one bird (W. Irvin); June 22, 1972, storm wreck, Atlantic Beach, one bird (*Chat* 38 23, *USNM); July 4, 1983, four birds (DSL, *NCSM); July 12, 1983, 20 birds (DSL, *NCSM); July 19, 1983, 20+ birds (DSL, *NCSM); July 25, 1983, six plus birds (DSL, *NCSM); July 29, 1981, one bird (DSL, *NCSM); August 9, 1983, eight birds (DSL); August 11, 1981, 12 birds (DSL, *NCSM), August 20, 1983, off Beaufort, three birds (W. Irvin). I should point out that my offshore counts are extremely conservative. When flushing flocks of resting storm-petrels, I could normally confirm only one or two as Band-rumpeds before they dispersed. In actuality probably many more of the birds encountered in flocks were this species. Many single flying birds which I suspected were Band-rumpeds were not included in these tallys.

This brings up the question: If Band-rumpeds are so regularly encountered off North Carolina in the summer, why had they not been reported previously? There are several answers to this question. First, the species has not been encountered regularly except off Oregon Inlet. Most of the regular bird-watching trips operating in the area depart from Hatteras Wayne Irvin, a research associate of the North Carolina State Museum (NCSM), has been surveying the deep waters off Beaufort regularly and he has only seen four. Thus the species may not be uniformly distributed along the entire southeastern, or even the North Carolina, coast. Second, most of the regular trips are timed to encounter spring and fall migrants, and are just outside the documented period of occurrence for Band-rumped Storm-Petrels. Third, my previous summer's offshore work was concentrated along the inner edge of the Gulf Stream (*ca.* 100 fathoms) and I did not have much opportunity to encounter the species. Fourth, summer storm-petrels were not studied carefully until observers became aware that Band-rumpeds probably occur regularly. Interestingly, the birds found on May 30, 1982 were seen and identified only days after the March-April 1982 *American Birds* [36(2)] arrived in the mail, bringing word of my July 29, 1981 offshore specimen.

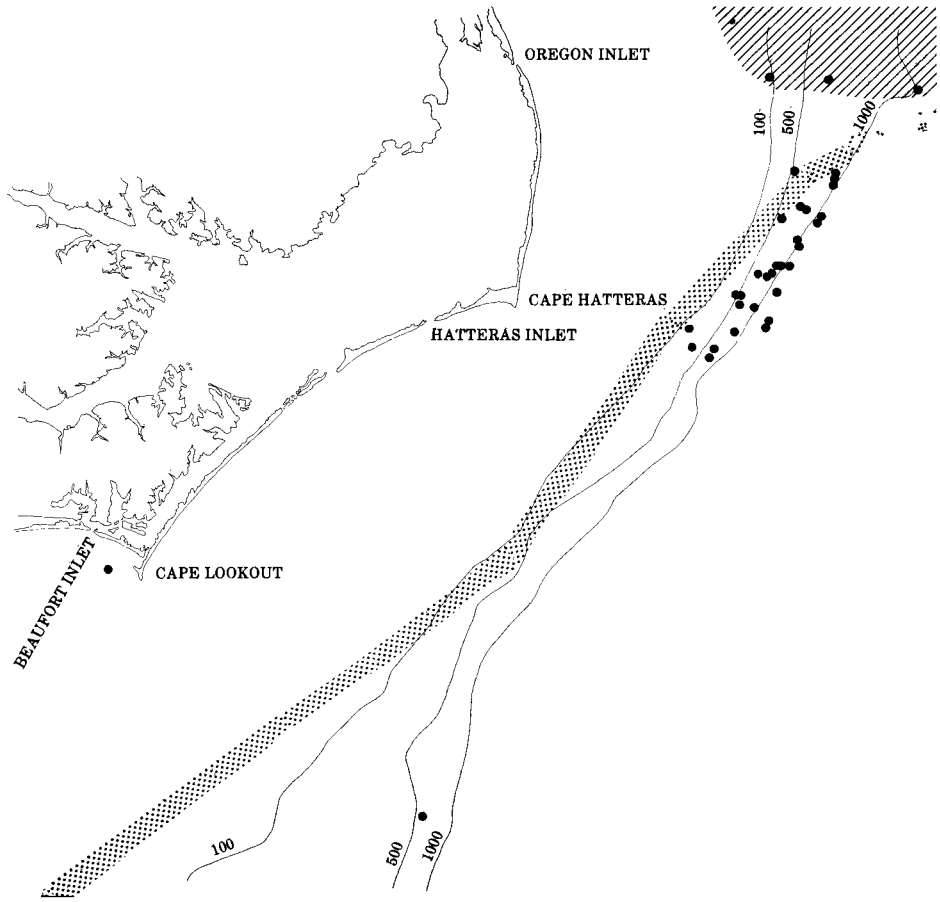

Figure 1. *Map of general area discussed. 100, 500 and 1000 fathom contours marked. Inner edge of Gulf Stream stippled. Diagonal lines indicate deep green water zone from which several White-faced Storm-Petrel records were obtained. Dots indicate sightings of one or more Band-rumped Storm-Petrels in 1981 and 1983.*

A North Carolina State Museum staff member who was on the July 29, 1981 trip had a good opportunity to study the species at close range. He was also on the May 30, 1982 trip and was not convinced that the birds were Band-rumped Storm-Petrels. They certainly were not Wilson's Storm-Petrels (*Oceanites oceanicus*), but in his mind not conclusively Band-rumped either. They were observed as close as 25 yards along with Wilson's, further attesting to the problems of positive identification of storm-petrels at sea. Paul DuMont generously sent me a draft copy of a summary of his observations that later appeared in *American Birds* (36:840; summarized by Harry LeGrand, with comments by R.L. Ake). He provided a convincing account as well as some good points for field identification, and I see no value in scrutiny of the record. Although his is the earliest record for the area, it is certainly within a reasonably expected season of occurrence

Based on this information, the period of occurrence for Band-rumped Storm-Petrels in the western North Atlantic is from late May through mid-August, with peak abundance in mid-July. Offshore trips I have made into deep-water areas in mid-May and throughout the fall suggest the bird is not present much outside of this period. This expected season of occurrence is consistent with the molt sequence of the specimens collected (see below). Furthermore Berndt *et al.* (1966, *in* Cramp and Simmons 1977) saw birds believed to be this species in the mid North Atlantic (43°30′-48°30′N west to 42°30′W) in June and July, and the previously mentioned Delaware record is from August 14, whereas on trans-Atlantic voyages Harris and Hansen (1974, *in* Cramp and Simmons 1977) found them only in the vicinity of known breeding stations between October and November

Band-rumped Storm-Petrel, showing darker wing coverts than Wilson's, and feet not projecting beyond tip of tail. Photo/R. Naveen.

The pelagic distribution of *Oceanodroma castro* in the Pacific is rather extensive (Crossin 1974) so it should not be particularly surprising that it is wide ranging in the North Atlantic as well. That this documentation has developed in such piecemeal fashion is a reflection of the limited effort put into seabird study in the North Atlantic.

