

Identification of 'black-and-white' storm-petrels of the North Atlantic

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ABSTRACT This review article consolidates identification criteria for the six species of 'black-and-white' storm-petrel recorded or claimed in the North Atlantic: European Storm-petrel *Hydrobates pelagicus*, Wilson's Storm-petrel *Oceanites oceanicus*, Leach's Storm-petrel *Oceanodroma leucorhoa*, Madeiran Storm-petrel *O. castro*, Black-bellied Storm-petrel *Fregetta tropica* and White-bellied Storm-petrel *F. grallaria*. Established knowledge is updated with fresh insights and illustrated with instructive digital images. We have two aims: (a) to support County Recorders in Britain now responsible for evaluating Wilson's Storm-petrel submissions; and (b) to bring to a wider international audience current understanding about identification of North Atlantic 'black-and-white' storm-petrels. The article has two main sections: (a) a general discussion about identification of the storm-petrels under review; and (b) detailed species accounts, and information on how each species can be distinguished from the other five species (though white-bellied *Fregetta* storm-petrels remain problematic). A template that outlines our view of what constitutes a sound submission of a reportable 'black-and-white' storm-petrel is proposed. The main text is supported by ten appendices covering size illusion and exaggeration, factors of scale, angle of view, descriptive terminology for flight behaviour, chum and chumming, and wear, moult and bleaching. We focus on vessel-based observation since, realistically, this is the optimal means of getting to grips with storm-petrels in the field and is the main source of our experience. Land-based observation rarely affords the views essential to apply the finer points of this presentation.

An observer who has once had the good fortune of watching the two species [Wilson's and Leach's Storm-petrels] together can thereafter distinguish them almost as far away as the birds can be seen (Murphy 1915).

Observation and identification of tubenoses (Procellariiformes) became 'fashionable' in Britain in the 1980s with publication of Peter Harrison's two seabird guides (Harrison 1983a, 1987) and the advent

of pelagic trips into the Western Approaches aboard MV *Chalice* (with Harrison, from 1986 to 1988), and on RMV *Scillonian III* (1989–2004). These pelagic trips enabled many birders to experience North Atlantic tubenoses

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at close quarters and made possible the rare opportunity to photograph them. In those 'early days', Wilson's Storm-petrel *Oceanites oceanicus* was the Holy Grail that tempted many British 'listers' to participate in what was for some a stomach-wrenching venture to sea.

However, from 2000, observations from regular short-range pelagic trips off the Isles of Scilly between June and September established that Wilson's is, in fact, a regular though scarce summer and early autumn passage migrant in Scillonian waters, and is not a sacred rarity (see Appendix 1). In 20 years, the status of Wilson's Storm-petrel plummeted from Holy Grail to one where it was no longer considered as a national rarity (as from 1st January 2006; Rogers *et al.* 2005). Suddenly, assessing reports of Wilson's became the responsibility of County Recorders, but there has been no recent substantive consolidated identification update on Wilson's and similar so-called 'black-and-white' North Atlantic storm-petrels to aid decision-making at a county level.

Furthermore, interest in storm-petrels has escalated in tandem with multiplying pelagic trips from many ports, on both sides of the North Atlantic. Knowledge has accrued about where and when to see them, while the mix of chum and methods of chumming have improved, bringing more storm-petrels even closer to observers and photographers (see Appendix 2). The combination of more pelagic trips, close proximity of storm-petrels and improvements in digital photography has yielded superb images of storm-petrels at sea, including many published for the first time here. Insights into the identification of storm-petrels have arisen through critical analysis of digital stills and videos in combination with at-sea observations. Conversely, unhelpful myths have been propagated (see Appendix 3). So, in addition to supporting local recorders in Britain, there is an international need for a review article on 'black-and-white' North Atlantic storm-petrels, integrating established knowledge with fresh insights and new photographic material.

North Atlantic 'black-and-white' storm-petrels

Four species of 'black-and-white' storm-petrel occur regularly in the North Atlantic: European Storm-petrel *Hydrobates pelagicus*, Wilson's Storm-petrel *Oceanites oceanicus*, Leach's Storm-petrel *Oceanodroma leucorhoa*, and

Madeiran Storm-petrel *O. castro*. European breeds during the northern summer in the northeast Atlantic and the Mediterranean, wintering mainly off the west coast of Africa. Wilson's is a circumpolar breeder along the Antarctic coastline as well as on sub-Antarctic islands during the southern summer and part of this population winters in the North Atlantic (another population breeds in the Chilean fjords). Leach's breeds during the northern summer in the northwest and northeast regions of the Atlantic and winters mainly in regions of tropical convergence (there are also populations in the Pacific). Madeiran breeds throughout the year in the tropical and subtropical Atlantic; it is dispersive and/or migratory and recorded in the western Atlantic from Brazil to Canada (there are also populations in the Pacific). However, to the north and east of its Atlantic breeding range, Madeiran is an extreme vagrant to Western Europe, except Portugal where there is a relatively small offshore breeding colony, estimated at c.50 pairs by Brooke (2004), and c.200–400 pairs in BWPI (2006).

In western Europe, including Scandinavia, vagrant Madeiran Storm-petrels have been recorded from Britain (one, November), Finland (one, January), France (one, August; two, October), Ireland (one, October), Spain (singles in January, February, June and November and two in July), and Switzerland (one, December) (Appendix 4). The data are difficult to interpret because of the limited numbers, while there is a complication with Madeiran Storm-petrels breeding in the Azores, where two distinct populations 'time-share' burrows, each having non-overlapping breeding and dispersal periods (Friesen *et al.* 1998; Monteiro & Furness 1998; Sangster 1999). The data tentatively suggest that Madeiran is most likely to occur as a vagrant in western Europe during the storm-prone months from October to February (often among other wrecked seabirds). Pelagic or land-based (tape-lured) records in summer for Spain and France may relate to 'wanderers,' probably from the small colony off Portugal but conceivably from another, larger North Atlantic colony.

In addition, a Black-bellied Storm-petrel *Fregetta tropica*, presumably from the South Atlantic populations, was seen and photographed c.70 km southeast of Oregon Inlet, North Carolina, on 31st May 2004 (Guris *et al.* 2004). Another was seen and photographed

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nearby in the Gulf Stream off Cape Hatteras on 16th July 2006 (www.patteson.com). A White-bellied Storm-petrel *F. grallaria* was reported north of the Cape Verde Islands on 17th August 1986 (Haase 1988; Clarke 2006). However, the description is brief and there is some doubt whether Black-bellied can be excluded (BWPi 2006). Moreover, there is confusion in the literature regarding the white-bellied *Fregetta* storm-petrels that breed in the Tristan da Cunha group (here taken to include Gough Island). It is possible that a population of white-bellied Black-bellied Storm-petrels breeds alongside a population of White-bellied Storm-petrels, making the field identification of any white-bellied *Fregetta* storm-petrel in the North Atlantic extremely difficult (Appendix 5). Nonetheless, both *Fregetta* storm-petrels are potential vagrants to British waters.

Identification

At-sea identification of seabirds involves unique difficulties. Encounters are often extremely brief; on all but large and steady vessels telescopes are redundant; and changeable light and weather conditions can dramatically 'manipulate' context and the impressions gained. Furthermore, with tubenoses we are dealing with a complex and often subtle plumage *problematique* since petrels are 'clad in plumage that is some combination of black, white and shades of grey and brown' (Brooke 2004). These factors also pose unique difficulties for rarities committees (Bradshaw 2002). Cryptic plumage and other difficulties are cues for a methodical approach to at-sea storm-petrel identification and we consider five key issues, which are discussed below: jizz and analysis, size, structure, plumage, and flight behaviour.

Jizz and analysis

As we experience it, the process of storm-petrel

identification unfolds as follows. Size, structure, plumage, and flight behaviour at first sight combine into a whole first-interpretation, or 'jizz'. Jizz interpretation facilitates a 'first-stab' at identification: for example, 'Oceanodroma at the back of the slick!' or 'Oceanites-like "stormy" approaching from down-wind!' Dunne (2006) attempted to convey jizz using catchphrases that are familiar to all. Those relevant to this article include: Wilson's 'dances with waves', Leach's is the 'crazed or drunken Nighthawk of the sea', and Madeiran is the 'plain dark storm-petrel' (p. 112). Similes also offer an effective way of capturing the essence of a storm-petrel (table 1). The idea of using catchphrases and similes to summarise the quintessential character of a storm-petrel can be very effective but there are caveats. First, jizz interpretation breaks down in extreme circumstances at sea, such as during strong and gusty winds. Second, jizz is modified when the bird's flight feathers are heavily worn and/or in moult (Appendix 6). Third, jizz interpretation alone, like pigeonholing, runs the risk of over-simplification. Hence, there also is need to employ an analytical approach that gets to grips with finer details of storm-petrel identification. Our analytical approach comprises four main tasks: judging size, noting structure, describing plumage, and recounting flight behaviour. If the four tasks can be performed satisfactorily, then most storm-petrels (with the exception of white-bellied *Fregetta* storm-petrels) encountered in the North Atlantic may be identified with confidence.

Size

Two inter-related size judgements are desirable: (a) relative body lengths and wingspans of the unidentified storm-petrel and nearby storm-petrels or other seabirds; and (b) actual body length and wingspan of the storm-petrel (table 2).

