

Dark *Pterodroma* petrels in the North Pacific: identification, status, and North American occurrence

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Color Plate by Keith Hansen

THE LEAST-EXPLORED FRONTIER OF North American birding lies over the deep ocean waters beyond the Pacific continental shelf. Despite the great increase in pelagic birding in recent years, the more remote waters out to the 200-nautical-mile limit remain inaccessible to most birders. On those rare occasions when a birding boat ventures far offshore, the amount of time actually spent searching the deep-water zones is very limited, and weather frequently makes observation very difficult. Compounding this problem is the difficulty of identifying many species of pelagic birds, as epitomized by the gadfly petrels of the genus *Pterodroma*. This genus includes many similar species and parallel plumage variations, and their field separation and range at sea remain little known and controversial. A tossing boatload of queasy landlubbers attempting to fix their spray-coated binoculars on distant fleeing petrels, the likes of which they

have never encountered, often produces a variety of conflicting impressions as to what was seen. It is little wonder that these infrequent adventures provide more heat than light on the North American status of groups such as the *Pterodroma* petrels.

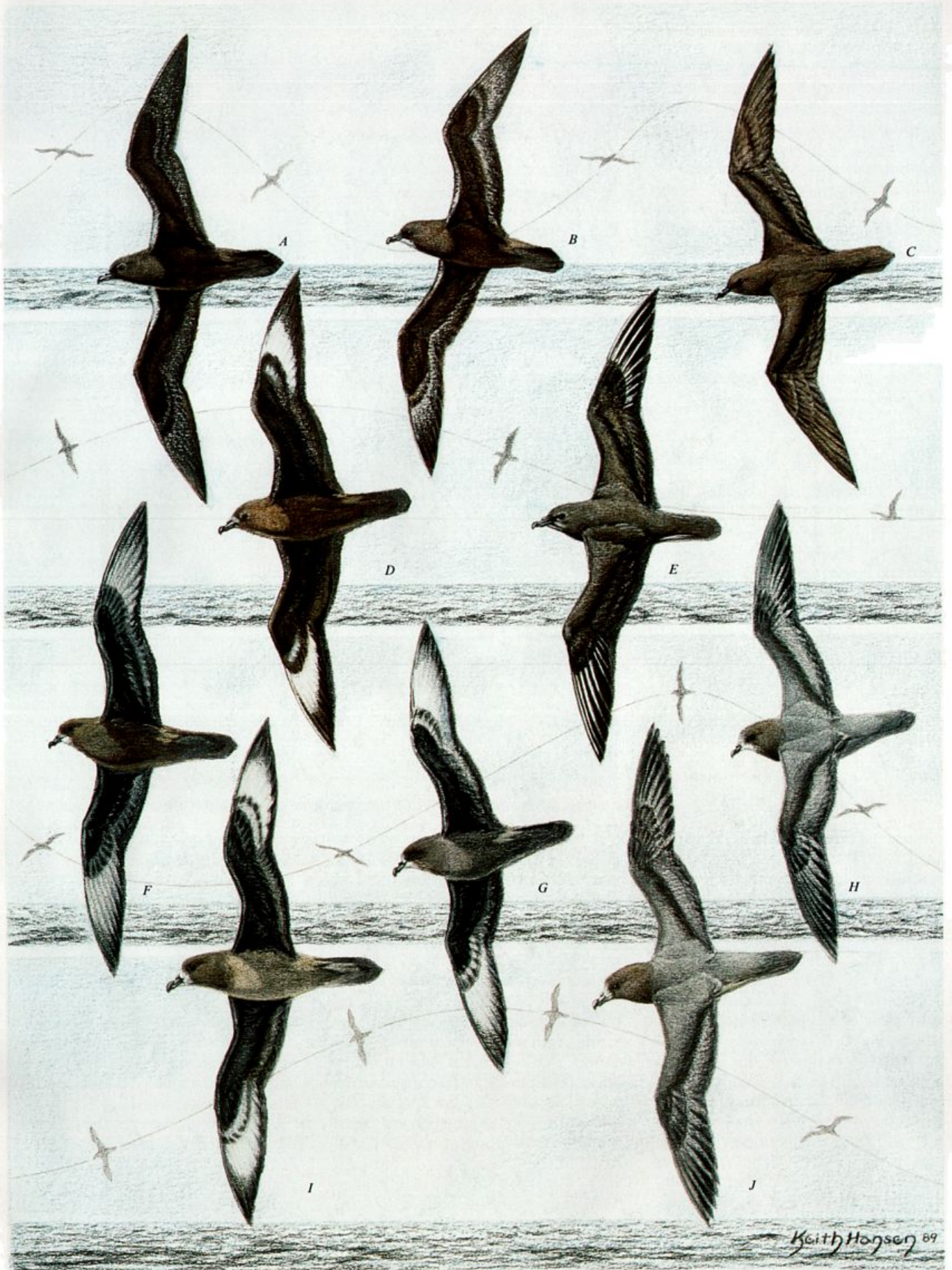
For the nearshore ocean waters of the Pacific states we now have adequate sampling to understand the seasonal status and abundance of most birds, and even their variations from year-to-year (Ainley 1976, Stallcup 1976, DeSante and Ainley 1980, Roberson 1985, Briggs *et al.* 1987, Ainley and Boekelheide, in press). This area is strongly influenced by the Alaska and California current systems and by coastal upwelling, which result in cold, nutrient-rich waters supporting high levels of ocean productivity. Beyond the influence of these systems, however, lie the warmer waters of the North Pacific Gyre, a water mass supporting a considerably different ecosystem. Beginning in the area variably

40 to 150 nautical miles off the North American coast, the avifauna, including principal species, seasonal movements, and year-to-year patterns of occurrence, has received little attention. Not only are there seabird species visiting our waters that are as yet absent from the North American list, but some may prove to be regular in occurrence or even common without this having been documented.

Beginning 10 years ago (McCaskie 1980), seabird biologists aboard oceanographic ships have observed *Pterodroma* petrels in these offshore California waters, occasionally in substantial numbers. These ships provide a stable platform for surveying pelagic birds, and some of the biologists have had prior experience with the species reported. Pelagic boat trips have often been chartered soon after sightings by researchers, and these trips have spent a few hours in the same waters and sometimes found small numbers of *Pterodroma*. Nevertheless, the identification of these birds has remained controversial in many cases, and the sightings have been so infrequent and irregular that they only hinted at the seasonal abundance and regularity of North American occurrence. Furthermore, considerably more work is needed to elucidate the occurrence of the species involved.

Most controversial have been the records of "large, dark *Pterodroma*"

Plate 1. A: Herald Petrel, completely dark morph. B and C: Herald Petrel, dark morph with paler underwings and white throat. D: Kermadec Petrel, warm brown dark morph. E: Kermadec Petrel, grayish dark morph. F: Murphy's Petrel, under "normal" light conditions, showing subdued underwing flash. G: Murphy's Petrel, with brighter lighting on ventral surface, showing brighter underwing flash and glossy belly. H: Murphy's Petrel, with whiter face than average. I: Solander's Petrel, with whiter face. J: Solander's Petrel, with darker face. Behind each species is a typical flight path during moderate winds (see text). Painting/Keith Hansen.



Illustration/Keith Hansen

This category is an artificial grouping of several species that are not all closely related within the genus but that share medium to large size and all-dark body plumage. Four species have been found in the Pacific north of the equator: Solander's Petrel (*Pterodroma solandri*), Murphy's Petrel (*P. ultima*), Kermadec Petrel (*P. neglecta*), and Herald Petrel (*P. arminjoniana heraldica*). This paper covers the identification, status in the North Pacific, and recorded Pacific North American occurrence of these four species.

Identification of Dark *Pterodroma* in the North Pacific

Sources of information

The following discussion and illustrations synthesize identification marks known to us from published literature, personal field experience, personal communications from other seabird experts, examination of museum study skins, examination of photographs, and materials available to us through our review of records as members of the California Bird Records Committee (Bailey and Pyle). Much of this information is reported or integrated for the first time in this paper. Recent field guides (e.g., Harper and Kinsky 1978, Harrison 1983, 1985, 1987, Pratt *et al.* 1987) represent major improvements over the literature previously available, but their treatments of dark *Pterodroma* are not fully reliable or adequate. For example, many of the measurements in Harrison (1983, 1985, 1987) need correction. Good photographs of most dark petrels are in Harrison (1987) and Lindsey (1986).