While I feel comfortable that the seasonal distribution of this species in the western North Atlantic is fairly well understood, the birds' geographic distribution is not. To date, North Carolina is the only area where Band-rumped Storm-Petrels have been encountered regularly, but this is a result of concentrated field effort. Excluding storm-blown individuals there is only the previously mentioned Delaware record to the north. Rowlett (1980) does not record any from his study area in the Northern Chesapeake Bight, but his cruise transects do not go farther east than the 100-fathom contour. South of Hatteras, because of the great width of the continental shelf, it is difficult to make regular trips into deep-water areas (and virtually impossible to do so on one-day cruises). J. Christopher Haney has been conducting systemic surveys off the Georgia coast. To date he has accumulated three sight records of Band-rumped Storm-Petrels (18 days of observation). One record from September 4 slightly extends the known period of occurrence in the western Atlantic. Two birds were between the 100- and 200-fathom contours and the third was over only about 40 fathoms. This latter sighting was in an eddy of the Gulf Stream (Haney, *in press*). Haney has not surveyed deep-water areas so it is not possible to compare information on abundance or even the regularity of occurrence.

Behavior at sea

The band-rumped storm-petrel's behavior at sea in many ways closely parallels that of Leach's Storm-Petrel (*Oceanodroma leucorhoa*). Unlike Wilson's Storm-Petrels, *Oceanodroma* species are not attracted by chum, do not follow boats, and seldom approach them. In fact it is difficult to follow them in boats and even more difficult to approach closely. They typically retreat and stay away at the approach of a boat. I have watched Band-rumped Storm-Petrels feeding in association with other seabirds—Cory's (*Puffinus diomedea*), Greater (*P. gravis*), and Audubon's (*P. lherminieri*) shearwaters, Black-capped Petrels (*Pterodroma hasitata*), and Wilson's and Leach's storm-petrels. Unlike other western Atlantic storm-petrels, they do not hesitate to alight on the water to feed. In my experience the other storm-petrels normally alight on the surface only to rest. In July and August 1981 we followed several for long distances. They would fly to surface-feeding shearwaters, alight on the water, attempt to feed with them, and then take off as our boat approached. Frequently we found small flocks (5-30 individuals) of sitting storm-petrels, apparently resting together after communal feeding. Sometimes these flocks would be composed entirely of Band-rumped Storm-Petrels, at other times a few Band-rumpeds would be mixed in a flock of Wilson's, and once we collected both of these species and Leach's Storm-Petrels in a single flock (July 19, 1983). Approximately 50% of all Band-rumped Storm-Petrels I encountered were flushed from flocks resting on the surface. When approached in mixed resting or feeding flocks, Band-rumpeds invariably were off the water and several yards away before any other birds took wing. During July and August about 80% of all rafts of storm-petrels I found in deep water contained one or more Band-rumped Storm-Petrels.

In flight Band-rumped Storm-Petrels often fly higher above the ocean's surface (1-3 m) than do our other storm-petrels, and characteristically soar like shearwaters. They tend to be more direct in their flight than Wilson's or Leach's storm-petrels, but some of this is certainly because we were frequently in pursuit of the birds. None of the birds I observed pushed forward ("foot-patter") with their feet as Wilson's often do. The zig-zag flight of Band-rumped Storm-Petrels has been noted by several authors (Harrison 1983, Naveen 1981-1982, and others). They do characteristically fly in a zig-zagging course but the angles are slight and this aspect of the flight pattern may not be conspicious. Wilson's also may fly in zig-zag paths when tacking into the wind. In high wind or when closely pursued, Band-rumped's straight-line flight predominates. W. Irvin (*pers. comm.*) estimated a rapidly flying bird

doing little soaring to be traveling in excess of 18 knots (20.7 mph). Several we pursued went even faster.

In gliding flight, the birds hold their wings parallel to the water surface with the outer primaries bowed below the rest of the wing. They resemble a small Audubon's Shearwater in flight, and they normally remain at a constant height. Additional behavioral information is provided by the various authors attempting to describe differences between storm-petrels for identification purposes. Here I am reporting only aspects of behavior I myself have noted.

Age, weights and other measurements

Based on molt sequence of collected individuals, five male and four female birds all were post-hatching-year individuals. The absence of bursae indicated they were not juveniles. Reproductive organs were reduced, but correspond in size with other breeding-aged storm-petrels we have collected. Male gonads ranged from 1 × 2 to 3 × 5 mm and females from 4.3 × 4.4 to 5 × 6 mm, with no seasonally correlated change of size. Total weights ranged from 42.8 to 50.6 gm for males and from 45.9 to 49.2 gm for females. These weights are heavier than those reported from nesting grounds (41.7 gm mean, sample 376 Galapagos, Harris 1969; 43.5 ± 5.0 gm mean, sample 12, Ascension, Allan 1962). Other measurements were variable (see Table 1) but well within the range of an adult sample of 18 males and eight females from the Selvagens, Madeira, and the Cape Verde Islands (see Cramp and Simmons 1977), and study of individuals from various breeding sites around the world shows no significant geographic variation (Austin 1952). We also measured total length and wingspread on freshly collected individuals. Total length varied from 179 to 201 mm and wingspan from 444 to 472 mm (see Table 1).

Molt

Published information on molt in Band-rumped Storm-Petrels is scant. According to Cramp and Simmons (1977), molting starts with inner primary and body feathers during the last stages of the breeding cycle and wing molt is just completed at the onset of the next breeding cycle. Crossin (1974) presents information on molt sequence of 10 specimens collected in the Central and Eastern Pacific. Since the North Carolina series of specimens is composed entirely of post-juvenile birds, the information provided by their molt sequence deserves discussion. In the earliest specimen, collected June 22, all of its feathers appear old and worn (I did not examine the innermost primaries of the folded wings of the specimen and the early stages of the molt sequence may have commenced), and it is assumed that the bird had recently arrived from its nesting area. Our single July 5 specimen is aberrant and will be discussed separately. One July 12 bird has new innermost primaries (#1-7), primary #8 is one-half developed and #9-11 are old. The primary coverts and tail coverts are in a similar developmental stage. Four of the secondaries on each side and the left side of the tail are in molt. There is no head molt, and the body molt is moderate. The four birds collected on July 19 are all in a stage slightly advanced beyond the July 5 specimen in wing, body, and tail molt. The innermost primaries (#1-7) in three specimens are new, and primary #8 is one-half to three-fourths developed, #9 is still in its sheath and #10 and #11 are old. In the fourth specimen #1-8 are new, #9 is three-fourths developed, #10 is breaking its sheath and #11 is old and missing on the left and right wings, respectively. The primary and tail coverts are in approximately the same sequence. The secondaries are also in molt with various feathers missing, old, in sheath, and new. Molt is heavy on the head, neck, back, and belly in three of the birds, and heavy in the head and neck of the fourth. The tail feathers are in various stages of molt on all birds in this series, although Cramp and Simmons (1977) state that the tail molt is irregular (I assume this refers to season). On a single July 29 bird the primaries are all new, about 50% of the secondaries are new and the body and tail molt is nearly complete. The upper tail

Table 1. Weights and measurements of storm-petrel specimens from the Carolinas.