Table 1. Similes for the six species of 'black-and-white' storm-petrel recorded or claimed in the North Atlantic: European Storm-petrel *Hydrobates pelagicus*, Wilson's Storm-petrel *Oceanites oceanicus*, Leach's Storm-petrel *Oceanodroma leucorhoa*, Madeiran Storm-petrel *O. castro*, Black-bellied Storm-petrel *Fregetta tropica* and White-bellied Storm-petrel *F. grallaria* (* denotes comparison found in recent literature).

Genus	Species	Like a ...
<i>Hydrobates</i>	European	small bat (Chiroptera)*
<i>Oceanites</i>	Wilson's	smallish hirundine, in particular a Barn Swallow <i>Hirundo rustica</i> *
<i>Oceanodroma</i>	Leach's & Madeiran	respectively, Common Nighthawk <i>Chordeiles minor</i> * and European Nightjar <i>Caprimulgus europaeus</i> *
<i>Fregetta</i>	Black-bellied & White-bellied	well-accomplished exhibition skateboarder (in both cases)

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Table 2. Part (i) shows actual body length and wingspan (in mm) of 'black-and-white' storm-petrels recorded or claimed in the North Atlantic (European Storm-petrel *Hydrobates pelagicus*, Wilson's Storm-petrel *Oceanites oceanicus*, Leach's Storm-petrel *Oceanodroma leucorhoa*, Madeiran Storm-petrel *O. castro*, Black-bellied Storm-petrel *Fregatta tropica* and White-bellied Storm-petrel *F. grallaria*). Sources: (1) BWPI (2006); (2) Blomdahl *et al.* (2003); (3) Marchant & Higgins (1990); (4) average of the median figure in sources (1)–(3); this figure is used in species accounts below.

Part (ii) shows relative body length and wingspan of the same species, calculated from column 4 in part (i). For example, the relative body length and wingspan of European and Wilson's are, respectively, 1.08 and 1.05; in other words, the body length of Wilson's is, on average, 1.08 times larger than that of European and the wingspan is 1.05 times larger.

(i)								
Ref.	Body length				Wingspan			
	1	2	3	4	1	2	3	4
European	140–180	150–160	na	158	360–390	370–410	na	383
Wilson's	150–190	160–185	150–190	171	380–420	380–420	380–420	400
Madeiran	190–210	190–210	na	200	440–460	430–460	na	448
Black-bellied	190–210	na	200	200	440–470	na	450–460	455
White-bellied	190–210	na	180–220	200	440–470	na	460–480	462
Leach's	190–220	180–210	190–220	202	450–480	430–480	450–480	462

(ii)						
Relative body length (above species' names)						
European	1.08		1.27	1.27	1.27	1.28
1.05	Wilson's		1.17	1.17	1.17	1.18
1.17	1.12	Madeiran		1.00	1.00	1.01
1.19	1.14	1.02	Black-bellied		1.00	1.01
1.21	1.16	1.03	1.02	White-bellied		1.01
1.21	1.16	1.04	1.02	1.01	Leach's	

Relative wingspans (below species' names)						
European	1.08		1.27	1.27	1.27	1.28
1.05	Wilson's		1.17	1.17	1.17	1.18
1.17	1.12	Madeiran		1.00	1.00	1.01
1.19	1.14	1.02	Black-bellied		1.00	1.01
1.21	1.16	1.03	1.02	White-bellied		1.01
1.21	1.16	1.04	1.02	1.01	Leach's	

Ideal circumstances that facilitate accurate judgement of actual and relative body length and wingspan involve observers with reasonable experience on a familiar vessel in known waters with well-known comparison species (i.e. 'sea-birders on their patch'). Nonetheless, making size comparisons between storm-petrel species is challenging. We have experienced two size-illusion phenomena: that between storm-petrel species at sea (Appendix 7); and that resulting from factors of scale (Appendix 8).

Structure

There are five key structural features to note: (a) wing shape, (b) tail shape, (c) toe projection, (d) body build, and (e) bill shape and proportions.

Wing shape

This differs among species and changes according to flight behaviour (see below). When a storm-petrel is travelling, or feeding by gliding, skimming and surface-snatching, note the following: the angle at the carpal joint – from smoothly rounded, to shallow angle, to deep angle; shape of trailing edge – from

straight to angular; and head-on wing profile – either straight or bowed in a shallow 'M'. Some species feed by hanging in the air above food items, with wings held at an angle ranging from below the body to above the body in a V-shape while the primaries are fanned, making the trailing edge of the hand rounded and the wings seemingly paddle-shaped. Note the angle of the wings relative to the body, ranging from slightly depressed, through horizontal and a flattened-V, to an erect-V. Some species hover rather than hang. The paddle shapes mentioned above differ somewhat among species as a result of different wing formulae; these shapes are not well documented and in any case are difficult to assess in the field, although photographs may help.

Tail shape

This also differs among species and changes according to flight behaviour (see below). The tail is normally closed when travelling (species dependent) and fanned while hanging or hovering above food items. Whether the tail is closed or fanned, note whether the corners are rounded or squared-off, and note whether the

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tail-tip is rounded, square-ended, or forked, and the depth of any fork from deep, to shallow, to merely concave. Note also that wear and moult affect both wing shape and tail shape (Appendix 6).

Toe projection

Relative leg length (including feet and toes) to tail length varies significantly among species. Travelling storm-petrels hold their legs mainly straight-out, immediately under the tail and tucked beneath the undertail-coverts. Consequently, the toes project considerably beyond the tail-tip in species with relatively long legs (e.g. Wilson's) but generally not in species with relatively short legs (e.g. Leach's). Note that storm-petrels rarely retract their legs while travelling (but if long-legged species retract their legs, then toe projection is obviously eliminated) and also that the extent of toe projection can alter with moult and wear. Species that normally do not show a toe projection might do so when the tail is heavily worn or in moult (BWP*i* 2006).

Body build

This varies among species, from short and compact like European, to long yet chunky like Madeiran, to fat and compact like Black-bellied and White-bellied.

Bill shape and proportions

Significant variation is found across the six species. Note the length and depth of basal and distal halves, overall curvature, and extent of the hook at the bill tip. Gaining unequivocal views and logging details of bill shape and proportions is very difficult at sea and often unsatisfactory in video footage. High-quality digital stills are the most reliable way of capturing bill details.

Plumage

There are five key plumage features to describe: (a) upperwing-covert bars; (b) underwing-covert and axillary panels; (c) white on rump, uppertail- and undertail-coverts and rear flanks; (d) white on belly; and (e) general colour and colour tones. Plumages of sexes and ages are essentially alike in storm-petrels and there are no seasonal differences, but grey colour tones become paler and black-brown tones browner as feathers become worn and bleached. Fresh juveniles of some species show

narrow white fringes to certain feathers, but this rapidly wears away and is of no consequence to field identification.

Upperwing-covert bars

Length, width and shape, prominence, colour and colour tone of wing-covert bars vary considerably among species. Prominent wing-covert bars stand out at long range. The main feather tract involved is the greater coverts, but bars sometimes cross feather tracts including greater, median and lesser coverts, especially at the distal end, which broadens the bars in that area and extends them towards the leading edge of the wing. Note: *length* of covert bars, either reaching the leading edge or falling short of it; *width* (either narrow – pale tips to greater coverts, medium – pale greater coverts, or broad – bar covering several feather tracts); and resulting *shape* – respectively like a pencil-line, roughly rectangular, or a tear-shape, broadening distally. Also note prominence, from bright to dull, as well as colour and colour tones (in conjunction with state of wear).

Underwing-covert and axillary panels

This region is variably pale in the six species and to some extent varies individually. Prominent panels stand out at long range. The main feather tracts involved are the greater-underwing and greater under-primary coverts and axillaries, but other feather tracts may be included. Note whether this region appears dark, bronze-flushed, pale or white. Some white panels gleam, whereas others appear 'dirty' in parts, which should be noted. The dirty look occurs when wholly or partly dark feathers are admixed, typically among the outer greater primary coverts. High-quality digital stills should reveal the precise pattern.

White on rump, uppertail- and undertail-coverts and rear flanks

The extent and shape of white in this region varies considerably between some species, while in others it is similar. In species where white on the upperside extends to the underside, the white always seems to be on view, even at considerable range, whether the storm-petrel is in flight or sat on the sea. Conversely, with species where the white barely extends to the underside, the white in this region is at best on view occasionally and may be hard to see, even at close range. Note whether the white patch is visible

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across the width of rump and uppertail-coverts and whether it is narrow or broad, roughly square or rectangular, and U-shaped or V-shaped (a V-shape is created by dark feathers in the central/upper area of an otherwise white rump). Note whether white extends to the undertail-coverts and rear flanks.

White on belly

Look for white on the belly, especially if a storm-petrel seems fat and compact. A white belly immediately suggests *Fregetta* storm-petrels from the South Atlantic or something astonishing – such as White-vented Storm-petrel *Oceanites gracilis*, the miniaturised Wilson's Storm-petrel of the Pacific! Before collapsing, note whether the whole belly is white and whether the borders with the black-brown upper breast and undertail-coverts (if dark) are straight and clean-cut or smudgy. Note any evidence of a dark central belly stripe and whether broken or complete; if the latter, note whether it unmistakably connects the dark breast to the undertail-coverts. Still photographs are the best way to clinch the pattern of the underside (even if somewhat out-of-focus).