The very large collection of the American Museum of Natural History was especially useful in elucidating in-hand characters that can also be used in the field. It was examined independently by the three authors. Spear, accompanied occasionally by Pyle or Hansen benefitted from the knowledge gained during extensive seabird surveying and collecting in the Eastern Tropical Pacific for David G. Ainley (Point Reyes Bird Observatory). Pyle's personal field experience with this group includes many observations of all four species during fall



Figure 1. Plumage variation in Kermadec Petrel shown by specimens in American Museum of Natural History (AMNH), lateral view. AMNH photographs/Stephen F. Bailey.



Figure 2. Plumage variation in Kermadec Petrel, same AMNH specimens, ventral.

cruises with Spear in 1987 and 1988, plus scattered observations of Murphy's, Kermadec, and Herald petrels elsewhere in the Pacific. Bailey's field experience with them was limited prior to 1989, being mostly unsatisfying views of California birds. The expedition of April 29–30, 1989, reported below, added greatly to the senior authors' understanding. Illustrator Keith Hansen accompanied Spear on a Spring 1988 cruise, during which he saw all four species. His illustrations for this paper are based on these observations, photographs of live birds, photographs of museum study skins, the measurements taken by Spear from birds collected in the Eastern Tropical Pacific and those given by Murphy and Pennoyer (1952), and discussions with the authors.

General considerations

Large, dark *Pterodroma* petrels approach the Sooty Shearwater (*Puffinus griseus*) in size, but their bills are shorter and proportionally thicker. Their tails tend to be longer and more wedge-shaped and their feet and legs are much smaller. Under most wind conditions their flight is quite distinct from a shearwater's, being relatively buoyant and with higher arcs on wings more bent and bowed.

Other species. Besides the four species we consider, several other dark *Pterodroma* species could occur as vagrants to the North Pacific because of their extensive ranges at sea and potential tendency to wander, but their occurrence in our waters is sufficiently unlikely that we will only mention them here. The Great-winged Petrel



Figure 3. Plumage variation in Herald Petrel, AMNH specimens, lateral view. Darkest bird is Atlantic form.



Figure 4. Plumage variation in Herald Petrel, same AMNH specimens, ventral.

(*P. macroptera*), Kerguelen Petrel (*P. brevirostris*), and the Soft-plumaged Petrel (*P. mollis*) are widespread, but the dark morph of the Soft-plumaged is rare. The Mascarene Petrel (*P. aterima*) and Fiji Petrel (*P. macgillivrayi*) were only recently rediscovered and remain little-known. None of these species has been recorded north of 18°S in the Pacific; for their identification see Harrison (1985, 1987). Two other genera are easily distinguished from the species we treat. Bulwer's Petrel (*Bulweria bulwerii*) and Jouanin's Petrel (*B. fallax*) are considerably smaller and have long pointed tails. The four species (three dark) of the genus *Procellaria* are larger and shaped more like large fulmars (Spear pers. obs.).

Variation. Plumage variation must be considered in the identification of almost all bird groups. In fresh plu-

mage, the Murphy's and Solander's petrels show rather little variation except in details of facial pattern. Conversely, the body plumage of both the Kermadec and the Herald petrels varies almost continuously from all dark to dark above and white below (Murphy and Pennoyer 1952; Figures 1-4). We focus on those color morphs with no white on the belly, as they could be confused with the other all dark species. Treatment of the paler morphs, showing white bellies, must await a paper including the other large white-bellied Pacific *Pterodroma* species. Furthermore, we do not treat the nominate subspecies (or species?) of the Herald Petrel (= Trinidad Petrel) found in the Atlantic and Indian Oceans. It averages larger than *heraldica* and has whiter underwings in its dark morphs.

Wear and molt. All *Pterodroma* pe-

trels show color changes with plumage wear and molt. Fresh individuals are paler and grayer, especially on the back. Progressive wear makes these tones darker and browner, and any dorsal patterns tend to decrease in contrast. Similarly the wings become darker and browner with wear, but the temporary loss of some coverts and remiges during molt can expose the white or light bases of underlying feathers, thus producing white spots, patches, or stripes in the wings. Similar white or pale spots may result in the body plumage.

The timing of peak molt of each individual is strongly correlated with its breeding schedule (Murphy and Pennoyer 1952), which in turn can be protracted and variable within each of the four species. Although most molt should immediately follow breeding, *Pterodroma* species show very protracted body molt when away from the breeding grounds (Spear, Pyle pers. obs.). Much more work is needed on the at-sea molt strategies of seabirds.

Size, shape, and flight. Characters of size, shape, and flight behavior are consistently useful for all four species. However, it must be remembered that all species alter their flight behavior according to the wind speed. Their flight is more languid and depends more on flapping during calm conditions, but at winds of 30 knots all *Pterodroma* (and most shearwaters for that matter) fly in high banking arcs and rapid swoops. In light-to-moderate winds, the smaller petrels with lesser wing area normally fly with more bouncing arcs and more abrupt banking than do the larger, broader-winged species, and the latter in turn are lighter and more buoyant than the lower and more labored flight of shearwaters.

Lighting. One also needs to consider that variation in lighting can change the apparent colors of the plumage. Depending on differences such as sunny versus cloudy skies and the angle of view, birds can appear browner or grayer, and more, or less, contrasting in their color patterns. This is especially important when evaluating underwing patterns.

Feet. In normal flight the feet are tucked well into the abdominal feathers and are not visible. However, they are briefly visible when a bird takes off or lands. In these species the feet



Figure 5. Upper surface of primaries of Kermadec Petrel, AMNH.

are either bicolored or all black. Bicolored feet are light-colored (usually flesh) on the tarsus and proximal metatarsus, with the remainder of the foot black. Foot color has been thought to be an important character in distinguishing these species, but in fact we found that all four species can have bicolored feet and three can have all-black feet. Only Murphy's Petrel seems constant in its foot color, which is bicolored flesh and black. In both the Kermadec and Herald petrels the paler morphs have bicolored flesh and black feet but the darker morphs have either bicolored or all-dark feet, as shown by specimens (Bailey pers. obs.). The feet of most Solander's Petrels are uniform black or dark gray, but instead they may be bicolored blackish and yellowish (Murphy and Pennoyer 1952). We do not use foot color for field identification of these species.

Kermadec Petrel

In many respects, the Kermadec Petrel is the most variable of the four species. However, all color morphs of the Kermadec Petrel show a distinctive and diagnostic upperwing pattern. The shafts and basal halves of the inner webs of the primaries are white (Figure 5). When the wings are spread widely, a white patch is exposed that covers much of the upper surface of the primaries (Lindsey 1986, p. 196, Harrison 1987, p. 56). The amount of white shows moderate individual variation, but even when only the white primary shafts are visible they are normally conspicuous

(Plate 1e). The remainder of the upperwing is uniformly gray or brown, so in the absence of molt there is essentially no "M" pattern across the wings. As with the primaries, the basal portions of the inner webs of the rectrices are also white, but this is seldom visible in the field.

The underwing is largely dark, but features a sharply defined, bold white patch on the basal half of the primaries (Plate 1d; Figures 6 and 7). The greater under primary coverts are broadly dark-tipped and white-based so that a very narrow white crescent is usually present but separated from the white primary patch by a broad curved dark bar. Thus the white patch resembles that of the Solander's Petrel (Plate 1i) except that there is less white exposed on the coverts and more on the outer (leading) primary on the Kermadec (Figures 6, 7, and 16). See Solander's Petrel for a detailed comparison. Some dark Kermadecs show the white bases to the greater under primary coverts as a row of small spots (Figures 6 and 7). On some dark morphs the remainder of the underwing is dark (Figure 6), but in others and in paler morphs, there is a narrow mottled white wedge or bar on the propatagium, just below the anterior edge of the wing and proximal to the wrist (Plate 1d). This is normally difficult to see in the field on dark Kermadecs. Also, one should remember that molt may expose the white bases of feathers and cause white spots to appear almost anywhere in the plumage of any dark *Pterodroma*.

Figures 1 and 2 represent the spectrum of Kermadec Petrel morphs.

They range from birds having the underparts white and the head and nape very pale, frosty grayish white to birds that are completely dark on the body and head. Birds we discuss as dark morphs have no white on the body. The gray, gray-brown, or warm brown of dark morphs is often uniform over the body and upperwings, and it varies from medium dark to very dark. Paler dark morphs can have slightly paler underparts than upperparts. This coloration can contrast with darker undertail coverts but is usually uniform from the vent to the throat, not darkening at the chest, producing a hooded appearance as in the Solander's Petrel

The face of dark Kermadec Petrels is quite variable. Contrary to several field guides, there is often no white whatsoever, or perhaps the slightest trace of paling around the base of the upper mandible. A ragged or blended white chin may occur, sometimes extending into the throat, and with or without pale or white feathers completely encircling the base of the bill. These patterns are only visible at close range.