Species	*Weight*	*Wing Span*	*Wing Chord*	*Total Length*	*Tail Length*	*Tarsus*
Wilson's Storm-Petrel						
Average of 10 male and 10 female NC specimens	32.9 g	414 mm	144 mm	174.8 mm	76.5 mm	34.1 mm
Leach's Storm-Petrel						
Male NCSM 4194	——	——	161 mm	——	85 mm	25 mm
Male NCSM 8784	40.8 g	471 mm	——	206 mm	——	——
Male NCSM 9515	43.0 g	471 mm	155 mm	198 mm	83 mm	21 mm
Female NCSM 7899	37.6 g	——	152 mm	197 mm	81 mm	24 mm
Female NCSM 8770	44.1 g	460 mm	154 mm	207 mm	81 mm	23 mm
? USNM 564835	——	——	162 mm	——	86 mm	24 mm
Band-rumped Storm-Petrel						
Male ChM 1972.37	34.0 g	——	147 mm	176 mm	75 mm	21 mm
Male NCSM 8049	47.2 g	451 mm	148 mm	193 mm	74 mm	26 mm
Male NCSM 9514	50.6 g	472 mm	154 mm	199 mm	70 mm	23 mm
Male NCSM 9527	49.3 g	438 mm	144 mm	189 mm	70 mm	21 mm
Male NCSM 9536	42.8 g	444 mm	144 mm	179 mm	64 mm	22 mm
Male NCSM 9549	48.4 g	456 mm	153 mm	193 mm	70 mm	21 mm
Female NCSM 9513	45.9 g	452 mm	152 mm	193 mm	69 mm	21 mm
Female NCSM 9512	49.1 g	463 mm	152 mm	194 mm	68 mm	21 mm
Female NCSM 8037	49.2 g	467 mm	151 mm	201 mm	71 mm	25 mm
Female USNM 566873	——	——	147 mm	——	70 mm	23 mm
White-faced Storm-Petrel						
Female USNM 527825	47.6 g	424 mm	151 mm	——	73 mm	51 mm

coverts exhibit a moderate molt. The August 11 specimen has entirely new flight and tail feathers although many of the coverts are still in sheath and the back is in heavy molt. This represents our latest specimen record. I assume that the entire molt takes 9 to 10 weeks and once it is completed the birds depart for their breeding grounds. Such a molt sequence is in line with other storm-petrels whose migration is not transequatorial (Scott 1970).

The July 5 specimen is out of phase with the above molting sequence. The bird (NCSM 9536) is smaller in overall length and weight. Its wing length is similar to the other specimens (see Table 1), but the rump patch is narrower. This bird has completely new primaries, secondaries and wing coverts and moderate to heavy head and body molt. The tail feathers are in all stages of development. The only specimen (and record) for South Carolina (Charleston Museum # 1972 37) is also of a small bird with a narrow (and off-white) rump patch. Its molt sequence is out of phase with the North Carolina specimens except for the one collected on July 5. The tail contains a mixture of mostly old and a few new feathers. Some head and body molt is apparent. On both wings the outer two primaries are old, the next one about one-quarter grown and the rest are new. There is no reason to assume it would not have been at the same molt stage as the July 5 bird by the first or second week of July. The specimen was captured alive after strong southeasterly winds 5 miles south of McClellanville, Charleston County, South Carolina; its stomach was empty and it had no subcutaneous fat. Size and weight information appears in Table 1. Harris (1969) notes that, as a rule, populations in areas with warmer surface waters have longer extremities and less white in the rump compared with those in cooler waters. A larger series of western North Atlantic birds would be useful, but these specimens strongly suggests that two or more breeding stocks occur off the North Carolina coast.

Because of the angle of the carpal joint of *Oceanodroma* and the orderly and singular replacement of flight feathers, it is not possible to note molt sequence in flying birds, as it often is with *Oceanites* and most shearwaters. This is unfortunate because it would be advantageous to collect specimens selectively, based on molt sequence, in order to determine a bird's age and possible taxonomic variations.

Food

THE ONLY SUBSTANTIAL INFORMATION is that supplied by Harris (1969), who examined 15 stomachs of Galapagos specimens. He found that Band-rumped Storm-Petrels feed on small fish and cephalopods. Regurgitated fish of two mist-netted adults were 37 and 50 mm in length, and an estimated cephalopod weight, based on beak size, was 3-4 grams.

The birds we saw were definitely feeding during the day, and the two collected in 1981 were obtained only because they were preoccupied by feeding activity, although their stomachs were nearly empty.

A total of eight stomachs was examined. One was completely empty and none contained recently consumed material; birds often disgorge large, recently consumed food items during collection. Six contained digested portions of small fishes—fleshy parts, small bones, vertebrae, eye lenses or otoliths. One bird contained six otoliths that measured 1-3 mm in diameter. Two contained portions of squid beaks 1.5 mm length. One contained a large nematode and one numerous segments of a tapeworm. A feather, presumably ingested while preening, and a small bit of gravel were also recorded.

Identification at sea

THE PRINCIPAL OBSTACLE in understanding the marine distribution of Band-rumped Storm-Petrels has been an inability to distinguish this species from other white-rumped storm-petrels. This knowledge deficit has only recently been alleviated (Brown 1980, Naveen 1981-82, and Harrison 1983a, 1983b). People not aware of field identification problems at sea will have difficulty appreciating how inadequate most field marks are for species recognition even under ideal sea conditions.

Naveen (1982) correctly notes that as a first step in identifying Band-rumpeds, ". . . you must know Wilson's Storm-Petrel very, very well. . . ." Wilson's Storm-Petrels have a vast repertoire of flight behaviors, several of which closely resemble those of both *Oceanodroma*

Wilson's Storm-Petrel, showing paler wing coverts than Band-rumped, and feet projecting beyond tip of tail. Photo/R. Naveen.

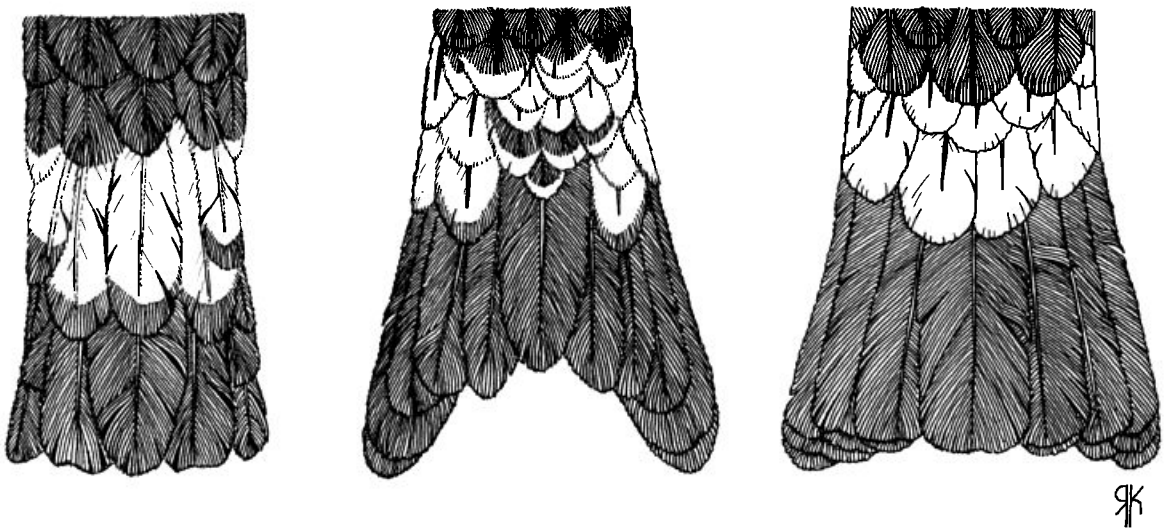

Figure 2. *Tail shape and pattern of typical summer (left-right) Band-rumped, Leach's and Wilson's storm-petrels.*

species. Their abundance in both the season and zone in which Band-rumped Storm-Pertrels occur on one hand compounds the problem, but on the other usually provides a handy comparative reference. Leach's Storm-Petrels are even closer in structural appearance and size, and also are found, although not commonly, in the same season and offshore zone.