General colour and colour tones

Although all of the 'black-and-white' storm-petrel species can be described as black-brown (not black) and white, the extent to which black dominates brown is different in each species and the tone of the black-brown ranges from cool to warm. Note the black-brown colour and colour tones of head, body, wings and tail, even though they vary according to light conditions. Where possible, compare colour tones directly with those of other storm-petrels, which allows comparison under similar light conditions. Bear in mind that colour tones change with feather age and that exposed feathers of head, body, wings and tail become browner with age. Pale feathers that form upperwing-covert bars become paler and more bleached with time, and may even begin to disappear with age and wear.

Flight behaviour

There are two main flight behaviours to note: travelling (including migration, flights between feeding grounds and breeding colonies, and a general search for food) and feeding. Storm-petrels feed on items found on or just below the sea surface and, once food has been located, the bird must manoeuvre over it, and seize, snatch

or pick at the prey, even dive for it. The basic task is the same for all species, but the way it is carried out differs among species. Flight is clearly affected by wear and moult of flight feathers (Appendix 6). Terminology has evolved to describe flight behaviour of storm-petrels and several of the terms (explained in Appendix 9) may be used to portray each species: e.g. a travelling Wilson's in moderate wind might be described as having '*purposeful direct flight on stiff wings with steady wingbeats* close to the sea surface for an extended period', while a travelling Leach's in similar conditions might be described quite differently and have '*erratic flight on elastic wings with deep wingbeats interspersed with shearing glides*'.

Sealing the identification

Sealing the identification of a North Atlantic 'black-and-white' storm-petrel is, in principle, straightforward given sound basic knowledge and reasonably close and extended views, in moderate to fair weather conditions (though white-bellied *Fregetta* storm-petrels remain problematic). Photographic stills help since they capture the detail of structure and plumage not always visible at sea. Equally important, video footage captures flight behaviour for subsequent critical analysis. Stills and video add substance to a rare storm-petrel claim (e.g. Flood *et al.* (2004) and Stephenson *et al.* (2007a) in the rediscovery of the New Zealand Storm-petrel *Pealeornis maoriana* or Guris *et al.* (2004) in the identification of a presumed White-bellied Storm-petrel, subsequently revealed through stills to be the North Atlantic's first Black-bellied). However, although highly desirable, we do not believe that photographs are in every case essential for a rare storm-petrel to be accepted by a rarities committee.

We acknowledge that, with storm-petrels, no single feature is incontestably diagnostic. Jizz is a subjective measure. Judgement of size is imprecise and subject to size illusion and factors of scale. Wing and tail shapes alter with moult and wear. Plumage varies with moult, wear, bleaching, and aberration (and not all plumages are fully understood). Flight behaviour is influenced by moult, wear and wind strength. However, a suite of features all pointing to one species with no contradictory evidence may, in many cases, be taken as diagnostic (see table 3 below). If observers are suffi-

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ciently experienced and attain satisfactory views, then a well-prepared submission focusing on the key features discussed here, preferably supported by photographs and/or artwork, will, in most cases, make decision-taking comparatively problem free.

Accordingly, our notion of a sound storm-petrel description is one that sets out the circumstances of an observation and then concentrates on the following particulars:

- Size of vessel, range of storm-petrel, height of observation point above sea surface and thus angle of view (Appendix 10).
- Jizz, animated through catchphrases or similes (table 1), or similar phrases that resonate with the observer's experiences.
- Actual body length and wingspan, relative body length and wingspan compared with other storm-petrels (and seabirds) present at the time (table 2), but with awareness of size illusion and factors of scale (Appendices 7 & 8).
- Structure in terms of (a) wing shape, (b) tail shape, (c) toe projection, (d) body build, and (e) bill shape and proportions, all with reference to moult and wear (Appendix 6) and angle of view.
- Plumage details of (a) upperwing-covert bars, (b) underwing-covert and axillary panels, (c) white on rump, uppertail- and undertail-coverts, and rear flanks, (d) white on belly, and (e) general colour and colour tones, all with reference to angle of view.
- Flight behaviour, specifying whether travelling or feeding, employing common terminology (Appendix 9) or some other well-defined terminology, noting the impact of moult and wear on flight behaviour where relevant (Appendix 6).
- Photographs and/or artwork.
- Explain how other storm-petrel species were eliminated.

Species accounts

These describe in detail the six storm-petrel species in terms of taxonomy, Atlantic range and movements, and the five key identification issues introduced above. Species accounts are constructed from our observations at sea, analysis of structure and plumage using our still photographs, analysis of flight behaviour using our video footage, all in conjunction with extant knowledge summarised in Naveen

(1981–82), Harrison (1983b), Marchant & Higgins (1990), Enticott & Tipling (1997), Sibley (2000), Shirihai (2002), Brooke (2004), BWPi (2006) and Onley & Scofield (2007). Several common characteristics are summarised separately. Accounts concentrate on features relevant to vessel-based observation and identification, except where wing structure is described.

Common characteristics

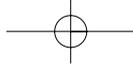
All six species share the following characteristics. They remain exclusively in the lowest 10 m of airspace above the sea surface; many remain in the lowest 5-m band and some occur mostly in the lowest 2 m. All species have 11 primaries although the outermost (P11) is minute and not relevant to this discussion, so P10 is taken as the effective outermost primary. When birds feed by hovering or hanging, the primaries are fanned, yielding paddle-shaped wings, the actual shape of the 'paddle' being determined by the wing formula. Remiges and rectrices are darker than wing-coverts and body feathers. Bill, legs and feet are black (although Wilson's alone has yellow foot-webbing). All are normally silent at sea, save for occasional quiet chattering among feeding flocks of Wilson's (and perhaps other species).

European Storm-petrel

Taxonomy Recent research suggests that this species may be polytypic, with nominate *pelagicus* in the Atlantic and *H. p. melitensis* in the Mediterranean (Lalanne *et al.* 2001; Cagnon *et al.* 2004).

Atlantic Breeds northeast Atlantic and Mediterranean, April–September. Dispersal mainly transequatorial, on eastern side of Atlantic, September–November. Movement of Mediterranean birds is unclear and at least some remain there into the northern winter. Atlantic birds winter west coast of Africa as far south as South Africa, mainly in boundary zones between shelf littoral and deep ocean, November–March. Significant return passage off western Africa, March–April. The return of immature non-breeders to colonies is more leisurely while others, perhaps the youngest birds, remain in waters along coasts of western Africa and southern Europe during breeding season. Vagrant to Atlantic seaboard of USA (nine records to end of 2006; www.patteson.com).

Jizz Like a small bat.



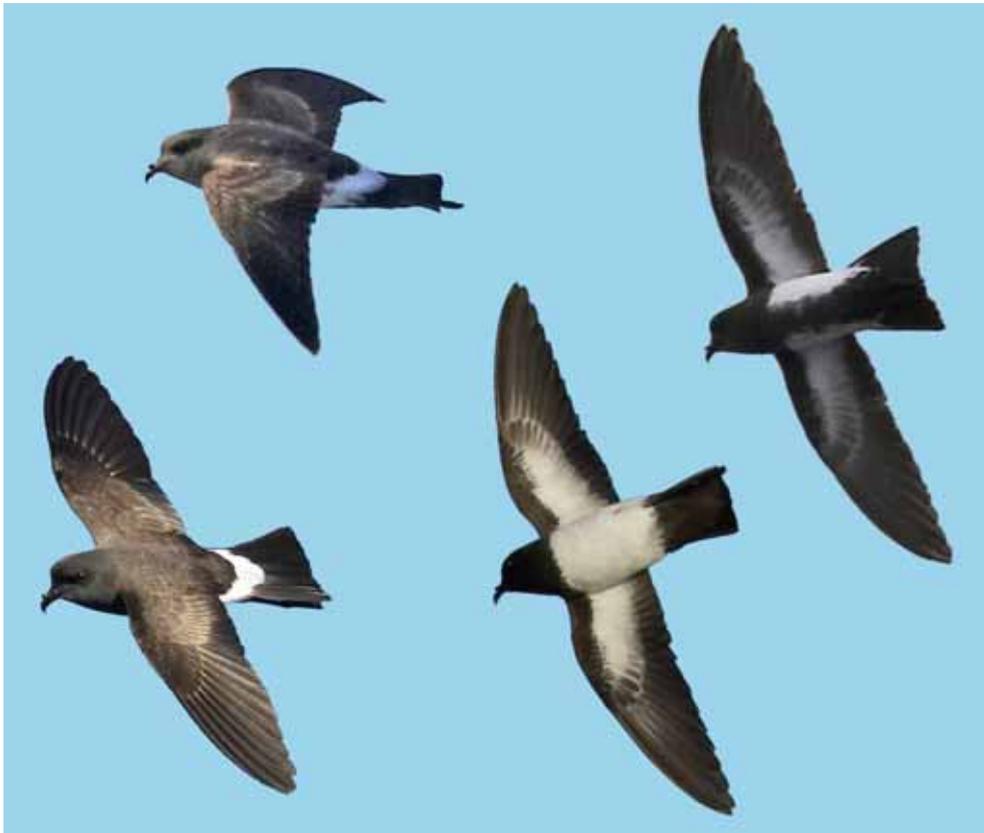
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165. Uppersides and undersides of the two *Fregatta* species, all roughly to scale as well as to scale with plate 164. Top Black-bellied Storm-petrel *F. tropica*, Drake Passage, March 2006; bottom White-bellied Storm-petrel *F. grallaria* (see Appendix 5), off Tristan da Cunha group, March 2006. Compare extent of toe projection (presumably legs retracted on Black-bellied Storm-petrel underside shot); upperwing patterns (contrast between species normally greater than shown here), and underbody patterns.