The Kermadec Petrel is medium-sized within this group, being larger than Herald but smaller than Solander's. The Kermadec's body and head are rather plump, especially compared to the Herald. Its bill is rather short and slightly more robust than those of the Herald and Murphy's petrels (Figure 8), but this would only be visible at very close range. The larger bill of the Solander's should be visible in a good view, however. The tail of the Kermadec is relatively short and square (Murphy and Pennoyer 1952), which can be helpful in distinguishing it from the Solander's with the latter's longer and normally wedge-shaped tail. On its relatively broad and long wings, the Kermadec's flight varies from rather languid to powerful in appearance, with less vertical banks than typical of the smaller-winged species.

The color patterns of the Kermadec Petrel resemble those of jaegers, especially the conspicuous white upper primary shafts and under primary flash. Furthermore, during bouts of flapping it can resemble a jaeger quite closely, but in gliding flight the Kermadec appears typical of *Pterodroma*, at which point it is readily distinguishable from jaegers even at great distances.

Herald Petrel

In general, the Herald Petrel's spectrum of color morphs (Figures 3 and 4) parallels that of the Kermadec; the differences are beyond the scope of this paper. The lack of white on the upper surface of the primaries is the most constant field mark separating all morphs of the Herald from the Kermadec. Dark-morph Herald Petrels are blackish brown (Plate 1a-c). Dorsal colors of the Herald tend to be blacker than in the Kermadec, and the back is darker and browner than the blue-gray of fresh Murphy's and Solander's petrels. This dark color is fairly uniform across the wings, with essentially no dorsal "M" pattern (Plate 1c).

Most dark Pacific Heralds have a mottled white throat and chin, of quite variable extent. There may also be a trace of pale coloring across the top of the bill base, but the white throat does not extend upward through the malar area as it does in the Murphy's Petrel (Plate 1b, c, f, g, and h; Figure 8).

Contrary to Murphy and Pennoyer (1952) and Harrison (1985), the underwing pattern of Herald Petrels varies, somewhat in parallel to the darkness of the body colors. In the Pacific, dark-morph Heralds do not show the same underwing pattern as do the pale morphs, which have the bases of the primaries truly white, partly-white greater primary coverts and greater secondary coverts, thus extending the primary flash in along the underwing as a narrowing mottled white band (see Harrison 1985), and a large white wedge on the propatagium. Conversely, the underwings of Pacific dark-morph Heralds are all dark (Plate 1a) to mostly dark (Plate 1b). The latter birds' underwings may resemble those of the Murphy's Petrel, with the primary bases silvery gray, greater primary coverts medium gray, and the rest of the underwing shades of blackish gray, but some also have small amounts of white on the greater primary coverts. Dark Heralds normally have a white line on the propatagium, but it is so narrow and mottled that it is difficult to see in the field (Figure 6).

The Herald Petrel is the smallest of the four species. Its bill is slightly more delicate than in the Kermadec, and its head, body, and wings are all notice-



Figure 6. Underwings of (top to bottom) dark-morph Herald Petrel (LACM 104360), dark-morph Kermadec Petrel (LACM 104357), Murphy's Petrel (LACM 104356), and Solander's Petrel (LACM 102806). Photograph courtesy Natural History Museum of Los Angeles County.

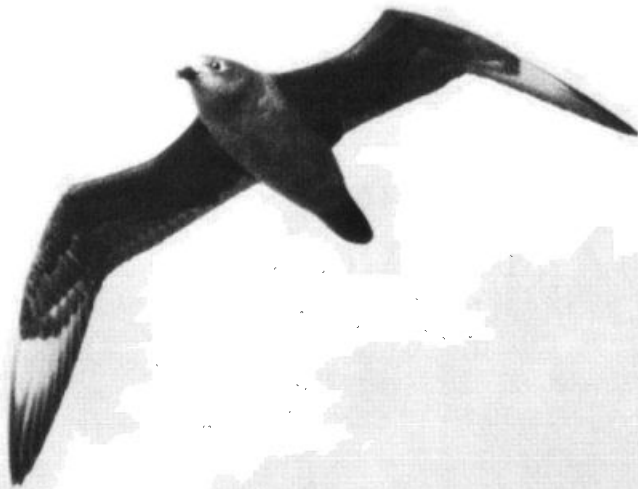


Figure 7. Dark-morph Kermadec Petrel at Ball's Pyramid, Australia, March 1985. Photograph/Chris Corben.

ably more slender. This delicate build and the bird's much more buoyant flight make it appear distinctly different from Kermadec Petrels at sea. At low to moderate wind speeds the flight is quite bouncy, with more vertical and delicate arching than is performed by the other dark *Pterodroma*. In stronger winds, these steep banks are such that the bird often partly flips over at the top of its arc. This delicate flight style also helps to separate the

Herald Petrel from the Christmas Shearwater (*Puffinus nativitatis*), which can otherwise resemble a dark Herald Petrel quite closely, especially at a distance (Spear and Pyle pers. obs.).

Murphy's Petrel

The Murphy's Petrel is a rather glossy dark gray to brownish gray bird with a mottled white throat (Plate 1f-



Figure 8. Heads and bills of (top to bottom) Herald, Herald, Murphy's, Solander's, Kermadec, and Kermadec petrels, AMNH. Top Herald is Atlantic form.



Figure 9. Murphy's Petrel 67 miles west southwest of Point Reyes, California, April 30, 1989. Photograph/Stephen F. Bailey.

h, Figures 9–11) A lesser amount of whitish usually circles across the top of the bill base. The glossiness of the plumage is reminiscent of the more extreme glossiness of the closely related (Jouanin and Mougin 1979) Kerguelen Petrel. In fresh plumage this glossiness causes the appearance of the Murphy's Petrel to change with the lighting conditions. This is conspicuously true of the underwing. From below the primaries are silvery gray, blending very gradually with somewhat darker tips. The apparent color of these primaries varies from dark to whitish, depending on the lighting and the position of the bird. When a bird is strongly illuminated from above, and the underwings are not reflecting light strongly toward the viewer, the primaries look dark (Plate 1f). Conversely, under a dark overcast sky, especially with the sun toward the horizon, the primaries can catch this low-angle light and flash so brightly as to seem pure white. Under intermediate conditions and whenever seen closely, the primaries are revealed to be a silvery gray that appear to lighten and darken as the bird flies and changes its angle with respect to the viewer and the light. The greater primary coverts of the underwing are medium gray, between the primaries and the overlying coverts in degree of darkness (Plate 1g; Figure 6). This three-tone comparison can be seen under favorable conditions. Sometimes the edge of the medium gray greater under-primary coverts, contrasting against the silvery flash of the primaries, gives an illusion of darker tips on the greater coverts, forming a dark crescent as in the Solander's, most Kermadec, and some Herald petrels. This effect should never be as strong as in the Solander's, however. The secondaries, and to a lesser extent the greater under-secondary coverts, are also medium gray and paler than the blackish gray median and lesser coverts, so the former sometimes appear paler in the field. Thus at times the glossy underwing flashes light all the way from near the primary tips to quite far in along the secondaries. Although the palest part of the underwing is always the base of the primaries, this flash is not as concentrated or as well-defined as in the Solander's and Kermadec petrels.

The upperwings show a fairly well-marked "M" pattern composed of the

blackish outer primaries, diagonal covert bar, and tertials contrasting with paler gray inner primaries, secondaries, inner lesser coverts, and back (Plate 1h; Figure 10). Faint pale shaft streaks may appear on the upper surface of the primaries, at least rarely (Figure 11), but it is doubtful that these would be noticed in the field. This seems to be a transitory effect of the plumage's glossiness. The back itself is medium blue-gray with a glossy or steely appearance in fresh plumage. It becomes browner with wear, but still appears more gray than brown in the field. The head and nape are darker than the back, but especially so in fresh plumage when the back is paler blue-gray. Below, Murphy's Petrel is uniform medium dark gray except for the whitish throat. However, under some light conditions there is a tendency for a dark hood to appear briefly, when the belly and flanks reflect the light more directly at the viewer than do the head and upper breast. In the field this effect does not persist as does the true hooded effect of the Solander's Petrel. This plumage difference is easily seen in museum skins under varying light angles (Figures 12 and 13).

The mottled white throat is variable, but includes or blends into the malar area of the face (Plate 1f–h, Figure 14). The forehead can show no whitish at all, can have a narrow band of pale color wrapping across the bill base, or can be fairly extensively mottled white. Despite this variation, the throat always has noticeably more white than the forehead. In the field at close range Murphy's Petrels can be seen to be whitish on the throat, with or without less whitish on the forehead and lores (Figure 9). Although this face pattern is fairly diagnostic of the Murphy's Petrel, it is not a long-range field mark. In the Herald Petrel the white throat does not include the malar area (Plate 1b and c; Figure 8). The Solander's Petrel usually shows whitish completely encircling the bill base, but it never has more white on the throat than on the forehead, instead having as much or more pale color over the bill than below it (Figure 15).