Band-rumped Storm-Petrels look (and are) larger than Wilson's and normally fly differently. Contrary to statements previously published, the difference in overall size between Wilson's and Band-rumped Storm-Petrels is striking in the field and in hand. (This is in contrast to the measurements in Table 1, where wings were extended to their maximum.) I laid out fresh specimens of each and traced overall outlines of the birds, positioned in typical flight profile. Comparing these illustrations Wilson's was 30% smaller in wingspan and 12% smaller in total length than Band-rumpeds. Surprisingly, Leach's were 5% smaller in wingspan but their total length was similar; however, when the wings of Leach's are stretched to their full extent, they are somewhat larger (also see Table 1). These differences are more striking in the field because Wilson's and Leach's do not typically hold their wings horizontally, as traced on the paper, and therefore give the impression of having even shorter wings.

The trailing edge of the wing on Band-rumpeds is nearly straight, even when the primaries and secondaries are in molt. This is not true for Leach's, and because of wing angle this area of the wing does not appear straight in flying Wilson's. As pointed out earlier, Band-rumped Storm-Petrels tend to fly higher, with stiff horizontal wings, glide more, and have a less erratic flight than other locally occurring species. The wings do not appear to rise above the horizontal on the upstroke, producing what others have referred to as a shallow wing beat. Leach's Storm-Petrels fly erratically, reminding one of a low-flying nighthawk (*Chordeiles*); Wilson's Storm-Petrels have a wide repertoire of flight characters, and both Wilson's and Leach's regularly lift their wings above the horizontal, but this varies with wind conditions.

Under good observation conditions the long legs of Wilson's can be seen protruding past the tail or hanging below the body, but they do not normally show on Band-rumped or Leach's. The yellow webbing of Wilson's can seldom be seen, and I have collected one specimen (NCSM 5948) that has no yellow in the webbing. The forked tail of a Leach's Storm-Petrel is not obvious from certain angles and the protruding legs of Wilson's Storm-Petrels could be mistaken for a forked tail. The tail shapes of Band-rumped and Wilson's storm-petrels are slightly different (see Fig. 2), but this would not be a good field character. Some literature suggests the tail of the Band-rumped is slightly forked. This is not the case in specimens I examined, and "slightly concave or nearly square-tailed" would be a more accurate description.

Band-rumped Storm-Petrels look darker overall than summer Wilson's or Leach's. This is partly a result of the wing coverts on Wilson's and Leach's being frayed and worn in the summer, giving the illusion dorsally of a distinct diagonal bar and ventrally in Wilson's of a white flash mark under most light conditions.

Rump patches in Band-rumped Storm-Petrels are reportedly even cut. This is a result of the white tail coverts being black at the terminal end, masking a feathered look. The high percentage of molting upper tail coverts during the season when the birds are off North Carolina, however, tends to make this a less than ideal field mark (see Fig. 2). The various stages of feather growth arrange the black areas in such a way that a clear white band is not evident. People suggesting this as a viable field character are basing it on observations or specimens near nesting grounds when the rump is not in molt. I did not find the shape of the rump patch to be a reliable field character for birds summering off North Carolina. The rump patches of both Wilson's and Band-rumped storm-petrels are, however, bright and clear (except for the one South Carolina specimen) compared to Leach's. All Leach's specimens observed or collected for North Carolina have generally off-white rump patches, partly obscured by darkish feathers down the center. Again the molt of the upper tail coverts leaves dark-edged feathers in various stages of development, even further obscuring the patch. The birds would be closest in appearance to reference specimens 6 and 7 in Ainley's (1980, Fig. 1) study of geographic variation in Leach's Storm-Petrels. Thus, Leach's are birds with light upper wing coverts

and smudgy rump patches, and Band-rumpeds conversely are all dark-winged with white rumps (Harrison 1983a).

The white rump of Band-rumped Storm-Petrels extends around the side of the tail more than in a Leach's but less than in Wilson's (Naveen 1981-1982). This can normally be seen only under good light and sea observation conditions.

The size difference in our locally occurring storm-petrels is not great enough for me to spot individual differences easily in rafts of birds resting on the water. This field problem is further compounded by the Band-rumped's habit of quickly departing as a boat approaches. All local storm-petrels, unlike phalaropes, for example, seem to have the same overall size and profiles when resting on water.

In spite of warnings to the contrary, Band-rumped Storm-Petrels can be recognized easily after a little field experience, and can be spotted immediately as something different by anyone tuned in to behavioral profiles of storm-petrels, even when they have not had previous experience with this species. The behavioral differences are the key points, and students who have relied strictly on field marks for identification will probably have problems recognizing these birds. Persons who accompanied me on various offshore summer trips had no trouble distinguishing Band-rumped Storm-Petrels from the hundreds of Wilson's Storm-Petrels we encountered. Often they were able to identify individuals correctly at considerable distances. We were able to confirm these identifications with occasional collecting of specimens, which undoubtedly shortened the learning time.

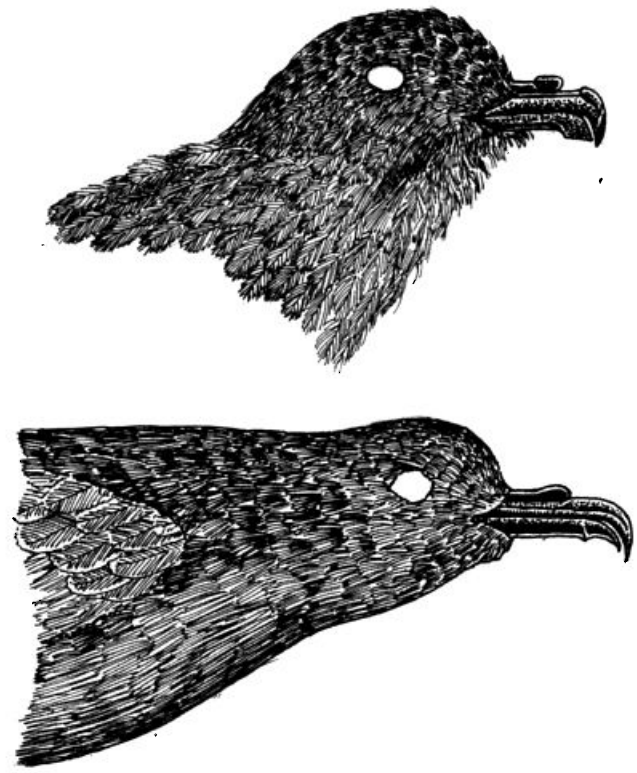

Figure 3. *Head profiles of Band-rumped (above) and Leach's (below) storm-petrels.*