Size Body length 158 mm. Wingspan 383 mm.
Structure *Wing shape* Wing formula: P9 longest; P10 6–13; P8 1–3; P7 7–12; P6 16–19; P1 56–66 mm shorter. Outer primary pointed in juveniles, less so if worn, rounded in adults. When travelling, wings short and broad, wing-tips blunt-ended, with both leading and trailing edges strongly angular. *Head-on travelling profile* Wings normally slightly bowed forming shallow-M, arms and hands quite short. *Tail*

shape Short, can look square, though gently rounded; clearly rounded when fanned. *Toe projection* None. *Body build* Compact, with short body. *Bill shape and proportions* At sea looks small. At close range short, though length and depth are in proportion, slightly decurved and hooked; nasal tubes 40% of bill length.

Plumage *General colour and colour tones* Darkest North Atlantic storm-petrel. In fresh plumage looks sooty-brown, but bleaches

164. (Left) Uppersides and undersides of the four regular 'black-and-white' storm-petrels of the North Atlantic, all roughly to scale, and to scale with plate 165. Top European Storm-petrel *Hydrobates pelagicus*, off Scilly, August 2004; upper middle Wilson's Storm-petrel *Oceanites oceanicus*, off Scilly, July 2005; lower middle Madeiran Storm-petrel *Oceanodroma castro*, off St Helena, April 2006; bottom Leach's Storm-petrel *O. leucorhoa*, Equatorial Atlantic 0°00.000'S, 17°33.462'W, April 2006. Compare differences between the wing shapes; tail shapes; toe projection; upperwing-covert bar, underwing-covert and axillary panels, white on rump, uppertail- and undertail-coverts, and rear flanks. The white underwing panel of European Storm-petrel is more striking than shown here when feathers are fresh.

[Footnote: A DVD containing movie footage of all six 'black-and-white' storm-petrels plus White-faced Storm-petrel *Pelagodroma marina*, with a focus on flight behaviour, is available from Bob Flood, while digital stills of the same species, focusing on plumage and structure, are available from Bryan Thomas. Please use the contact details on p. 000.]

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browner with age. Close up, paler and greyer on forehead and chin, browner below, with upper-body feathers darker than upperwing-coverts. Fresh juveniles have narrow whitish edges to upperpart feathers that wear off quickly. *Upperwing-covert bars* At range, apparently uniform dark upperwings without covert bars. Close-up, greater coverts form very dull bars, a little more obvious when bleached, but never shows broad pale bars. At close to medium range, brown-cream pencil line along tips of greater coverts (outer webs fringed pale), whitish and more

pronounced on autumn juveniles, but this wears off quickly. *Underwing-covert and axillary panels* In fresh plumage, eye-catching white panels in flight, even at long range. Photographs of birds off Scilly reveal greater under primary coverts white with dark tips, greater underwing-coverts white, and axillaries dark with white tips. Markings less obvious in worn birds, when can be tricky to see, even at medium to close range. *White on rump, tail-coverts and rear flanks* Lower rump feathers sooty-brown with white tips, uppertail-coverts white, longest with

black tips, which combine to give a roughly rectangular, well-defined, bold and (from above) slightly U-shaped white rump-patch. Patch extends to lateral undertail-coverts, which are white with black tips, and to rear flanks. In flight, white patch seemingly always in view whatever the angle of observation; also visible when sat on sea at moderately close range. *White on belly* None.

Flight behaviour Flies mostly within 2 m of sea surface, but occasionally up to 5 m. *Travelling* Flight characterised by fast, shallow, bat-like fluttering wingbeats (has fastest wingbeats of the six species) interspersed with occasional short glides. Sometimes casually zigzags, may shear in strong wind. Presumed migrants observed in October from headlands in Scilly, flying directly into strong wind, made good headway. In contrast, Leach's



Bryan Thomas

166. European Storm-petrel *Hydrobates pelagicus*, off Scilly, July 2005. Storm-petrels relish tiny pieces of fish liver used in chum! To collect the liver, this European hovered above it, using feet as stabilisers, dipped down to seize it, then quickly moved on, repeating this manoeuvre many times in quick succession. Note the paddle-shaped wings, short legs, white on the rump and uppertail-coverts extending to undertail-coverts and rear flanks, and white underwing-covert and axillary panel.

Identification of 'black-and-white' storm-petrels

observed in similar conditions was unable to progress directly into oncoming wind. *Feeding* Patrols area of food source such as a slick in dashing and excited fashion, zigzagging back and forth, twisting and turning. When food located comes to a dead halt, is briefly forced upwards in so doing, then drops and, facing into wind, hovers over food item with wings normally held in an erect V-shape (far more erect than Wilson's), using feet as stabilisers, dips head down and seizes food, then moves on. 'Hovers, dips, seizes and moves on' repeatedly and in quick succession. Hovering may be extended to perhaps four seconds, at which time engages in foot-pattering proper. Hovering difficult with little breeze, so instead of foot-pattering utilises body buoyancy by virtually sitting on sea surface, and hangs by holding wings normally in an erect V-shape, surface-seizes and moves on. 'Sits, hangs, seizes and moves on' repeatedly and in quick succession. Off South Africa, also recorded diving to collect food items (Griffiths 1981). Follows in the wake of vessels and associates with feeding cetaceans. **Overall impression** Small, compact, dark, busy and seemingly restless; flashes white on underwings in flight (less so when worn).

Wilson's Storm-petrel

Taxonomy Polytypic, with nominate *oceanicus* (sub-Antarctic islands south of Antarctic Polar Front) and *O. o. exasperatus* (Antarctic mainland and islands of Scotia Sea) of relevance here; some of both subspecies believed to migrate into North Atlantic. **Atlantic** Breeds December–March with dispersal April–May, earlier if burrows blocked by hard snow causing breeding failures. Large northward movement Weddell Sea by mid March and major emergence into sub-Antarctic waters in April. Passage up both sides of Atlantic, mainly

west side, but allegedly not through central Atlantic in any numbers; though Wilson's observed regularly March and April 2006 en route to South Georgia, Tristan da Cunha group, St Helena, Ascension, then over the equator to Cape Verde Islands, last observed mid-way between Ascension and Cape Verde Islands 12th April 2006 (pers. obs.). Also movement into Indian and Pacific Oceans. Arrival northwestern Atlantic along coasts of USA from third week of April with concentrations in Gulf Stream off North America by end June. Common in Canary Current, but only small numbers reach northeastern Atlantic, e.g. off Scilly June–September, where it becomes very scarce from late August (Appendix 1). Southward movement obvious September–October. Returns to colonies November–December. Immature non-breeders' return to colonies more leisurely, others remain in tropical waters off South America and South Africa during breeding season.

Jizz Like smallish hirundine, especially Barn Swallow *Hirundo rustica*.

Size *Body length* 171 mm. *Wingspan* 400 mm. Females said to be significantly larger than males in all proportions (Brooke 2004) though Shirihai (2002) noted extensive overlap between sexes. Subspecies *exasperatus* larger than nominate, though may be clinal (Brooke 2004). Some slight variation in size noted off Scilly.

Structure *Wing shape* P9 longest; P10 5–10; P8



Bryan Thomas

167. Wilson's Storm-petrel *Oceanites oceanicus*, Brown Bluff, Antarctic Peninsula, March 2006. Wilson's disperse from breeding grounds April–May, but earlier if burrows become blocked by hard snow, as shown here (alongside Gentoo Penguins *Pygoscelis papua*), as breeding attempts then fail.

Identification of 'black-and-white' storm-petrels

3–8; P7 10–19; P6 21–30; P1 75–87 mm shorter. Outer primary pointed in juveniles, less so if worn, rounded in adults. When travelling, wings medium length, broad with pointed wing-tips, leading edge smoothly curved, lacking sharp angular bend at carpal joint, trailing edge straight. *Head-on travelling profile* Wings held out straight, giving stiff-winged appearance, which is excellent clue when Wilson's approaches vessel head-on from down-wind; also 'arms' short and 'hands' medium length. *Tail shape* Longish and slightly concave, outermost tail-feather 2–8 mm longer than central in *exasperatus* and 0–5 mm longer in nominate; often looks square, corners rounded, tail slightly rounded when fanned. *Toe projection* Long spindly legs, thus toes project well beyond tail-tip when travelling, visible at medium range. Extent of projection varies to some extent among individuals. Variation possibly amplified if tail heavily worn or in moult. Note that rarely retracts legs into belly feathers eliminating toe projection. Alexander Wilson, after whom the species is named, was the first to record toe projection as a means to distinguish Wilson's from Leach's (Wilson & Bonaparte 1831; Boswall 1979). *Body build* Medium length, evenly proportioned length and girth, though longish tail with toe projection creates long rear-carriage look. *Bill shape and proportions* At sea looks small. Close up, medium-length, broad-based, slightly hooked, with nasal tubes 40% bill length.