Murphy's Petrel is medium-sized within this group. The rather delicate bill of the Murphy's Petrel is emphasized by its head being relatively large and round, especially compared to the

smallish head of the Herald. The body is also plump, but not in comparison to the large head. The tail of the Murphy's is not as long nor as distinctly wedge-shaped as that of the Solander's. The Murphy's Petrel has proportionally narrower and shorter wings than either the Solander's or Kermadec petrels. At low to moderate wind speeds its flight is buoyant and bouncy, though not as much so as that of a Herald Petrel. Murphy's flaps lightly low over the waves before bouncing abruptly upward into a high arc. Banking relatively vertically in the arc, it often shifts into a long gently sloping glide in contrast to the more precipitous descents of a Herald. In stronger winds its flight is fast and dramatic. The heavier wing-loading of Murphy's results in high and long arcs, the flight pattern resembling that of a Sooty Shearwater in strong winds.

Solander's Petrel

The Solander's Petrel is the largest of the four species, and it has a noticeably larger bill (Plate 1; Figure 8). Pale or mottled white normally encircles the base of the bill, but it never forms a distinct white throat as in the Murphy's Petrel. Most of the plumage including the underparts is brownish gray, but the back is the same medium blue-gray as in Murphy's Petrel. The effects of wear and molt on Solander's back color parallel those in Murphy's.



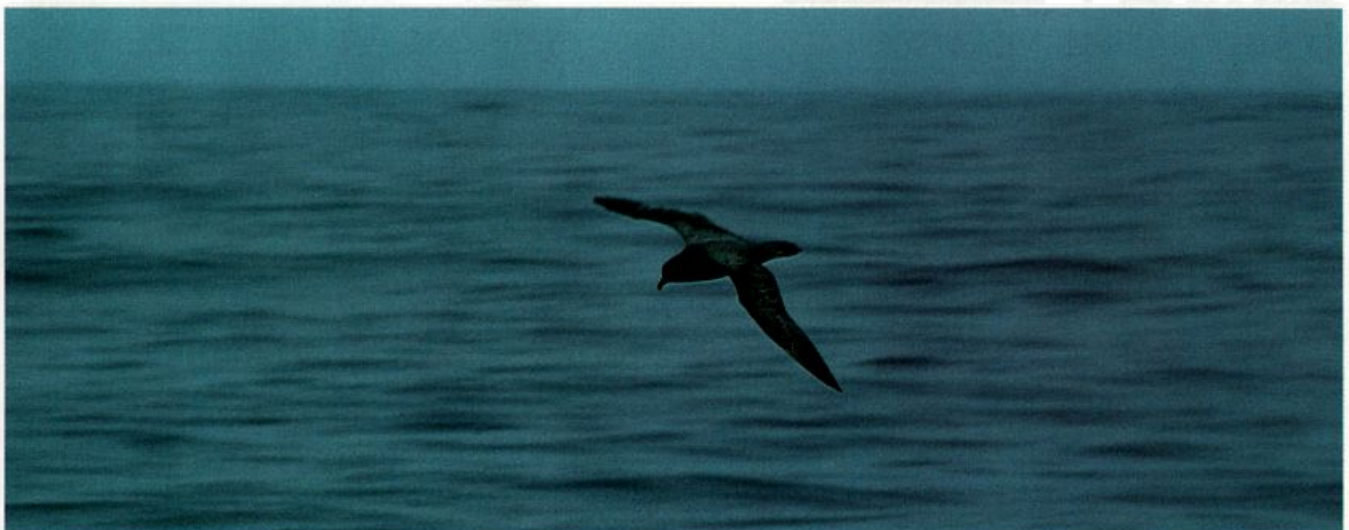
Figure 10. Same Murphy's Petrel, dorsal. Photograph/Stephen F. Bailey.

The upperwing is also similar to Murphy's, but averages a somewhat less pronounced "M" pattern (Figure 17). A hooded effect is present both above and below, as the head, neck, and upper breast are darker than the back, lower breast, and belly (Plate 1i and j; Figures 16 and 17). This effect is visible at all light angles because it is caused by feathers of different shades, unlike the ephemeral effect of the glossy plumage of the Murphy's Petrel (Figures 12 and 13). The dark hood is an important field character.

The underwing flash of Solander's is strongly whitish, and it is restricted to the basal half of the primaries and of the greater under primary coverts

(Plate 1i; Figure 16). The tips of the latter are broadly dark, so that they form a conspicuous dark crescent separating the white primaries from the exposed white bases of the greater primary coverts (Figure 16). The remainder of the underwing is dark. Although the white extending out the primaries does not end quite so abruptly as on the Kermadec Petrel (Figure 6), the white patch does look fairly sharply defined all around, giving a highly contrasting appearance to the underwing pattern. This differs from the silvery flash of Murphy's Petrel; when the latter flashes "white" this effect usually blends farther out into the tips of the primaries and/or in-

Figure 11. Murphy's Petrel showing faint upper primary shaft streaks, about 40 miles southwest of Point Reyes, April 30, 1989. Photograph/Peter Pyle.



ward along the secondaries. Both this difference and the different pattern of the greater primary coverts can be difficult to evaluate in the field, however, and the observer should beware of the transient effects of lighting on passing birds. Unlike in the Kermadec Petrel, the white flash of a Solander's does not include much of the outermost (leading) primary (Figures 6, 7, and 16). The resulting shape of the underwing flash is quite different in the two species (Harrison 1987). In the Kermadec the distal end of the white flash ends in an angle on primaries 10 and/or 9 (Figures 6 and 7). The flash of the Solander's instead ends in a curve that extends farthest on primaries 7 and/or 8, and then slants basally toward the leading greater under primary covert (Figures 6 and 16; Harrison 1987).

The pale color around the base of the bill of the Solander's varies from barely detectable to broad, mottled white, but it is never concentrated to form a white throat. Rather, it appears to be uniform all around the bill base or usually is more extensive above the bill compared to below the bill (Figure 15). That is, the chin and throat of a Solander's normally have the least whitish rather than the most, as is always the case in the Murphy's. Sometimes there is no pale at all on the chin and throat. In such individuals the paling over the bill is so slight as to be almost impossible to see in the field.

The bill of the Solander's Petrel is substantially larger than those of the other three species, both in length and depth, but it is only slightly deeper (Figure 8). The massive hook of the culmen gives it a rather bulbous tip, so that the bill looks larger relative to the head, which itself is slightly smaller proportionally than in the Murphy's. The Solander's Petrel has a longer and more distinctly wedge-shaped tail than the other three species (Figure 16; see also Harrison 1987). This is a useful field character when it can be seen. On its relatively broad, long wings, the flight of the Solander's Petrel is steadier, more horizontal, and less bouncy than Murphy's or the Herald in similar wind conditions. In light winds the Solander's progresses by slow, easy flapping and long, languid glides. In heavier winds the glides are long and more precipitous, but not as fast as in the Murphy's.

Identification Summary

This summary assumes that the bird in question is seen well enough to show the body to be all dark, with nothing paler than medium brown on the belly or medium blue-gray on the back. Except when heavy molt may expose some white or pale gray feather bases, the only white or very pale areas will be on the wings or the throat and/or face. Table 1 lists key characters for these four dark species.

Size, shape, and flight. The Solander's Petrel is the largest of the four species and the only one with a bill that is noticeably large and robust. The Herald Petrel is the smallest and proportionally the slenderest, with the Kermadec and Murphy's about equal to one another in body size. The tail of the Solander's is long and wedge-shaped whereas that of the Kermadec is shortish and rather square, with the tails of Murphy's and Herald intermediate. At a given wind speed, the Herald is the most buoyant in flight, Murphy's is also bouncy but with more gradual descents, and the two larger-winged species are more languid, with banking areas that are less vertical. With experience, flight style will provide a tentative identification for petrels as far as they may be seen.

Wings. Bold white shafts on the upper surface of the primaries identify the Kermadec Petrel, and their absence should eliminate this species. A crisp, white under-primary flash that is longest on the outermost primaries is also distinctive for the Kermadec. A well-defined, whitish under-primary flash, containing a distinct dark crescent, favors the Solander's. If the flash is more diffuse and silvery gray (not white), and only suggests a weak crescent, either the Murphy's or Herald is probable. A truly all dark underwing (except for an inconspicuous propatagial line) indicates a Herald Petrel. All of these underwing patterns require reasonably good views for confident assessment, and the pattern of the Murphy's especially appears to change with the light and the angle of view.