LEACH'S STORM-PETREL

THERE ARE SURPRISINGLY FEW RECORDS for Leach's Storm-Petrels from North Carolina. Locally, it is essentially a transient with a recorded spring migration period from May 12 to June 25. In the fall the species has been seen from between September 16 and the first week of November. An August 21, 1980, specimen record (NCSM 8770) is of an adult bird, which I assumed was a vagrant that had left its breeding area early as a result of nest failure (see information below on molt). However, several birds were seen (and one collected) on July 19, 1983, and I suspect the species is more common in the summer than our few records indicate. The National Museum has two summer specimen records—from Maryland (August 16, 1972, USNM 566273) and off Delaware (August 11, 1975, USNM 567713). The North Carolina region does not appear to provide areas attractive to the Leach's Storm-Petrel, which is a cold-temperate equivalent of the Band-rumped. Rowlett (*pers. comm.*) regards Leach's as a deep-water species off the Maryland coast. Accessible deep-water areas off North Carolina, however, are mostly dominated by the warm Gulf Stream, which may account for the high percentage of inshore records of this bird (see Lee and Booth 1979). Many Leach's we encounter are moving rapidly north or south during migration. Nevertheless, we have also encountered, well within the Gulf Stream and even in the summer months, individual birds that did not seem to be actively migrating. Excluding two storm-wrecked individuals, there are only four specimen records for North Carolina.

On December 5, 1978, I observed a storm-petrel that probably was this species, and one was seen from the Chesapeake Bay Bridge-Tunnel, Virginia, on January 10, 1971 (*Am. Birds* 25:558). Another Leach's was seen off Oregon Inlet on April 2, 1984. However, lack of sufficient offshore winter observations makes any statement concerning the winter status of Leach's Storm-Petrel speculative at this time.

The molt information we have on North Carolina birds is scant. The July 19 specimen is an adult showing no molt, and the feathers appear worn. The August 21 specimen, also an adult, is well advanced in its molting sequence. Primaries #1-6 are new, #7 is three-fourths developed, #8 is in sheath and the outer #9-11 are old. The primary coverts, head and neck are in heavy molt, the body in light molt, and the tail feathers are all new. Other specimens are from spring or fall have no observable molt pattern although most are immature. Cramp and Simmons (1977) and Ainley *et al.* (1976) state that some body-feather molt starts at the end of the breeding cycle, the tail and wing feathers molting soon after. Adults blown ashore in Europe between October and November exhibit early stages of tail and primary molt. The main molt occurs from November through February in the wintering areas. A similar cycle exists for Pacific birds (Ainley *et al.* 1976). Nonbreeders, and I assume this includes individuals with nesting failures, may start primary molt between August and September. The molting August 21 specimen, is an adult bird (based on lack of bursa and gonad size) so apparently its

presence off North Carolina in the summer resulted from an early nesting failure. Its molt is well advanced beyond what one would expect for the time of year.

Food habits of Leach's Storm-Petrels have been discussed or studied by various authors, with the findings compiled most recently by Cramp and Simmons (1977) and Clapp *et al.* (1982). Little information is available about specific food habits. Four stomachs I examined all contained food items or traces of food items. All contained remains of small fishes; one stomach had 10 otoliths (2-8 in diameter). Legs of a small anthropod and a small squid beak were present in one. One bird had recently consumed a pink, 15-mm ctenophore and one had two 12-mm jellyfish, very likely the pelagic hydroid *Velella*. A piece of thread approximately 110 mm long was also in one stomach. The presence of ctenophores and hydroids in the stomachs is most interesting. Although they have not previously been reported such food items would probably be digested so quickly that it would be difficult to assess how regularly they are consumed.

Stomachs of Leach's Storm-Petrels were larger than those of the Band-Rumped and based on eye-lens and otolith size, prey was somewhat larger. Except for the "jellyfishes" no intact food items were present in any of the *Oceanodroma* I examined.

WHITE-FACED STORM-PETREL

ALTHOUGH THERE ARE SEVERAL additional records of White-faced Storm-Petrels to report since 1979 (see Lee and Booth 1979), I do have some speculations on their area of occurrence. Two of North Carolina's non-storm-related records are from east-northeast of Oregon Inlet. All but three of my 95 offshore trips, and all trips by others off North Carolina, have been south of Oregon Inlet and usually into the Gulf Stream. To the northeast of Oregon Inlet is a deep "green-water" zone, which normally lies inshore of the influence of the Gulf Stream (see Fig. 1). The two birds collected, and a few other less detailed reports from boat captains, have come from this region in the late summer and fall during a period when migrating White Marlin (*Tetrapturus albidus*) regularly inhabit the area. The species probably does not occur in less than 100 fathoms of water, and would typically be expected in water that is much deeper The few visits I have made to the area have not revealed any noticeable difference in composition of the bird fauna, but the number and diversity of marine mammals, particularly large whales, is strikingly different from what is routinely observed in the deep-water areas in the Gulf Stream. Since the Hatteras region is, to date, the southernmost recorded area of occurrence for *Pelagodroma* in the western Atlantic, and since there are a number of sightings in late summer and fall off states to the north, I suspect that this deep "green-water" area off northeast North Carolina represents the White-faced Storm-Petrel's southernmost area of normal occurrence, and that strays will be encountered only rarely south of the Hatteras area.

On August 28, 1981 a single bird was seen and photographed over deep water off Cape Hatteras, and two were seen on October 9, but details have not yet been published. The large number of survey trips off Hatteras further supports the idea that this storm-petrel does regularly occur here, but the regularity of its occurrence in the area described above is yet to be determined.

The one stomach I examined contained the partial skeleton of a small fish and 6+ marine water striders, *Halobates micana*. The latter food items were not found in any of the other storm-petrels I have examined. No detailed food studies have been conducted for this storm-petrel and all of the incidental reports of food have come from the Southern Hemisphere.

GADFLY PETRELS

SOFT-PLUMAGED PETREL

FEW REPORTS OF THE Soft-plumaged Petrel are available away from its breeding areas, and this species has not previously been recorded from North America. It is one of the least known seabirds in the North Atlantic, with small populations having staggered breeding seasons on various subtropical islands in the eastern North Atlantic (Madeira, *ca.* 50 pairs; Desertas, 45-50 pairs; and Cape Verde Islands, 100 pairs; various sources). The extent of the marine range is unknown, and there are only four pelagic reports: two southwest of the Canary Islands, September (Bourne 1955); one off Guinea, April (Bourne 1965); one off Mauritania, September (Bourne and Dixon 1973, in Cramp and Simmons 1977), and an old report of large numbers off Guinea in May (Bannerman 1914) However, the species is common and widespread in the Southern Hemisphere, even though it also nests at relatively few locations in that region.

A single Soft-Plumaged Petrel was seen off Oregon Inlet on June 3, 1981 (35°13′N, 74°51′W). The bird was over 1000-fathom-deep water having a surface temperature of 75.6°F. It looked slightly larger than any of several Audubon's Shearwaters flying near it. The bird flew from left to right 40 to 50 yards in front of the boat and was studied well. It exhibited a *Pterodroma* "roller coaster" flight pattern, banking first one way and then another so that both the dorsal and ventral surfaces were viewed. The ventral surface was exposed when the bird was directly in front of the boat. The arcs in the flight were not nearly as high as those of Black-capped Petrels seen on the same day, but like Black-capped Petrels, one wing or the other was pointed down as the bird flew. The following field marks were observed: wing profile pointed, crooked; underwings dark, darkest on leading edges but not pronounced; ventral surface of body white with a visible, seemingly complete, dark neck/breast band; dorsal surface of body and wings gray, large pale rump and tail; head and face with some white pattern, with a dark eye streak, and different from that of Black-capped Petrel, though not well studied. The bird had a compact, heavy-looking build for its size.