Plumage General colour and colour tones In fresh plumage, warm-toned black-brown, but bleaches browner with age. Close up, chin and belly slightly duller, crown and sides of head tinged grey. *Upperwing-covert bars* Obvious and broad, start short of leading edge and extend to body, formed by brown-grey, at times almost silvery, greater coverts, white-fringed when fresh (white fringes wear off quickly), and duller median coverts, these several tones paler than lesser and marginal coverts. Covert bars become paler with age though may become narrower through feather wear. *Underwing-covert and axillary panels* Sooty-brown with bronze or (less frequently) pale flush, especially when fresh, and rarely pronounced pale panels (pale panel in c. 1 in 250 birds Weddell Sea and South Atlantic March–April 2006, none in c. 1,000 Antarctic Peninsula December 2006 and January 2007; pers. obs.). *White on rump, tail-coverts and rear flanks* Lower rump feathers

black-brown tipped white, uppertail-coverts white without dark spots on tips, together yielding a roughly rectangular, well-defined, bold and (from above) slightly U-shaped white patch. White patch extends to lateral undertail-coverts and rear flanks. Overall result is bold, broad white band that extends from rump to underside, almost encircling tail. In flight, white seemingly always in view whatever the angle of observation, also visible when sat on sea (Sibley 2000; pers. obs.). Aberrant bird with dark rump seen near South Georgia (Bourne 1987). Curtis (1988) recorded bird with dark rump and suggested that it was an example of melanism. *White on belly* None. *Yellow webbing of feet* Variable amount of yellow on webbings of feet. Criticised as diagnostic feature by Boswall (1979) who states only seen in highly favourable circumstances. Harrison (1983b) claimed seen only twice in several thousand sightings, while Blomdahl *et al.* (2003) stated visible only in exceptional circumstances. Our experience off Scilly does not concur with these three commentaries, probably as a result of our chum-and-drift method (see Appendix 2). From our vessels, Wilson's often are at close range and observed from a shallow angle of view. When birds are feeding over a slick, positioned roughly between observer and sun, legs dangling, sunlight shines through and regularly 'illuminates' yellow on webbings. We see yellow webbings on most Wilson's so positioned, even with moderate cloud cover.

Flight behaviour Flies mostly within 2 m of sea surface, but may rise up to 5 m. *Travelling* Flight can be strong, purposeful and direct, continually flapping wings for extended periods of time; occasionally veers from side to side, with spurt of rapid wingbeats broken by short glides. At other times seemingly less purposeful, and employs skimming flight low over sea surface with shallow stiff wingbeats interspersed with sustained glides holding wings slightly depressed, likened to a tropical butterfly (Blomdahl *et al.* 2003). Feet rarely retracted while travelling. No vertical bounding as such, but rarely darts upwards, and is forced upwards when making a dead halt over food item. *Feeding* Flies low over sea surface with outstretched stiff wings, gliding, skimming, running, skipping, hopping, sometimes splashing, while dipping head to snatch food items. May hang (rather than hover) over food source with sufficient breeze, facing into wind,

Identification of 'black-and-white' storm-petrels

wings often held in a flattened V-shape, though sometimes horizontal, sometimes more erect, with the angle ostensibly determined by wind strength (but much flatter than for European), wings paddle-shaped, tail fanned and sometimes raised slightly upwards, head lifted, bill angled down, dipping head to surface-seize or pull at floating food. Long spindly legs used in comical exaggerated bouncing over sea surface as if on a pogo-stick. Such 'dancing' is seemingly choreographed and unmistakable! When dancing, stays over one spot or drifts backwards or sideways with wind or makes slow progress into wind, sometimes dancing for periods of many minutes; often arcs back to origin of food source and starts procedure again. Arcing back typical of Wilson's feeding over slick during short-range pelagic trips off Scilly, but also witnessed in the southern hemisphere. Also makes short, shallow dives; off South Georgia and south Shetlands timed at one or two seconds (from video). Follows in wake and alongside bow-wash of vessels; also associates with feeding cetaceans.



Bryan Thomas

168. Wilson's Storm-petrel *Oceanites oceanicus*, South Georgia, March 2006. This Wilson's is hanging over a kelp bed, facing into a stiff breeze, wings held roughly horizontal to back and semi-paddle-shaped, tail fanned and raised slightly upwards, long spindly legs used in comical, exaggerated bouncing over sea surface as if on a pogo stick, head lifted, bill angled down, about to dip head to surface-seize – this 'dancing routine' seemingly choreographed.



Bryan Thomas

169. Wilson's Storm-petrel *Oceanites oceanicus*, South Georgia, March 2006. This Wilson's (alongside the Wilson's in plate 168) is feeding over a kelp bed, but has just dived to collect a food item, and its tail is just about to submerge. Note that even from directly below, it is still possible to see white undertail-coverts.

Overall impression Small to medium-sized, evenly proportioned, warm-toned black-brown, with obvious upperwing-covert bars; accomplished in flight.

Identification of 'black-and-white' storm-petrels



Bryan Thomas

170. Wilson's Storm-petrel *Oceanites oceanicus*, South Georgia, March 2006. This Wilson's is feeding and hence its wings appear paddle-shaped, its tail is fanned, and the long spindly legs are dangling down. Note how the light is catching the right underwing-coverts creating the effect of a bronze flush; the left upperwing-coverts and covert bar are hidden by the right wing, so only the brown-black left upperwing primary coverts show. In addition, the yellow webbings of the left foot are visible in this image.

Leach's Storm-petrel

Taxonomy Polytypic, with nominate *leucorhoa* (North Pacific and North Atlantic) of relevance here.

Atlantic Breeds May–September. Immature non-breeding visitors depart colonies August or earlier. Numbers build on both sides of the Atlantic in same latitudes as colonies, September–October. Thereafter declines in west. Peak numbers in east in October–November apparently greater than total eastern population (assessed through counts during autumn gales and wrecks), thus almost certainly including birds from northwest Atlantic populations. Widely dispersed across tropical and subtropical Atlantic, October–March, return passage March–May. First arrivals on British breeding grounds late April. Immature non-breeders' return to colonies is more leisurely, others remain in tropical zones during breeding season. Leach's regularly prospects and even

builds nests in small numbers in southern oceans (Imber & Lovegrove 1982; Randall & Randall 1986).

Jizz Like a Common Nighthawk *Chordeiles minor*.

Size *Body length* 202 mm. *Wingspan* 462 mm. Small size differences between subspecies (Ainley 1980; Brooke 2004), although Post (1998) found notable differences from published data when measuring 35 birds wrecked off Portugal, December 1996/January 1997.

Structure *Wing shape* P9 longest; P10 5–12; P8 1–5; P7 9–15; P6 20–28; P1 76–92 mm shorter. When travelling, wings long and quite narrow, decidedly pointed wing-tips, both leading and trailing edges strongly angular and wings often swept back. *Head-on travelling profile* Wings slightly bowed, forming shallow-M, arms medium length, hands long. *Tail shape* Medium length, deeply forked and scooped; longest tail feathers as long as primaries when sat on sea

Identification of 'black-and-white' storm-petrels

(Sibley 2000), but can be difficult to see at distance, especially when angle of view is shallow. Lightly forked when fanned. *Toe projection* None. *Body build* Rather long, slim body. *Bill shape and proportions* At sea looks relatively long and slender. Close up, long and slender look substantiated; slightly hooked, with nasal tubes 40% bill length.

Plumage *General colour and colour tones* Cool-toned black-brown, but bleaches browner with age. Close up, browner below, pale ashy-brown on chin and forehead, with strong grey- or slate-blue tinge on upperparts and chest in fresh plumage (ashy, grey and slate-blue elements contribute to cool tone). Juvenile has pale edges to body feathers that wear off quickly. *Upperwing-covert bars* Striking, stretching from leading edge to body, formed by cool brown-grey greater coverts, plus some median and lesser coverts on outermost of bars, hence bars broaden towards and reach leading edge, giving a teardrop shape on each wing. Covert bars become paler with age though may become narrower through feather wear. *Underwing-covert and axillary panels* Evenly black-brown. *White on rump, tail-coverts and rear flanks* Uppertail-coverts white, some irregularly tipped black-brown, although central feathers often all-dark forming diagnostic 'grey-divide' down centre of roughly rectangular white rump, which, from above, makes the white



Bryan Thomas

171. Leach's Storm-petrel *Oceanodroma leucorhoa*, equatorial Atlantic 0°00.000'S, 17°33.462'W, April 2006. The white patch of the rump, tail-coverts and rear flanks is normally roughly rectangular, is longer than it is broad, and has a diagnostic 'grey-divide' down the centre which, from above, makes the white patch V-shaped. Rarely, as shown here, white is restricted to sides of rump, thus erasing the bottom of the V-shape, making residual white quite difficult to see and the bird look superficially like a Swinhoe's Storm-petrel *O. monorhis*. In this case, the possibility of misidentification was accentuated by the dull upperwing-covert bars, more typical of Swinhoe's than Leach's; in fact, this bird was initially called as a Swinhoe's! However, in addition to flight jizz that was typically Leach's, the following pointers are important: the bird is holding its wings swept back, whereas Swinhoe's holds its wings further forwards (more like Madeiran); and the tail has a relatively deep fork, is scooped and looks ragged, whereas the fork in Swinhoe's is considerably shallower, more like a notch, and is mostly closed, similar to the side-on profile of a long-tailed swift (Apodidae).



Bryan Thomas

172. Leach's Storm-petrels *Oceanodroma leucorhoa*, equatorial Atlantic 0°00.000'S, 17°33.462'W, April 2006. All classic structural and plumage features of Leach's are captured in this image (see text).

Identification of 'black-and-white' storm-petrels



Bryan Thomas

173. Leach's Storm-petrel *Oceanodroma leucorhoa*, equatorial Atlantic 0°00.000'S, 17°33.462'W, April 2006. In travelling flight, the overall course of a Leach's is irregular, punctuated with unpredictable speed and/or direction changes, involving darting, vertical leaping, and bounding ahead. The Leach's in this image is making a sudden direction change.

patch V-shaped. White patch is longer than it is broad; dull white rather than gleaming white; and, rarely, is restricted to sides of rump, thus erasing bottom of V-shape (when white very restricted in this area, looks superficially like Swinhoe's Storm-petrel *Oceanodroma monorhis*; see plate p. 81 in Blomdahl *et al.* 2003). White patch barely extends to rear flanks or lateral undertail-coverts. Thus, white hard to see in flight, being easier when close up, especially given a deep angle of view. Likewise, white barely visible when sat on sea (Sibley 2000). *White on belly* None.