The presence or absence of the dorsal "M" pattern is especially useful in combination with the color of the underprimary flash. The Kermadec has a white flash but no "M"; the Solander's has a white flash plus an "M";

the Herald has a gray (or no) flash and no "M"; and the Murphy's has a gray flash and a strong "M".

Face. Details of face pattern provide diagnostic distinctions between some of these species, but these require good close views. Any Kermadec Petrel seen closely enough for the face pattern to be visible should show its white primary shafts, so its extremely variable face will be excluded from consideration here, except to note that both the Kermadec and Herald petrels may wholly lack pale coloring on the face and throat. However, some Solander's may have almost no pale color on the face and throat. The Kermadec aside, the relative distribution of pale coloring in these areas indicates the species. A white throat that includes the malar area indicates a Murphy's, and a more restricted white throat indicates a Herald. Pale or mottled white that is more noticeable over the bill than under it, or in a uniform band all around it, indicates a Solander's. Whiter Murphy's Petrels overlap with Solander's in the amount of white on the forehead, but these Murphy's will then have a very prominent white throat as opposed to relatively little whitish that is restricted to the chin on the Solander's.

Body plumage. A paler belly and lower breast contrasting with a darker hood indicates a Solander's, but beware of the Murphy's Petrel showing this effect briefly at certain light angles. The others have generally uniform underparts between the throat and the vent. A darker hood contrasting with a paler blue-gray back indicates the Solander's or Murphy's, with the Herald and Kermadec more uniform above. Overall glossy, gray plumage suggests a Murphy's. Darker brown plumage suggests the Herald or Kermadec. The Murphy's usually has the strongest dorsal "M" pattern, with that of the Solander's typically somewhat weaker but noticeable. Dark Herald and Kermadec petrels normally show no dorsal "M" pattern.

Useful distance of characters. Flight characters are useful at the greatest distance, but they require some experience and consideration of the weather conditions. Other long-range characters include those of shape, wing color patterns, and the presence or absence of a dark hood (above and below). Details of face and throat color patterns and bill size and shape



Figure 12. Three Murphy's Petrels and two Solander's Petrels, with both species appearing hooded, AMNH.



Figure 13. Same three Murphy's Petrels and two Solander's Petrels, at different light angle. Note that hooded effect disappears on Murphy's Petrel but remains on Solander's Petrel.

provide diagnostic characteristics between some species, but can only be used at fairly close range. Although such marks are not often needed by very experienced seabird observers, they can be important to the person looking for marks requiring less comparative judgement.

American Records

Prior to 1989

Although these four species of dark *Pterodroma* have long been known to disperse into the North Pacific from their Southern Hemisphere breeding grounds, the discovery of one or more of these species in North American

waters has been quite recent. Table 2 lists all reports of dark *Pterodroma* petrels in North American waters (within 200 nautical miles of land) prior to 1989. It shows that both the Solander's and the Murphy's petrels have been reported on several occasions, and that other sightings have been attributed to this pair of species but not identified further. The three Murphy's Petrels found on Oregon beaches plus the results of the April 1989 expedition described below solidly establish this species on the North American list, but the occurrence of the Solander's Petrel remains controversial.

Robert L. Pitman originally identified all of the May 1981 birds as Solander's Petrels, but the subsequent discovery of the first Murphy's Petrel

dead on an Oregon beach on June 15, 1981, caused Pitman to downgrade his identification of all but the photographed individual to "Solander's and/or Murphy's petrels." The beached specimen was partially rotten, but nevertheless a study skin and body skeleton were salvaged for the United States National Museum of Natural History.

Following the single reports from 1983 and 1985, the April 1986 multiple sightings by research cruises stimulated birders to make day trips to the area beyond Cordell Bank June 1, 7, 13, and July 4, 1986. All trips recorded dark *Pterodroma* Petrels (Table 2). On June 1, 1986, one bird identified as a Murphy's and one identified as a Solander's were photographed both on the water and in

Table 1. Characters of dark North Pacific *Pterodroma*.

Character	Kermadec	Herald	Murphy's	Solander's
flight	variable	buoyant	fast, bouncy	languid
size	medium	small	medium	large
bill	small	small	small	large
upperprimaries	white shafts	plain	plain	plain
dorsal "M"	none	none	moderate to strong	moderate
underprimaries	white bases, incl. 10th	most dark	silvery	white bases, not on 10th
greater under prim. covert	thin white bases	variable, most dark	gray, glossy	white bases, dark bar
white throat	yes or no	yes or no	yes	no or slight
white malar	yes or no	no	yes	no or slight
white forehead	yes or no	no	yes or no	yes or slight
dark hood	no	no	above only	above and below
back color	gray to brown	dark brown	gray	gray
tail	shortish, squarish	average	average	long, wedge-shaped

flight (photos in Erickson *et al.* 1986). Despite the initial identifications of birds on June 7 and 13 (Table 2), at least one observer now believes that all birds on both days were Murphy's Petrels (D. Roberson, in litt.).

The second Murphy's Petrel from an Oregon beach was found alive, but it died and was preserved as a study skin, spread wing, and body skeleton in the Natural History Museum of Los Angeles County. This female was in late stages of primary molt.

Although David G. Ainley reported the approximately 100 birds in April 1987 as Solander's, he (pers. comm.) later conceded that only the best-seen birds were identified with confidence, and that the vast majority might better be considered as "Murphy's/Solander's". Richard R. Veit's report of eight Murphy's Petrels (and no Solander's) less than one month later suggested to others that some (or even

all) of Ainley's birds were likely Murphy's

A third Murphy's Petrel was found (dead) on an Oregon beach, two miles south of Cape Blanco, Curry County, on March 27, 1988 by M. R. Graybill. Pitman sent the field-stripped skeleton and wings to Bailey, who agreed with the identification. This bird was completing its primary molt. The specimen has been deposited in the Natural History Museum of Los Angeles County.

To summarize the pelagic sightings, prior to 1989 dark *Pterodroma* petrels were reported off California in numbers up to 100 per cruise, with dates ranging from April 10 to July 4. Singles were seen off Washington in April and September. The maximum numbers were in April off central California, but sampling was limited and irregular. Observers identified these birds as either Solander's, Murphy's,

or both, with no obvious seasonal or geographic patterns distinguishing the two species. Moreover, the observers identifying only Solander's Petrels and those identifying only Murphy's Petrels used largely different field characters in their identifications. Therefore some people have questioned the identifications.

In contrast to Murphy's Petrel, the identification of the Solander's Petrel in the state remains controversial despite photographs of several birds so identified. The California Bird Records Committee is currently in deliberation on the validity of most of the California records, with only two records having received decision votes. The California Bird Records Committee has rejected the two earliest California records as definite Solander's (D. Roberson, in litt.). We will not preempt the California Bird Records Committee decisions here. In-

Table 2. American records prior to 1989. These are the identifications as reported; they are not to be considered definite or accepted records because of their listing in this table. See text for comments.

Dates	Locations	Number reported per species			Observers	Remarks	Refer
		Solan	Murphy	Sol/Mur			
May 20, 1981	OR: Columbia R. mouth to Heceta Head, 55-70 mi off			4	R. L. Pitman		m
May 21, 1981	CA: Humboldt Co.; 38°26'N 124°23'W	1			R. L. Pitman	photo	h
same	CA: Cape Mendocino to Pt. Reyes, 45-70 mi off			19	R. L. Pitman		h,m
June 15, 1981	OR: Lincoln Co.; beach near Lost Creek		1*		R. Loeffel	* USNM571368	a
Sept. 11, 1983	WA: Grays Harbor Co.; over Gray's Canyon	1			T. R. Wahl & D. Aldcroft		g
June 3, 1985	CA: Marin Co.; 12-15 mi w. Southeast Farallon I.	1			D. G. Ainley & R. Ferris		b
April 9, 1986	WA: Pacific Co.; 35 mi w. Columbia R. mouth		1		T. R. Wahl	not Apr. 10	i,n
April 10, 1986	CA: Humboldt Co.; 40 mi s.w. Trinidad Head		1		T. R. Wahl		c
April 11, 1986	CA: Santa Barbara Co.; 40-50 mi n.w. Pt. Conception		4 or 5		T. R. Wahl		j
April 21, 1986	CA: Marin Co.; 15-20 mi s.w. Cordell Bank	20	3		D. G. Ainley		c
June 1, 1986	same	2	1	4	many obs.	photos	e
June 7, 1986	same	2	2	4	many obs.		e
June 13, 1986	same			5	many obs.		e
July 4, 1986	same			2	many obs.		e
March 6, 1987	OR: Coos Co.; Horsefall Beach		1*		P. Kollodge	* LACM103774	f
Apr. 10-21, 1987	CA: Cordell Bank to Cypress Pt., 20-120 mi off	100			D. G. Ainley		d
May 3-12, 1987	CA: Santa Barbara Co.; 100-300 mi s.w. Pt. Conception		8		R. R. Veit	7 in USA	k
March 27, 1988	OR: Curry Co.; 2 mi s Cape Blanco		1*		M. R. Graybill	* LACM	l