We attempted to pursue the bird but were unsuccessful. In addition to 12 Black-capped Petrels, one other gadfly petrel was seen the same day. Although not well studied, it was believed not to be a Black-capped, and was near enough to the original sighting to have been the same individual as described above

I am well aware of the problems associated with at-sea identifications, particularly for *Pterodroma,* and I would be hesitant to report this sighting if it were not for the fact that the pale morph of *P mollis* is so distinctively marked and that what I observed so closely matches illustrations and descriptions studied subsequently. The dark underwing alone rules out all other Atlantic species. I would like to say that additional field characters are also mentioned in the literature (face pattern, scaly-looking forehead, and mottled sides), but frankly I didn't see them It should also be stated that several races of *P. mollis* have been recognized, and it

would be unwise to speculate whether this individual came from a North Atlantic or South Atlantic race. Both population centers and their recorded marine ranges are well removed from the western North Atlantic, and dispersal behavior or dispersal needs may not be the same for different races. In fact Bourne (1983) suggests that the *P. mollis* assemblage of the Atlantic is composed of three distinct species — *P. mollis* nesting in the Southern Hemisphere and *P. feae* and *P. madeira* nesting in the Northern Hemisphere. Bourne (1967) gives a good account of long-range vagrancy in *Pterodroma*.

BLACK-CAPPED PETREL

BECAUSE OF MY INTEREST in the Black-capped Petrel (*Pterodroma hasitata*), I have from time to time summarized the known information concerning the local occurrence of this bird (Lee and Booth 1979). This species occurs off North Carolina at all seasons, but it appears most commonly in May, October, and December. Of my sightings, 85-95% have been in deep-water areas (500-1,000+ fathoms), in spite the fact that well over 50% of my observation time has been in shallower waters. The species is seldom seen over water less than 100 fathoms deep, and the limited amount of time I have spent in water much over 1000 fathoms suggests that it is not common in extremely deep areas. During the summer months, at least, it occurs inside the Gulf Stream in deep-water zones, but here is not particularly common. (In one of my earlier papers I suggested that this species was confined to the Gulf Stream.)

BERMUDA PETREL

ON APRIL 18, 1983, I saw a bird that I strongly suspect was a Bermuda Petrel (Cahow). The sighting was at 35°18′N 74°45′W, over water more than 1,000 fathoms deep. The overall small size and dark coloration strongly suggested that this bird was not a Black-capped Petrel. I report this record with some reservation. Perhaps the only merit in this discussion is to alert students of pelagic birds to the likelihood of the Bermuda Petrel occurrence off North America and the seemingly impossible problem of solid visual verification.

First, the problem. The Black-capped Petrels we encounter off the North Carolina coast display remarkable variation in size and markings. This variation is not related to age, sex, or molt sequence (Lee unpublished) 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 recruited from a number of distinct breeding populations. While it is not my intent to delve deeply into this problem here, the situation will cast doubt upon all sight records of Bermuda Petrels off our coast. Black-capped Petrels range from large (590+ gm) birds with classic black caps, wide distinctive collars, and conspicious "rump" patches, to small (350 gm) birds with little development of white collars and/or "rump" patches. Thus the smallest and darkest would approach a Bermuda Petrel in both size and, from a distance, appearance.

The bird in question was seen well, and close enough that it could easily have been collected, and certainly would have been if the species' total population was not known to be so small. The apparent Bermuda Petrel was considerably smaller than a Northern Fulmar (*Fulmarus glacialis*) that was in view at the same time. The bird looked smaller than the smallest Black-capped Petrels I have seen or collected, and there was no white on the neck or rump. The head looked proportionally small, and I assume this was because the bill was small by comparison. The black on the underwing seemed much more pronounced, covered a greater area, and/or was arranged differently than in *P. hasitata*. The face pattern was not well studied, but there was at least some white between the hood and the beak (well within the range of variation of dark *hasitata*). Additionally, the tail may have been shorter; at least the overall flight profile of the bird was different from that of Black-capped Petrels. This is actually the second or third bird I have seen of this type, but the only one I was able to study closely. The bird certainly looked different from the 1000+ Black-capped Petrels I have seen during the last nine years.

The above description was forwarded to David Wingate, Bermuda Conservation Officer, who concurred that the description fits that of a Bermuda Petrel. To date there are no verified records of *P. cahow* at sea, so there is little with which this record can be compared. Wingate stated that the colony he has been closely monitoring has been steadily increasing over the last few years. Although the species remains quite rare, the chances of encountering these birds is increasing. Considering their proximity to Bermuda, the rich feeding grounds found off North Carolina would certainly be logical foraging areas for these birds.

The day the bird in question was seen the surface water was cool—68.3° and most species encountered were of boreal–temperate affinities—Common Loons (*Gavia immer*), Northern Fulmars, Red Phalaropes (*Phalaropus fulicarius*), various jaegers and gulls. Publication of this record will not and should not warrant consideration for *Pterodroma cahow* as a part of the documented North America fauna.

HERALD PETREL

A DARK-PHASE HERALD PETREL, formerly South Trinidad Petrel, was sighted by Steve Platania and me on August 21, 1980, *ca.* 57 miles southwest off Oregon Inlet (35°28′N, 74°43′W), in over 1000 fathoms of water. This represents the third record for North America The other records are specimens, one in the same area on August 20, 1978 (Lee 1979) and an inland storm-wrecked individual in Ithaca, New York, on August 26, 1933 (Allen 1934). The 1980 bird was seen as it glided about 20 feet from our cruising boat. On my earlier encounter with this species, "chum" for attracting birds was present. This individual flew in at 15-20 feet to "inspect" an Audubon's Shearwater I had just collected and that was floating on the surface. The bird banked, half-circled the boat, and flew off, allowing good views from the front, a three-quarter profile, ventral surface, and rear. The bird had jaeger-like pale flash-marks on the undersides of the primaries, similar to those of the 1978 specimen I have described (Lee 1979) There is no question as to the identity of this bird. Both of the Herald Petrels I have observed flew with minimal wing-flapping and with wings parallel to the water's surface, and they did not exhibit the high-arched soaring and the cadence or depth of wing beats typical of other *Pterodroma* species. At least seven Black-capped Petrels were observed the same day, and under identical wind and sea conditions, these birds did not have the flight profile of the Herald Petrel Flight pattern and the bird's direct approach to boats may be good *clues* in identifying this species, especially in view of their variable plumages.