Flight behaviour Keeps mainly within 5 m of sea surface. *Travelling* Buoyant and graceful involving deep, elastic, languid wingbeats with frequent long shearing glides on slightly bowed wings. Overall course irregular, punctuated with unpredictable speed and/or direction changes, involving darting, vertical leaping, and bounding ahead. In strong wind, employs highly erratic flight, including shearing, zigzagging, and bounding through wave troughs. When shearing, likened to *Puffinus* shearwaters and in buoyant flight likened to *Sterna* terns (BWPi 2006); flight also likened to that of Soft-plumaged Petrel *Pterodroma mollis* (Veit *et al.* 1996). That said, a migrant observed in February from a headland in Scilly, heading into strong westerly winds, attempted to



Hadoram Shirihai

174. Leach's Storm-petrel *Oceanodroma leucorhoa* (left) with Wilson's Storm-petrel *Oceanites oceanicus* (right), equatorial Atlantic 0°00.000'S, 17°33.462'W, April 2006. The photographer estimated that the Wilson's is about 0.25 m behind the Leach's, but with optical effects taken into account the two storm-petrels are roughly to scale, as if on the same plane. Note how stiff the Wilson's wings appear compared with the flexible look of the Leach's wings, even in this still image. Note also how the Leach's legs and toes fall short of the tail-tip compared with the Wilson's, which has a noticeable toe projection. In addition, Wilson's seems to have a relatively long rear carriage compared to Leach's.

attempted to

Identification of 'black-and-white' storm-petrels

progress directly into wind with languid wingbeats for eight minutes, then 'conceded' by turning 90° left and sheared, briefly turned into the wind, again turned 90° left and sheared, repeating this behaviour three times, then lost to sight. In so doing it eventually progressed relatively quickly in a direction 90° left of the oncoming wind. In similar conditions, European Storm-petrel made surprisingly good headway into wind. *Feeding Swoops*

over and around food source such as an oily slick. When food item located, tends to hang or hover over it facing into wind, sometimes foot-pattering, with wings raised over back normally a flattened V-shape, though angle ostensibly determined by wind strength, wings paddle-shaped, and dips head to surface seize. In hovering flight, likened to *Larus* gull (BWPi 2006), presumably in the way *Larus* gulls hover and pick over food items in wave surf, rising up and dropping back down in synchrony with each wave. In light winds may sit on sea picking food from surface like Fulmar *Fulmarus glacialis*. Leach's observed at Cheddar Reservoir, Somerset, in November 1970 fed with wings held slightly raised and almost motionless while, at same time, short legs dangled, with feet occasionally pattering on water surface (Rabbits 1979). However, a bird observed at New Brighton, Cheshire & Wirral, in September 1978, fed over marine swimming pool, picking food from water surface, short legs dangling and feet pattering or walking on water surface (Page & Greaves 1979). *Contra* Blomdahl *et al.* (2003), Leach's follows vessels at least occasionally (pers. obs. in central-east Atlantic, March 2006; also see Atkin 1979). Probably associates with cetaceans.

Overall impression Medium-sized, slender, cool-toned black-brown, bold upperwing-covert bars, in flight buoyant, versatile and unpredictable.

Madeiran Storm-petrel

Taxonomy Considered monotypic, though probably polytypic given recent discovery of two distinct populations ('hot season' and 'cool



Bryan Thomas

175. Leach's Storm-petrel *Oceanodroma leucorhoa* (left) and Madeiran Storm-petrel *O. castro* (right), heads and bills, roughly to scale. Note that the bill of Leach's is long, slender and slightly hooked, whereas that of Madeiran is surprisingly bulky and heavily hooked for a storm-petrel.

season') in the Azores, each with non-overlapping breeding and dispersal periods, and which lack vocal recognition of the other (Bolton 2007). Ecological counterpart of Leach's Storm-petrel in tropical and adjoining sectors in warm, deep pelagic waters.

Atlantic Breeds Northeast Atlantic, Berlengas and Farilhões off Portugal, Desertas and Salvages off Madeira, Canary Islands, Cape Verde Islands and Azores; in the southeastern Atlantic, breeds Ascension and islets off St Helena. Uncertain whether birds disperse or undertake systematic migration after breeding (Brooke 2004). Madeiran Storm-petrels certainly move westwards and are seen regularly on pelagic trips off eastern seaboard of USA, most notably off North Carolina (see www.patteson.com). Apparently does not move northwards to western Europe, where it is an extreme vagrant (except Portugal; see Appendix 4), even though considerably closer to breeding grounds than eastern seaboard of USA. Seemingly coupled to warm deep pelagic waters in the Atlantic.

Jizz Like a European Nightjar *Caprimulgus europaeus*.

Size Body length 200 mm. Wingspan 448 mm. On Azores, weight of 'hot season' population notably lower than that of 'cool season' population, while populations from Azores larger than breeders on Salvages (Brooke 2004).

Structure *Wing shape* Formula, P9 longest; P10 5–9; P8 1–4; P7 8–13; P6 18–26; P1 88–96 mm shorter. When travelling, wings long with broad arms, blunt-ended wing-tips, and wings normally held straight out rather than swept back, thus leading and trailing edges only moderately angular. *Head-on travelling profile* Wings

Identification of 'black-and-white' storm-petrels



Bryan Thomas

176. Madeiran Storm-petrel *Oceanodroma castro*, off St Helena, April 2006. All the classic structural and plumage features of Madeiran are captured in this image (see text).

slightly bowed yielding shallow-M, arms medium length, hands long. *Tail shape* Shallow fork with outermost feather 4–12 mm longer than central feathers; appears square-ended when fanned. *Toe projection* None. *Body build* Length of body as Leach's, but because of greater girth has decidedly chunky look. *Bill shape and proportions* At sea looks bulky for a storm-petrel. Close up, surprisingly bulky and quite heavily hooked, with nasal tubes 40% bill length.

Plumage *General colour and colour tones* In fresh plumage, warm black-brown, but bleaches browner with age. Close up, browner below, with blue-grey tinge from hind-crown to back, sides of head, and chest. Overall rather plain-looking. *Upperwing-covert bars* At range, almost uniformly dark upperwings, with covert bars barely discernible in some conditions. Close up, greater coverts form dull bars, a little more obvious when bleached, but never shows broad pale covert bars and these do not reach the leading edge like Leach's. At close to medium range, pale pencil line along tips of greater coverts (outer webs fringed pale), but these

wear off quickly. *Underwing-covert and axillary panels* Evenly hued black-brown. *White on rump, tail-coverts and rear flanks* Narrow rectangular white patch, broader than it is long (hence North American name 'Band-rumped Storm-petrel'), which, from above, looks slightly U-shaped. 'Band rump' formed by white uppertail-coverts, longer ones tipped black, forming conspicuous, even band across base of tail. White extends to lateral undertail-coverts and rear flanks. In flight, white seemingly always in view whatever the angle of observation; also visible when sat on sea (Sibley 2000). *White on belly* None.

Flight behaviour Keeps mainly within 5 m of sea surface. *Travelling* Fairly steady and buoyant, progressing with runs of six or so shallow wingbeats, sometimes with low banking turns, sometimes with short *Puffinus*-shearwater-like glides on wings slightly bowed just below horizontal. Gliding sometimes prolonged given sufficient supporting breeze. Often progresses by weaving a regular horizontal zigzag, banking left and proceeding for a while, then banking right and proceeding, etc. *Feeding* Will

Identification of 'black-and-white' storm-petrels



Bryan Thomas

177. Madeiran Storm-petrel *Oceanodroma castro*, off St Helena, April 2006. Madeiran appears strangely reluctant to hang or hover over food items, foot-patter or surface-seize. Consequently, it employs this feeding strategy the least of the six storm-petrels' featuring in this paper. As in this image, Madeiran appears rather clumsy, especially if compared with the accomplished-looking Wilson's in plate 005.

foot-patter and walk with feet on sea surface, with wings raised over back, normally in a flattened V-shape, angle ostensibly determined by wind strength, wings paddle-shaped; but employs this feeding strategy least commonly of the four regular North Atlantic storm-petrels and is least accomplished at it (Blomdahl *et al.* 2003; BWP*i* 2006; pers. obs.). In the main, steadily and systematically explores food source, employing even flight intermixed with periods of gliding, rising 1–2 m with regular shallow wingbeats, then gliding back to sea surface as if following a gentle undulating contour. May double-back on itself, gaining height more steeply, circling up to 3–4 m above sea surface, presumably in search of prey, at which time flight a little more erratic, perhaps hinting at Leach's. However, does not leap and bound, or switch direction and speed like Leach's. Descends and seizes food items from sea surface. In light winds may sit on sea surface picking at food as Fulmar. Regularly dives; off St Helena timed at one or two seconds (from video). Off Azores, Bried (2005) showed that average maximum dive was 0.85 m and that diving was part of typical foraging behaviour. Opinion varies as to propensity of Madeirans to follow vessels, though near St Helena followed MV *Professor Molchanov* as well as readily asso-

ciating with small local fishing vessels (pers. obs.; also see Brown 1980). Probably associates with cetaceans.