Solan = Solander's Petrel; Murphy = Murphy's Petrel; Sol/Mur = Solander's and/or Murphy's Petrels; * = specimen; USNM = United States National Museum (of Natural History); LACM = Los Angeles County Museum = Natural History Museum of Los Angeles County. References: a = A.O.U. 1983; b = Campbell *et al.* 1985; c = Campbell *et al.* 1986; d = Campbell *et al.* 1987; e = Erickson *et al.* 1986; f = Garrett, K. L. in litt.; g = Hunn and Mattocks 1984; h = LeValley and Evens 1981; i = Mattocks 1986; j = McCaskie 1986; k = McCaskie 1987; l = Pitman, R. L. in litt.; m = Pitman and Wahl ms.; n = Wahl, T. R. in litt.

stead, we will accept these birds only as dark *Pterodroma* petrels and allow them to contribute to the overall pattern of this species group in the Pacific Ocean off North America. Our assessment and prediction of the status and seasonal occurrence of each species is based primarily on other evidence.

April 1989 Expedition

On April 29–30, 1989, Bailey and Pyle participated in an expedition aboard *MV Blitzen* to better document dark *Pterodroma* off the central California coast. We spent the mornings in the area 37°14'N to 37°31'N by 124°15'W to 124°40'W, moving as far north as 38°30'N, 125°00'W on April 29 and running a transect east and northeast from 37°31'N, 124°39'W to the North Farallon Islands on April 30. We were within 90 nautical miles of the mainland throughout the trip.

On those two days we counted 71 and 27 Murphy's Petrels respectively. We photographed many of these 98 birds, obtaining numerous identifiable photos (e.g., Figures 9–11). Several Murphy's Petrels came to a cod liver oil slick we laid at 37°19'N, 124°35'W (85 nautical miles west southwest of Point Reyes) on April 29, and Pyle collected one. This constitutes the first specimen of a Murphy's Petrel for California. It has been prepared as a study skin, detached spread wing, and body skeleton (Figure 18) and is CAS 84182 in the California Academy of Sciences. This bird was an adult female with ovary 10 × 5 millimeter and largest ova 1 millimeter. Its stomach was empty. It weighted 308 grams, and had a moderate amount of fat. The remiges were just completing molt, the rectrices were molting, and there was light molt of contour feathers throughout the body and wing coverts.

The 98 birds consistently showed the marks of the Murphy's Petrel described in the identification section, and we are confident of their identification. For example, we knew the collected bird was this species long before it was within gunshot range.

Most Murphy's Petrels were flying north northwest, generally parallel to the coast, suggesting a concerted northward migration. Densities were greatest in the waters 80 to 90 nautical



Figure 14. Six Murphy's Petrels, showing variation in face pattern, AMNH.

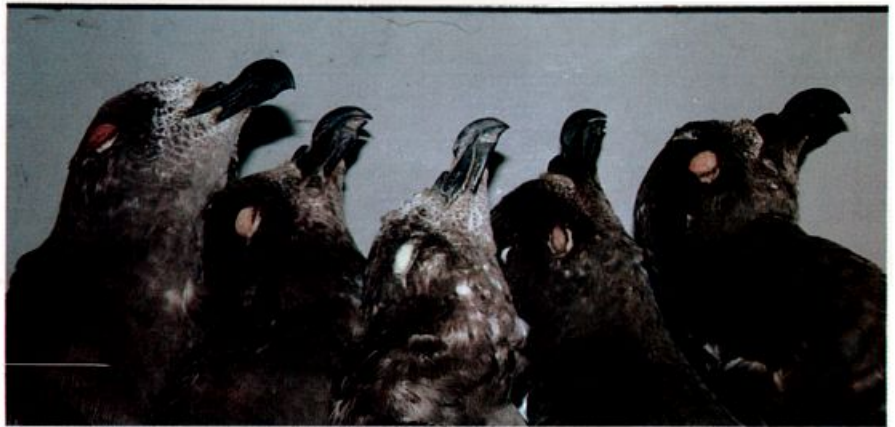


Figure 15. Five Solander's Petrels, showing variation in face pattern, AMNH.



Figure 16. Solander's Petrel off Wollongong, New South Wales, Australia. Photograph/Chris Corben.



Figure 17. Solander's Petrel off Wollongong. Photograph/Chris Corben.

miles off of Point Reyes. On the inbound transect of April 30, the density dropped between 75 and 50 nautical miles offshore (only three birds), but then we encountered 18 Murphy's Petrels between 50 and 32 miles southwest of Point Reyes. Most of these latter Murphy's were sitting on the water in loose association with Sooty Shearwaters. Nearly all the Murphy's were over water depths greater than 1900 fathoms, although the most landward was over about 1300 fathoms. The closest Murphy's were in the zone that represents the farthest offshore reached on the birding trips that have attempted to find *Pterodroma* petrels. It seems that only a few individuals are this close to shore, and that the main densities are much farther offshore in the eastern edge of the North Pacific Gyre.

Further evidence that we were censusing waters very distinct from those reached on shorter trips were our counts of 113 Cook's Petrels (*Pterodroma cookii*) and 136 Horned Puffins (*Fratercula corniculata*), both record numbers for California. We saw Horned Puffins as close to shore as we saw Murphy's Petrels, but the Cook's Petrels dropped out at 52 nautical miles off Point Reyes.

May 6, 1989

The first spring pelagic trip by birders off Mendocino County, California, was on May 6, 1989. Unaware of

the previous week's discoveries, this party found about ten dark *Pterodroma* petrels 16 nautical miles northwest of Fort Bragg, over upper Noyo Canyon at 600 fathoms. The three best-seen birds were identified as Murphy's Petrels by Kurt F. Campbell (pers. comm.), and he believed all ten birds were of the same species. The three were attracted to a chum slick of beef suet, fish parts, and popcorn, and one bird flew off carrying beef suet. Although the numbers of Murphy's Petrels were smaller than those we observed on April 29–30, the May 6 sightings were impressive for their proximity to shore and relatively shallow water.

Distribution and Status

All four of the species discussed in this paper are Southern Hemisphere breeders that disperse into the North Pacific (Harrison 1985). Lack of extensive, year round observations in the North Pacific (here defined as the area north of the Tropic of Cancer, 23°30'N) precludes a good understanding of the timing and distributional occurrence of each species in this area. Based on all North Pacific records, we speculate on their patterns of dispersal in this region and on their prospects for occurrence in North American waters.

Kermadec Petrel

The Kermadec Petrel breeds across the South Pacific, in the subtropical to high tropical (20°S–35°S) belt, from Lord Howe Island off Australia to the Juan Fernandez Islands off Chile (Harrison 1985). On Kermadec Island this species has two protracted breeding seasons, from late August to May and from December to late August (Lindsey 1986). Elsewhere the breeding cycle is not well known; it could parallel what is found on Kermadec Island or it may be more concentrated during the austral summer (Murphy 1936, Gould and King 1967, Harrison 1987). Dispersal patterns are poorly known, but the Kermadec Petrel appears to occur widely throughout the Pacific, being more concentrated in the tropical regions. During the Smithsonian Institution's Pacific Ocean Biological Survey Program, the

Kermadec Petrel was found in low densities in the central Pacific to 25°N at all times of the year but with a peak in abundance occurring in November–January (Gould and King 1967, King 1970). This petrel has recently been found regularly throughout the Eastern Tropical Pacific to 20°N in both spring and fall (Spear, Pyle, K. Hansen pers. obs., Pitman 1986).