On July 18, 1983, Benton Basham, Mary Kay Clark, Ron Naveen, and I saw a jaeger-like bird, which we watched for

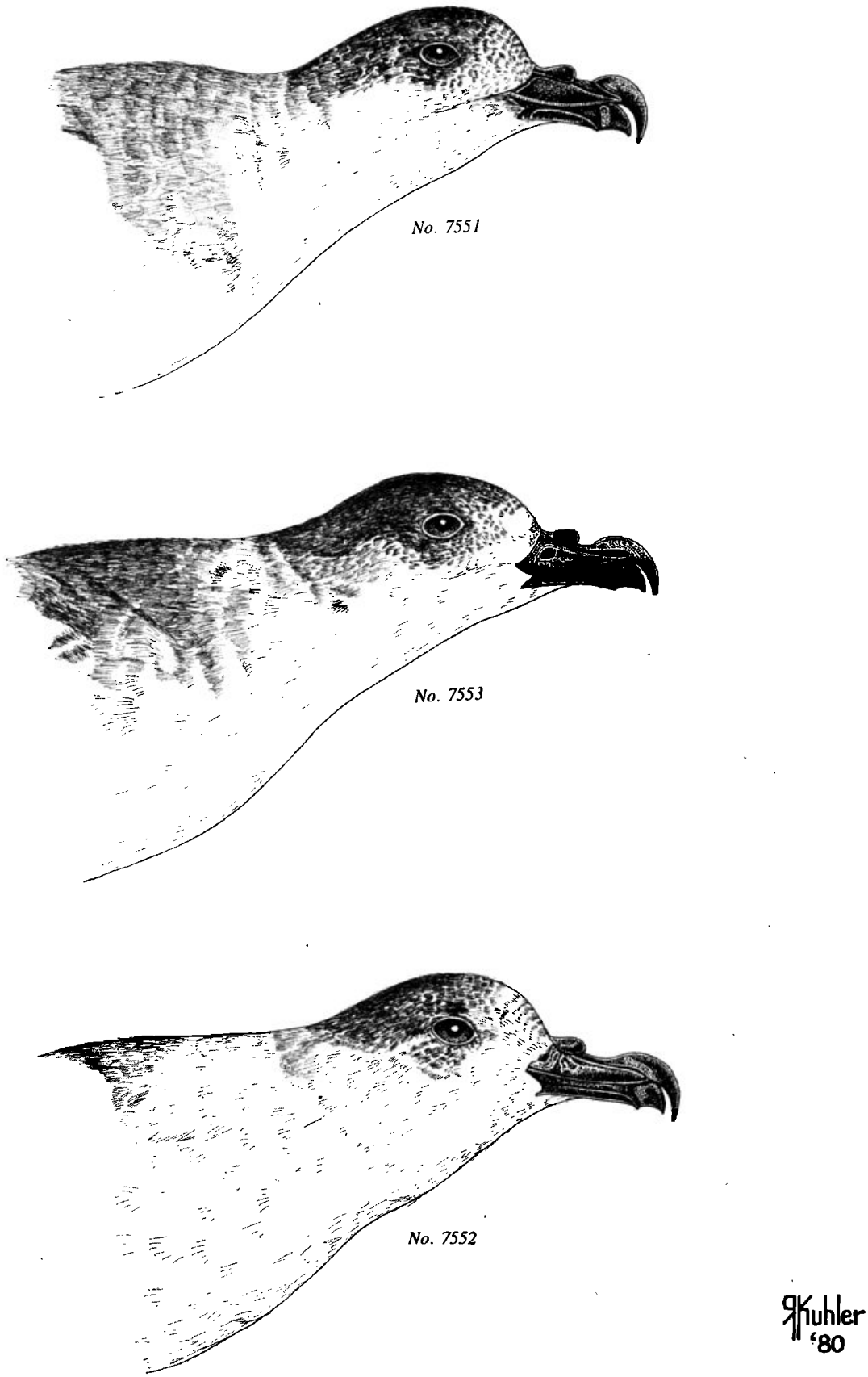

Figure 4. *Head profiles of Black-capped Petrels, showing plumage variation from dark (NCSM 7551, top) to light (NCSM 7752, bottom). Note variation in bill shape. Drawing/R. Kuhler.*

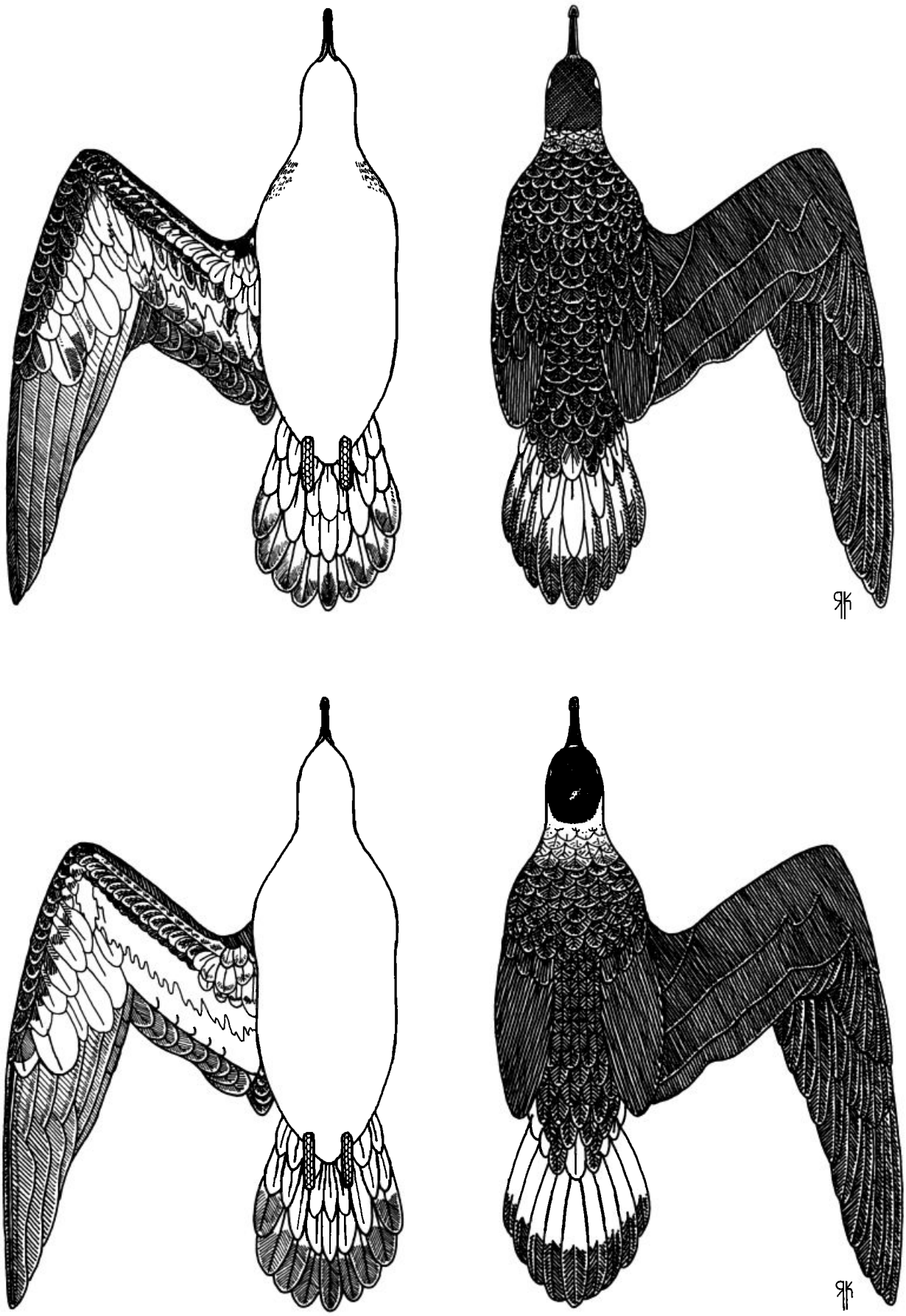

Figure 5. *Dorsal and ventral color variation in the Black-capped Petrel. Bird at top (NCSM 7551) represents a dark extreme in pigmentation, bird at bottom (NCSM 7552) represents a light extreme. See text for details. Drawings/R. Kuhler.*

several minutes The bird in question was dark on the breast, body, and wings, but we were too distant to distinguish white flash-marks in the wings. We initially suspected it to be a dark jaeger; but as it flew off, it exhibited a protracted soaring flight and flew at an intermediate height (10-15 feet) above the sea, which suggested it could have been this *Pterodroma*. Based on flight behavior and speed the bird certainly was not a jaeger. The sighting was within a quarter-mile of the 1000-fathom contour, at 35°22′N and 74°48′W.