Overall impression Medium-sized, chunky-bodied and heavy-billed, warm-toned black-brown, in flight methodical and predictable, but overall rather plain.

Black-bellied Storm-petrel

Taxonomy Polytypic, *F. t. tropica* (Auckland and Antipodes Islands, Kerguelen, Crozets and Prince Edward Islands, islands of Scotia Sea), *F. t. melanoleuca* (Gough Island); but see Appendix 5.

Atlantic Breeds mainly south of Antarctic Polar Front with main breeding October–April. Northwards movement from colonies April–May. Disperses northwards into tropical and subtropical seas to 10°N in Atlantic, May–October. Southward movement September–October with first returns variable between locations, roughly September–November. Little information on range of juveniles and immatures.

Jizz No obvious avian simile, but like an exhibition skateboarder skilfully traversing ever-changing sea contours and flipping between troughs.

Size Body length 200 mm. Wingspan 455 mm.

Identification of 'black-and-white' storm-petrels

Geographical variation not obvious (Brooke 2004) or minimal (Stephenson *et al.* 2007b).

Structure *Wing shape* P9 longest; P10 8–11; P8 1–3; P7 11–16; P6 22–27; P1 81–86 mm shorter. Primaries pointed in juvenile, rounded in adults. When travelling, wings overall broad, often strongly curved leading edges that taper to pointed wing-tips. Trailing edges straight. *Head-on travelling profile* Slightly bowed yielding shallow-M, arms short and hands long. *Tail shape* Short, square-ended, slightly rounded when fanned. *Toe projection* Toes project notably beyond end of tail, though less so than Wilson's. *Body build* Compact and fat. *Bill shape and proportions* At sea looks small. Close up, short, broad-based, finely hooked, with nasal tubes 50% bill length.

Plumage *General colour and colour tones* In fresh plumage, black-brown head, neck and upper-parts including wing-coverts, with head darkest, but bleaches browner with age. Back and upper-wing darker and warmer-toned brown than on White-bellied. Mantle and scapulars with white fringes (c. 0.5 mm in fresh plumage) less marked than White-bellied (c. 2.0 mm in fresh plumage) (K. Roselaar pers. comm.). *Upper-wing-covert bars* Greater coverts grey-brown creating inconspicuous covert bars, a little more obvious when bleached. *Underwing-covert and axillary panels* White across greater and median

underwing-coverts and axillaries, but slightly dirty-looking on outermost greater coverts that are dark-centred. White panel bordered by broad blackish leading-edge and blackish remiges. *White on rump, tail-coverts and rear flanks* Rump black-brown, uppertail-coverts white extending to underparts, white patch roughly rectangular and from above slightly U-shaped. Amount of white on undertail-coverts variable; central feathers all-black as a continuation of the black belly stripe (K. Roselaar pers. comm.). *White on belly* Sides of lower breast, abdomen and flanks white, with diagnostic black-brown central belly stripe, reduced or even broken on pale birds but which, if complete, joins V-shaped centre of black-brown upper-breast with black-brown undertail-coverts, but black-brown to white interfaces smudgy, yielding overall a dirty look. Population of *melanoleuca* breeding on Gough Island has white belly like White-bellied Storm-petrel, causing identification and taxonomic problems (see Appendix 5). Likewise, populations on some New Zealand sub-Antarctic islands show broken and thus incomplete belly stripe, with some individuals apparently showing no dark stripe or mid-line markings (B. Stephenson pers. comm.).

Flight behaviour Flies mostly within 5 m of sea surface, though tends to keep very low. *Travel-*

ling Glides like small shearwater, hugs sea surface, up and down over ever-changing contours, flips between troughs. In breezy conditions flaps wings infrequently in short bursts, more so in calmer conditions. *Feeding* Glides and skims, hugs ever-changing contours of sea surface, hopping, skipping and splashing, swinging from one side of trough to other, bounding from one trough to another, doubling back, surface-snatching,



Bryan Thomas

178. White-bellied Storm-petrel *Fregetta grallaria* (probable, see Appendix 5), off Tristan da Cunha group, March 2006. White-bellied, like Black-bellied, glides and skims close to ever-changing contours of the sea surface, hopping and skipping (sometimes splashing) as in this image, whilst opportunistically surface-snatching food items.

Identification of 'black-and-white' storm-petrels

also dives. Will foot-patter, albeit briefly. Follows in bow-wash and wake of vessels and probably associates with cetaceans.

Overall impression Medium-sized, fat, compact, pied, vaguely dirty-looking, hugging contours of sea in flight.

White-bellied Storm-petrel

Taxonomy Polytypic: *F. g. grallaria* (Roach Island of Lord Howe group, Kermadec Islands), *F. g. leucogaster* (Tristan da Cunha group, St Paul), *F. g. segethi* (Juan Fernández Islands), *F. g. titan* (Rapa of Austral group).

Atlantic Little known of non-breeding season, but may disperse widely from subtropical and temperate breeding sites into tropical and subtropical seas south of equator, presumably in Atlantic involving populations from Tristan da Cunha group (Marchant & Higgins 1990; Brooke 2004).

Jizz As Black-bellied.

Size *Body length* 200 mm. *Wingspan* 462 mm. Differences in biometrics important for subspecific identification, although further study required (Brooke 2004).

Structure As Black-bellied except: *Wing shape* P9 longest; P10 8–11; P8 0–4; P7 12–15; P6 24–28; P1 75–90 mm shorter. *Toe projection* Most literature states none or makes no mention, but apparently can show marginal projection (Shirihai 2002). Amount of projection varies geographically, individually, and to some degree with state of wear and moult (Shirihai pers. comm.).

Plumage Polymorphic with light, intermediate and dark morphs (last two from Lord Howe Island off eastern Australia and not dealt with here). *General colour and colour tones* In fresh plumage, black-brown head, neck and upperparts including wing-coverts; head darkest, but bleaches browner with age. Back and upperwing paler and cooler-toned black-brown than on Black-bellied. Mantle and scapulars show distinct white fringes (c.2.0 mm in fresh plumage) more marked than on Black-bellied (c. 0.5 mm in fresh plumage) (K. Roselaar pers. comm.), creating scaly effect at close range, but when distant these fringes appear to merge with black-brown of feathers creating greyer cast. However, fringes wear off with age, so this feature limited as a means of separation from Black-bellied. *Upperwing-covert bars* Greater coverts pale grey-brown creating fairly obvious covert bars, certainly more conspicuous than those of

Black-bellied; these become paler when bleached but may become less prominent as feathers wear. *Underwing-covert and axillary panels* As Black-bellied. *White on rump, tail-coverts and rear flanks* As Black-bellied except: Central undertail-coverts black-brown with narrow white tips, lateral undertail-coverts white with dark brown subterminal band (Marchant & Higgins 1990). Undertail-coverts depicted wholly white in Shirihai (2002). *White on belly* Lower breast, abdomen and flanks white, generally looking clean, having straight, sharp and neat interface with black-brown upper breast and undertail-coverts (also see Appendix 5).

Flight behaviour As Black-bellied, but perhaps more varied and erratic, including more glides (Shirihai 2002).

Overall impression Medium-sized, fat, compact, pied, clean-looking, hugging contours of sea in flight.

Acknowledgments

Thanks to Ashley Fisher for critical feedback on an earlier draft and for the idea of setting stills of several species within a single plate; to Hadoram Shirihai for critical feedback on an earlier draft and for allowing us to use an important digital still from his keenly awaited *Albatrosses, Petrels and Shearwaters of the World* to be published by A&C Black, London; and to Kees Roselaar and Brent Stephenson for critical feedback on an earlier draft and discussion of taxonomy of *Fregetta* storm-petrels of the Tristan da Cunha group. For assistance with vagrant Madeiran Storm-petrel records in Europe, we are grateful to Marc Duquet and Jean-Yves Fremont (Secretary) and the French Rarities Committee (Comite d'Homologation National), Peter Fraser (Secretary) and the British Birds Rarities Committee, Paul Milne (Secretary) and the Irish Rare Birds Committee, Ricard Gutiérrez (Joint Secretary CR-SEO/BirdLife) and Antero Topp. For assistance with vagrant North Atlantic *Fregetta* records, John Brodie-Good, Dominic Mitchell, and Angus Wilson provided valuable information, while Steve Gantlett, Morten Jørgensen, Tony Marr, Viv Stratton, and Will Wagstaff also provided useful general inputs. Ren Hathway prepared fig. 2 from a sketch by Robert Flood. Our very special thanks go to Alec Hicks and Joe Pender, respectively skippers of MV *Kingfisher* and MV *Sapphire*, for making it possible for us to go to sea off Scilly over 300 times from 2000 to 2006, facilitating extensive vessel-based observations of European, Leach's, and Wilson's Storm-petrels, plus invaluable opportunities to photograph them.

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Table 3. Summary table of identification features for European Storm-petrel *Hydrobatas pelagicus*, Wilson's Storm-petrel *Oceanodroma leucorhoa*, Madeiran Storm-petrel *O. castro*, Black-bellied Storm-petrel *F. grallaria* and White-bellied Storm-petrel *F. grallaria*. The main identification features of the six species have been extracted from the preceding species accounts.