In the North Pacific, records are concentrated in the late fall, but this may be an artifact of better coverage during this season. In addition to those of the Pacific Ocean Biological Survey Program above, reports from north of the Tropic of Cancer include: a male collected on Kure Atoll, northwestern Hawaiian Islands (28°25'N, 178°10'W) on April 30, 1923 (Gould and King 1967); at least six individuals between 39°N and 24°N, along the 158°W meridian in early November 1976 (Gould 1983); and a bird in northwestern Hawaiian waters at 27°03'N, 174°42'W on November 3, 1984 (Pyle and Eilerts 1986). In the western Pacific, Wahl (1978) reported a probable observation at 42°01'N, 150°45'E on June 7, 1975, and a record exists from Minami Daito Island, Japan (25°50'N, 131°15'E; Wild Bird Society of Japan 1982). In the eastern Pacific, Pitman (1986) recorded at least one individual in the vicinity of 27°N, 122°W, about 375 nautical miles southwest of San Quintin, Baja California Norte, Mexico, and the species appears to be regular off the coast of western Mexico south of Baja California (Pitman 1986, Spear, Pyle pers. obs.). Finally, on December 7, 1988, Pyle observed a Kermadec Petrel (dark-morph) flying east at 34°59'N, 126°41'W, about 248 nautical miles south southwest of Point Sur, Monterey County, California.

Given the latter observation and the number of observations made north of 30°N, we suspect that it is only a matter of time before the Kermadec Petrel is documented in Pacific North American waters. The pattern suggests that the best time to look might be November–January, although it may occur at any time of the year.

Herald Petrel

The Herald Petrel is the most tropical of the four species considered herein. Its breeding range is confined

to the tropical and low subtropical South Pacific (9°S–27°S), extending from Raine and probably other islands off Australia to Easter Island in the eastern Pacific (Lindsey 1986, Harrison 1985). Polymorphism in this species is strongly correlated with geography, with a distinct light-to-dark cline occurring from west to east within the breeding range (Murphy and Pennoyer 1952). Birds attend breeding colonies all year; egg dates suggest that a few individuals breed during the austral summer but that peak breeding occurs in March–September (Lindsey 1986, Harrison 1987, Pyle *et al.*, in prep.). Nonbreeding dispersal seems to occur primarily in waters south of the equator (Harrison 1987), although the Pacific Ocean Biological Survey Program recorded them infrequently in the central Pacific north to 25°N, with most observations being between October and January (Gould and King 1967, King 1970). In November 1988, numbers were noted regularly up to 9°N, 132–147°W, an area where none had been recorded during several previous May–October cruises (Spear, Pyle pers. obs.).

There have been few sightings of Herald Petrels in the North Pacific. King (1970) recorded a bird (identification tentative) at about 25°N, 154°W on October 18, 1964; a specimen was collected flying over a seabird colony in the French Frigate Shoals, northwestern Hawaiian Islands (24°N, 166°W) on March 14, 1968 (Amerson 1971); and Gould (1983) reported at least two individuals between 33°N and 39°N along the 158°W meridian in early November 1976.

Although the more robust Atlantic form of the Herald Petrel may occur regularly in Atlantic North American waters (Lee 1986, Gochfeld 1988), we cannot predict the same for its smaller Pacific cousin. Because of the scarcity of sightings in the North Pacific, we suspect that the Herald Petrel rarely, if ever, ventures close to Pacific North American waters.

Murphy's Petrel

Little has been added to our knowledge of the breeding of the Murphy's Petrel since this species was described

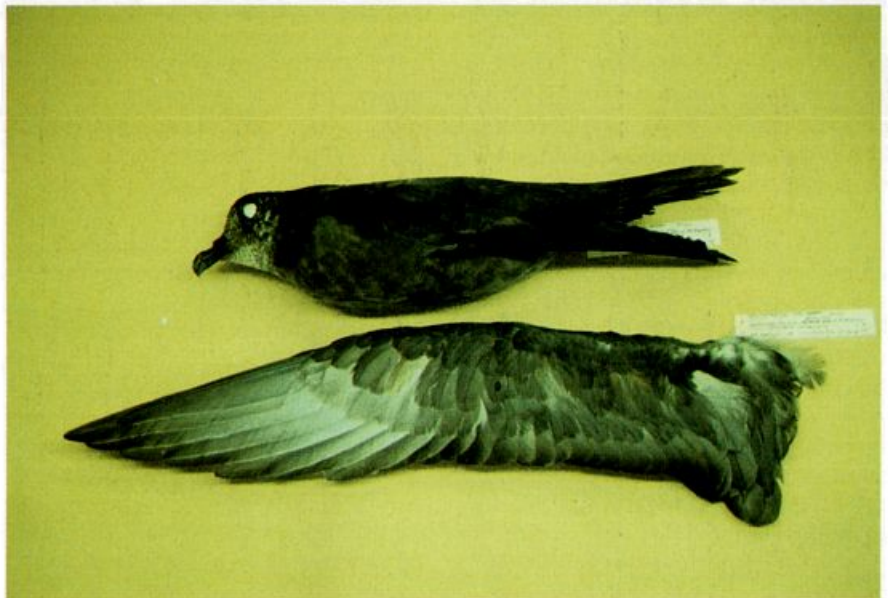


Figure 18. Study skin and spread wing of Murphy's Petrel collected 85 miles west southwest of Point Reyes, California, April 29, 1989. CAS 84182. Photograph/Stephen F. Bailey.

by Robert Cushman Murphy (1949). Its apparent breeding range is confined to six islands among the Austral (=Tubuai), Tuamotu, and Pitcairn groups, all between 22°S and 28°S (Murphy and Pennoyer 1952). Although no nest of this species has been found, the condition and presence of birds collected during the Whitney South Seas Expedition indicates that peak breeding on most of the islands occurs in April–May. However, the season on Ducie Island in the Pitcairns appears to be several months earlier, with a fledgling recorded in January and no birds observed during an exhaustive search in March (Murphy 1949).

The first indication that the Murphy's Petrel disperses into the North Pacific was the collection of four specimens by Pacific Ocean Biological Survey Program personnel: females in the northwestern Hawaiian Islands at Kure on October 7, 1963, and at French Frigate Shoals on September 9, 1966 (Gould and King 1967); and males seven miles off Barber's Point, Oahu, on October 29, 1966, and at 34°19'N, 126°24'W on April 3, 1967 (Clapp 1974). The latter bird was 340 nautical miles west of Santa Barbara, California. These specimens indicated that Murphy's were being seen during the Pacific Ocean Biological Survey Program but misidentified (Clapp 1974); in fact, the Barber's Point bird was initially identified as a Kermadec Petrel (Huber and Heiden 1967). Fur-

thermore, King (1970) recorded nine hypothetical "Solander's Petrels" in his study area near Hawaii, seven of which were observed heading south in October. Based on the timing and direction of flight, we suspect that these were Murphy's Petrels. One of these birds was the sole reason for the inclusion of the Solander's Petrel in Appendix A of the A.O.U. *Check-list* (1983). The species was downgraded to the "Hypothetical List", that is, from Appendix A to Appendix B in 1989 (A.O.U. 1989).

In the 1980s, Pitman (1986) and Spear began recording Murphy's Petrels sporadically in the Eastern Tropical Pacific. More northeasterly records include the American records summarized above and sightings by Pitman (in litt.) of two at 33°N, 137°W on February 19, 1984, 15 at 40°N, 128°W on April 20, 1985, and three the next day at 35°N, 130°W. The most northerly to date are four specimens collected by Pitman on July 19, 1985, at 50°N, 145°W (R. L. Pitman pers. comm.; LACM), and sightings by T. R. Wahl (in litt.) and Pitman (in litt.) in the southern Gulf of Alaska, north at least to 54°27'N, 144°52'W, on July 21, 1985. A bird found alive on Kauai (22°N, 159°30'W) on November 25, 1986, was tentatively identified as a Solander's Petrel (R. Pyle 1987), but the specimen's identification was later corrected by Spear to be a Murphy's Petrel (B. P. Bishop Museum 175801).

Observations to date suggest that the Murphy's Petrel occurs in North American waters primarily in March through June. Interestingly this is the period when the species is reported to be breeding. Several explanations seem possible. The birds visiting our waters in these months may be non-breeders, including young birds and adults not breeding for unknown reasons. These birds all may be from Ducie Island, where the breeding season seems to be earlier. The protracted breeding season on other islands may provide birds that are finished with breeding by these months. Some or all adults may have a two-year breeding cycle. Further work should clarify these possibilities.

Solander's Petrel

The Solander's Petrel is an uncommon species, with an estimated breeding population of 20,000 pairs on Lord Howe Island off Australia (Harrison 1985, Lindsey 1986). Recently this species has been discovered breeding on Philip Island (C. Corben pers. comm.) off Norfolk Island, which before extirpation was the largest breeding colony. Birds attend the Lord Howe colony at all times of the year, but appear to breed primarily in May–August (Lindsey 1986, Murphy and Pennoyer 1952). Dispersal seems to occur mainly in the western Pacific (Harrison 1985), although they are also present in very low numbers up to 20°N in the Eastern Tropical Pacific in May through November (Spear, Pyle, K. Hansen pers. obs.).