The identification problem caused by initial jaeger-like appearance is considerable. I have now accumulated a substantial number of summer jaeger sight and specimen records (mostly Pomarine) as well as one summer specimen record of a Sooty Shearwater (*Puffinus griseus*). The erratic flight pattern and flight silhouette of the Sooty Shearwater should eliminate any confusion in that direction if the bird can be observed for any period of time. The potential confusion with jaegers is difficult to comprehend. The deep, steady falcon-like wing beats of jaegers in typical flight and the fact that they normally fly 15-20 feet higher than the Herald Petrels I have observed would seemingly separate them. On the other hand, I have not yet seen a Herald Petrel exhibiting the typical roller-coaster flight profile of Black-capped Petrels, and its extended horizontal wing position does not suggest in my mind what a *Pterodroma* should look like. This is probably an artifact of my very provincial field experiences. It is therefore informative to note that other experienced observers of seabirds also at first mistook the July 18 bird for a dark jaeger.

Herald Petrels have been reported dispersing north of the subtropical convergence in the Pacific (Rumboll and Jehl 1977), and the gradually increasing number of records in the North Atlantic suggests that the South Trinidad Island population also is not, as previously believed, sedentary. Two old records from the eastern North Atlantic, at Cheshire, England, April 1908, (*P. neglecta*), and off the Cardigan coast, Wales, 1889 (*P. leucoptera*), are likely to represent *P. arminjoniana*. The specimens are not available and since both species identified are tropical Pacific birds the records are not acceptable. Interestingly, as early as 1914 authors started suggesting that the species involved was probably *P. arminjoniana*. Thus Herald Petrels may be more wide ranging in the North Atlantic than currently believed

SUMMARY

THREE SPECIES OF GADFLY PETRELS and four species of storm-petrels have now been documented from the Hatteras area of North Carolina (Lee and Booth, 1979; and this report). It is also likely that the Bermuda Petrel occurs here. Although a good observational data base is not available for all of these species, it seems appropriate to make some speculative comments about seasons of expected occurrence and ecological distributions of these birds. In some cases, the latter can be supported by similar observations in other portions of the species' range. All are pelagic, and several exhibit marked local zonation in offshore distributions. In fact many of the most interesting records have come from areas around the 1000-fathom contour zone. Local differences in water temperature, on the other hand, seem to have little impact on the marine distribution of these birds. The terms temperate, subtropical, and tropical apply here to the species' worldwide distribution, exclusive of migration period.

Black-capped Petrel (*Pterodroma hasitata*). Tropical-subtropical. Disperses widely from known nesting areas but generally recognized as a non-migrant. Common to abundant at all seasons. Peak counts in May, October, and December. Characteristic of the 500-1000 fathom zone, less common between 100-500 fathoms and past 1000 fathoms. Most records are in the Gulf Stream, but the species occurs in other deep-water areas in summer.

Bermuda Petrel (*Pterodroma cahow*). Subtropical (?). Distribution at sea unknown. One tentative April record. Presence of species off North America needs confirmation.

Herald Petrel (*Pterodroma arminjoniana*). Tropical. Two or three North Carolina summer records July 18 (?) and August 20 and 21. All sightings from deep water in Gulf Stream.

Soft-plumaged Petrel (*Pterodroma mollis*). Subtropical-temperate. One June record from over 1000 fathoms.

Wilson's Storm-Petrel (*Oceanites oceanicus*). Temperate-boreal, transequatorial migrant. Common to abundant summer resident and abundant migrant Recorded from March 8 to October 20, but common only between April and mid-September. Found at all depths, occasionally even close to shore, but most common within a few miles of the 100-fathom contour.

White-faced Storm-Petrel (*Pelagodroma marina*). Temperate. Five records between August 31 and October 2. This is a deep-water species expected to occur south of Hatteras area only as an occasional stray.

Leach's Storm-Petrel (*Oceanodroma leucorhoa*). Temperate, transequatorial migrant and potential rare winter resident. Essentially a spring and fall migrant (May-June and September-November) Several summer records exist. A potential winter resident. Although this bird is considered a cool-temperate water species, it is also found in the deep waters of the Gulf Stream. Presently available records exhibit no indication of marked zones of occurrence.

Band-rumped Storm-Petrel (*Oceanodroma castro*). Tropical. Disperses widely from breeding islands. Uncommon but regular summer resident observed between May 30 and August 20 in deep warm offshore waters over 500 fathoms

PERSPECTIVE

IN PREVIOUS STUDIES I have inferred that the relatively rich foraging grounds off the Outer Banks of North Carolina accounts for a rich species diversity of marine birds and that assigning the status of accidental or vagrant to even the rarer species might not be appropriate. As I become more familiar with the variability of the local marine micro-environments resulting from currents, water temperature, season, and depth, it is apparent that these factors combine with sea productivity and account for the area's ability to provide a dramatic species diversity The Hatteras area has long been regarded as a biological Mason-Dixon Line between boreal and tropical maritime elements While these faunal elements are supported and transported by major oceanic currents, the latitudinal position is one of temperate seas. Thus, the seabirds as well as marine mammals are often simultaneously represented by temperate, boreal, and subtropical species all within a relatively small geographical area. During the spring and fall, migrant species

also contribute to the diversity Perhaps it is important to note that the area, although rich in food resources, is for the most part unoccupied and unexploited by locally nesting seabirds. Thus, while the Hatteras offshore area does not support the predictable biomass of say, the Grand Banks during the summer months, it does boast the largest documented species diversity of pelagic seabirds (Lee and Booth 1979) and marine mammals (see Lee *et al.* 1982) in the western North Atlantic. The gadfly and storm-petrels of the region appear to be a good example of the complex seasonal and ecological distributions of birds off Hatteras. North Carolina currently represents the northernmost area of normal occurrence for two species (Band-rumped Storm-Petrel and Black-capped Petrel), the southernmost for one species (White-faced Storm-Petrel), and the only area for non-storm-related occurrence in North America for two, possibly three, species (Herald Petrel, Soft-plumaged Petrel and possibly Bermuda Petrel). The remaining two species are transequatorial migrants and range along the entire East Coast of the United States. It is clear that the birds discussed here are not evenly or randomly distributed off our coast; this applies to both geography and season, but identification of factors reponsible for local distributions will be difficult. As one astute student inquired: "How do the birds know how deep the water is?" The accessibility of the offshore Hatteras area makes it a practical study site; the combination of marine factors discussed above makes it a fortunate one. Ecological patterns documented here should eventually provide needed insight and clarification into micro-distributional factors for other portions of the species' ranges.

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