Most North Pacific records of the Solander's come from the west. They have been recorded regularly in May–August, in loose groups of up to 44 birds in the warmer currents off Japan (Kuroda 1955, Nakamura and Tanaka 1977, Wahl 1978, Pitman and Wahl ms.). At times it can be one of the most numerous birds north of the Subarctic Convergence east of Japan (T. R. Wahl pers. comm.). East of 180°, Wahl recorded 39 Solander's Petrels in the Subarctic Current between 47°N and 56°N east to 144°W in July and August cruises (Pitman and Wahl ms.). These included a well-photographed bird at 56°N, 145°W, on July 12, 1981, the northeasternmost record to date. Besides the California and Washington reports (Table 2) addi-

tional North Pacific records include two birds seen by Pitman at about 41°N, 137°W on May 6, 1984 (Pitman and Wahl ms.), one collected by Pitman at 40°N, 150°W on July 10, 1985 (R. L. Pitman pers. comm.; LACM 102806), and a bird seen by Pyle as it flew south at 29°47'N, 128°11'W (465 nautical miles south southwest of Point Conception, California) on December 6, 1988.

As with Murphy's Petrel, most of the North Pacific records of Solander's curiously occur at the time of peak breeding in the Southern Hemisphere. We suspect that it occurs infrequently but regularly in North American waters, although probably in smaller numbers than the Murphy's Petrel. The records from Japan to the Gulf of Alaska, Pitman's specimen, and some of the reports in California and Washington waters might indicate that June–December is the best time to look.

Distribution Summary

Pending further ornithological exploration of the outer Pacific North American waters, we predict that the Murphy's Petrel will prove to be regular and common in March–June, that the Solander's Petrel will occur sparingly from late spring through late autumn but especially in summer, that the Kermadec Petrel may occur rarely at any time of year, but that the Herald Petrel will not likely be found, at least regularly. More trips into the North Pacific Gyre, especially in the winter, are needed to clarify the true North American status of the dark *Pterodroma* petrels.

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facilitated its collection by providing information and a shotgun.

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LITERATURE CITED

- AINLEY, D. G. 1986. The occurrence of seabirds in the coastal region of California. *Western Birds* 7: 33-68.
- , and R. J. BOEKELHEIDE. in press. Seabirds of the Farallon Islands: ecology, structure and dynamics of an upwelling-system community. Stanford Univ. Press, Palo Alto, California.
- AMERICAN ORNITHOLOGISTS' UNION. 1983. Check-list of North American Birds. 6th Edition. American Ornithologists' Union, Washington, D.C.
- Supplement to the *Check-List of North American Birds* 1989. *Auk* vol. 106, no. 3, pp. 532, 537.
- AMERSON, A. B., Jr. 1971. The natural history of French Frigate Shoals, Northwest Hawaiian Islands. *Atoll Res. Bull.* 150: 1-383.
- BRIGGS, K. T., W. B. TYLER, D. B. LEWIS, and D. R. CARLSON. 1987. Bird communities at sea off California: 1975-1983. *Studies in Avian Biology* No. 11.
- CAMPBELL, K. F., A. D. BARRON, and S. F. BAILEY. 1986. Middle Pacific Coast Region. *Am. Birds* 40: 518-522.
- , R. A. ERICKSON, and S. F. BAILEY. 1985. Middle Pacific Coast Region. *Am. Birds* 39: 956-961.
- , 1987. Middle Pacific Coast Region. *Am. Birds* 41: 482-486.
- CLAPP, R. 1974. Specimens of three species of *Pterodroma* from the Pacific Ocean. *Ardea* 62: 246-247.
- DE SANTE, D. F., and D. G. AINLEY. 1980. The avifauna of the South Farallon Islands, California. *Studies in Avian Biology* No. 4.
- ERICKSON, R. A., S. F. BAILEY, and A. D. BARRON. 1986. Middle Pacific Coast Region. *Am. Birds* 40: 1248-1254.
- GOCHFELD, M., J. BURGER, J. SALLIVA, and D. GOCHFELD. 1988. Herald Petrel new to the West Indies. *Am. Birds* 42: 1254-1258.
- GOULD, P. J. 1983. Seabirds between Alaska and Hawaii. *Condor* 85: 286-291.
- , and W. B. KING. 1967. Records of four species of *Pterodroma* from the central Pacific Ocean. *Auk* 84: 591-594.
- HARPER, P. C., and F. C. KINSKY. 1978. Southern Albatrosses and Petrels: an identification guide. Victoria University Press, Wellington, New Zealand.
- HARRISON, P. 1983. Seabirds: an identification guide. First Edition. Houghton Mifflin, Boston.
- , 1985. Seabirds: an identification guide. Second Edition. Houghton Mifflin, Boston.
- , 1987. A Field Guide to Seabirds of the World. Viking Penguin, New York.
- HUBER, L. N., and R. S. HEIDEN. 1967. Notes for the Elepaio. *'Elepaio* 27: 83.
- HUNN, E. S., and P. W. MATTOCKS, Jr. 1984. Northern Pacific Coast Region. *Am. Birds* 38: 236-240.
- JOUANIN, C., and J.-L. MOUGIN. 1979. Order Procellariiformes. in E. Mayr and G. W. Cottrell, eds., Check-list of Birds of the World, Volume 1, Second Ed. Museum Comparative Zoology, Cambridge, Mass.
- KING, W. B. 1970. The trade wind zone oceanography pilot study. Part VII: Observations of seabirds, March 1964 to June 1965. U.S. Fish and Wildlife Service Report: Fisheries No. 586. 136 pp.
- KURODA, N. 1955. Observations of pelagic birds of the northwest Pacific. *Condor* 57: 290-300.
- LEE, D. S. 1986. Seasonal distribution of marine birds in North Carolina waters, 1975-1986. *Am. Birds* 40: 409-412.
- LEVALLEY, R., and J. EVENS. 1981. Middle Pacific Coast Region. *Am. Birds* 35: 973-977.
- LINDSEY, T. R. 1986. The Seabirds of Australia. Angus & Robertson, North Ryde, New South Wales.
- MATTOCKS, P. W., Jr. 1986. Northern Pacific Coast Region. *Am. Birds* 40: 514-518.
- MCCASKIE, G. 1980. Southern Pacific Coast Region. *Am. Birds* 34: 199-204.
- , 1986. Southern Pacific Coast Region. *Am. Birds* 40: 522-526.
- , 1987. Southern Pacific Coast Region. *Am. Birds* 41: 487-490.
- MURPHY, R. C. 1936. Oceanic Birds of South America, 2 vols. Amer. Mus. Nat. Hist., New York.
- , 1949. A new species of petrel from the Pacific. *Ornithol. Biol. Wissenschaft* 89-91.
- , and J. M. PENNOYER. 1952. Larger petrels of the genus *Pterodroma*. *Amer. Mus. Novitates* 1580: 1-42.
- NAKAMURA, K., and Y. TANAKA. 1977. Distribution and migration of two species of the genus *Pterodroma* in the North Pacific. *Misc. Rep. Yamashina Inst. Ornith.* 9: 112-120.
- PITMAN, R. L. 1986. Atlas of seabird distribution and relative abundance in the Eastern Tropical Pacific. Administrative Rep. LJ-86-02C, Southwest Fisheries Center, La Jolla, California 107 pp.
- , and T. R. WAHL. Unpublished ms. The occurrence of Solander's Petrel and Murphy's Petrel in the Eastern North Pacific. 19 pp.
- PRATT, H. D., P. L. BRUNER, and D. G. BERRETT. 1987. A Field Guide to the Birds of Hawaii and the Tropical Pacific. Princeton University Press, Princeton, New Jersey.
- PYLE, R. L. 1987. Hawaiian Islands Region. *Am. Birds* 41: 332-334.
- , and B. EILERTS. 1986. Pelagic seabird observations from Northwest Hawaiian Island waters. *'Elepaio* 46: 181-183.
- , L. B. SPEAR, and J. ENGBRING in prep. An undescribed population of Herald Petrel from Ta'u Island, American Samoa.
- ROBERSON, D. 1985. Monterey Birds. Monterey Peninsula Audubon Soc., Carmel, California.
- STALLCUP, R. W. 1976. Pelagic birds of Monterey Bay, California. *Western Birds* 7: 113-136.
- WAHL, T. R. 1978. Seabirds in the northwestern Pacific Ocean and south central Bering Sea in June 1975. *Western Birds* 9: 45-66.
- WILD BIRD SOCIETY OF JAPAN. 1982. A Field Guide to the Birds of Japan. Wild Bird Society of Japan, Tokyo.

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