Species	European	Wilson's	Leach's	Madeiran	Black-bellied	White-bellied
Size	Small	Small-medium	Medium	Medium	Medium	Medium
Overall impression	Compact, dark, busy and seemingly restless; flashes white on underwings in flight (less so when worn)	Evenly proportioned, warm-toned black-brown with obvious upperwing-covert bars; accomplished flight, especially when feeding	Slender, cool-toned black-brown, bold upperwing-covert bars; in flight buoyant, versatile and unpredictable	Chunky-bodied and heavy-billed, warm-toned black-brown; in flight methodical and predictable, overall rather plain	Fat, compact, pied, vaguely dirty-looking; hugs contours of sea in flight	Fat, compact, pied, clean-looking; hugs contours of sea in flight
Simile	Small bat	Barn Swallow	Common Nighthawk	European Nightjar	Exhibition skateboarder	As Black-bellied
Relative wingspan, body length	Baseline species, 1.00 & 1.00	1.05 & 1.08, but appears up to 1.5 times as big	1.21 & 1.28, but appears up to twice as big	1.17 & 1.27, presumably would appear as big as Leach's	1.19 & 1.27, presumably would appear as big as Leach's, though fatter	1.21 & 1.27, presumably would appear as big as Leach's, though fatter
Wing shape when travelling	Short & broad with wing-tips blunt-ended; both leading & trailing edges strongly angular	Medium length, broad, pointed wing-tips; leading edge smoothly curved, trailing edge straight	Long & quite narrow, decidedly pointed wing-tips; leading & trailing edges strongly angular, wings often swept back	Long, broad arms, blunt-ended wing-tips, normally held straight out so leading & trailing edges only moderately angular	Broad with short arms, strongly curved leading & straight trailing edges, tapers to pointed wing-tips	As Black-bellied
Travelling head-on wing profile	Wings slightly bowed forming shallow-M, arms & hands quite short	Wings straight & stiff, arms short, hands medium length	Slightly bowed in shallow-M, arms medium length, hands long	Slightly bowed in shallow-M, arms medium length, hands long	Slightly bowed in shallow-M, arms short, hands long	As Black-bellied
Tail shape	Short, can look square, though gently rounded; clearly rounded when fanned	Slightly concave, corners rounded; tail slightly rounded when fanned	Deeply forked & scooped; lightly forked when fanned	Shallow fork; appears square-ended when fanned	Short, square-ended; slightly rounded when fanned	As Black-bellied
Toe projection	None	Obvious, but rarely retracts legs	None	None	Obvious, but rarely retracts legs	Apparently slight, but rarely retracts legs
Body build	Compact with short body	Even proportions in length & girth, long rear carriage	Rather long, slim body	Decidedly chunky	Compact & fat	As Black-bellied

Identification of 'black-and-white' storm-petrels

Species	European	Wilson's	Leach's	Madeira	Black-bellied	White-bellied
Bill shape and proportions	Short, length & depth in proportion, slightly decurved & hooked	Medium length, broad-based, slightly hooked	Relatively long & slender, slightly hooked	Bulky and quite heavily hooked for storm-petrel	Short, broad-based, finely hooked	As Black-bellied
General colour tones	Darkest of six, sooty-brown, bleaches browner with age	Warm-toned black-brown, bleaches browner with age	Cool-toned black-brown, bleaches browner with age	Warm-toned black-brown, bleaches browner with age; overall, rather plain-looking	Black-brown, bleaches brown with age; mantle & scapulars have distinct narrow white fringes that wear off with age; back & upperwing darker and warmer toned than on White-bellied	Black-brown, bleaches brown with age; mantle & scapulars have distinct narrow white fringes that wear off with age, thus this feature limited as means of distinction from Black-bellied
Upper-wing-covert bars	At range, uniform dark upperwing; close up, greater coverts form very dull bars, marginally more noticeable when bleached, with pale pencil line along tips that becomes narrower with feather wear	Obvious & broad, short of leading edge and extend to body, brown-grey to silvery greater & duller median coverts; these paler when bleached though may become narrower with feather wear	Striking, from leading edge to body, cool brown-grey greater coverts, plus outermost median & lesser coverts, hence bars broaden towards & reach leading edge, giving teardrop shape; much more obvious than Madeira; bars paler when bleached though may become narrower with feather wear	At range, almost uniform dark upperwings with covert bars barely discernible; close-up, greater coverts form dull bars, a little more obvious when bleached, but never shows broad pale covert bars	Greater coverts grey-brown creating inconspicuous covert bars, a little more obvious when bleached	Greater coverts pale grey-brown creating fairly obvious covert bars, paler when bleached though may become narrower as feathers wear; always more conspicuous than Black-bellied
Underwing-covert & axillary panels	In fresh plumage eye-catching white panels, even at long range; less obvious in worn plumage	Evenly hued sooty-brown, some show bronze flush, rarely a pale panel	Evenly hued black-brown	Evenly hued black-brown	Obvious white panel, some outer greater underwing-coverts dark-centred with white fringes	As Black-bellied
White patch on rump, undertail-coverts & rear flanks	Bold, roughly rectangular; from above slightly U-shaped, extends to lateral undertail-coverts & rear flanks, seemingly always visible at sea	Bold, roughly rectangular; from above slightly U-shaped, extends to lateral undertail-coverts & rear flanks, seemingly always visible at sea	Dull & not gleaming white, barely extends to undertail-coverts & rear flanks, longer than it is broad, from above V-shaped, hard to observe at sea; rarely, white patch restricted to rump-sides erasing bottom of V-shape	Narrow, rectangular, broader than it is long, from above slightly U-shaped, extends to lateral undertail-coverts & rear flanks, seemingly always visible at sea	Rump black-brown, upperpart tail-coverts white extending to underparts, roughly rectangular; from above slightly U-shaped, undertail-coverts black-brown	Rump black-brown, upperpart tail-coverts white extending to underparts, roughly rectangular; from above slightly U-shaped, undertail-coverts white with dark brown subterminal band (but may be all-white)

Identification of 'black-and-white' storm-petrels

Species	European	Wilson's	Leach's	Madeira	Black-bellied	White-bellied
Belly	All-dark	All-dark	All-dark	All-dark	Sides, lower breast, abdomen & flanks white, looking clean with straight, sharp central belly stripe joins black-brown upper breast to black-brown undertail-coverts, all dark-white interfaces smudgy yielding dirty look; dark central belly stripe reduced on pale birds & absent on melanoleuca	Lower breast, abdomen & flanks white, looking clean with straight, sharp black-brown upper breast; white-bellied melanoleuca makes field identification of White-bellied hazardous in Atlantic
Travelling flight	Fast, shallow wingbeats, bat-like fluttering, short glides, casual zigzags, may shear in strong wind	Like smallish hirundine, strong, purposeful & direct, or may veer or less purposeful when skimming & gliding	Buoyant & graceful, deep, languid wingbeats, long shearing glides, unpredictable speed & direction changes, darting, vertical leaping, & bounding ahead	Steady & buoyant, runs of six or so shallow wingbeats, low banking turns, small shearwater-like glides, progresses weaving regular horizontal zigzag	Glides like small shearwater, hugs sea surface, up and down over ever-changing contours, flips between troughs	As Black-bellied
Feeding flight	Excited, dashing over food source, then dead halt & 'hovers, dips, seizes & moves on' repeatedly; in calm conditions 'sits, hangs, seizes & moves on' repeatedly; when hovering, wings normally held in an erect V-shape; also dives	Gliding, skimming, running, skipping, hopping, sometimes splashing & surface-snatching; or hangs perching, wings normally held in a flattened V-shape; may dive	Swooping back & forth over food source, hangs or hovers, sometimes foot-pattering & walking, surface-seizing; when hovering, wings normally held in a flattened V-shape; may dive	Systematic exploration over food source, even flight intermixed with periods of gliding, seems reluctant to foot-patter though will hang or hover; when hovering, wings normally held in a flattened V-shape; also dives	Glides & skims, hugs ever-changing contours of sea surface, hopping, skipping & splashing, swinging from one side of trough to other, bounding from one trough to another, doubling back, surface-snatching	As Black-bellied

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Appendix 1. Occurrence of Wilson's Storm-petrel in Scillonian waters during 2000–2006: a seven-year analysis.

Observations confirm that Wilson's is a scarce although regular passage migrant off Scilly (table 4). The main period of passage peaks from July to mid August, but numbers are variable between years (see also Flood & Fisher 2005).

Table 4. Occurrence of Wilson's Storm-petrel *Oceanites oceanicus* in Scillonian waters from short-range pelagic trips during June to September, 2000–06. ¹ Total number of pelagic trips undertaken during 2000–06. ² No. trips during which Wilson's Storm-petrel was seen. ³ Total number of Wilson's Storm-petrels seen during the week in question. ⁴ Percentage of trips on which Wilson's Storm-petrel was seen.

Week commencing	Cumulative weekly data			
	Total no. of trips ¹	Successful trips ²	No. of birds ³	% success ⁴
25th May	4	0	0	0%
1st June	8	2	2	25%
8th June	9	3	8	33%
15th June	11	3	11	27%
22nd June	15	5	12	33%
29th June	18	8	15	44%
6th July	25	12	17	48%
13th July	29	11	18	38%
20th July	30	16	23	53%
27th July	27	13	29	48%
3rd Aug	26	13	23	50%
10th Aug	30	17	31	57%
17th Aug	29	14	26	48%
24th Aug	35	9	14	26%
31st Aug	21	3	3	14%
7th Sept	12	0	0	0%
14th Sept	2	0	0	0%
TOTAL	331	129	232	

Appendix 2. Chum and chumming.

Three main modern-day purposes of chumming at sea are as follows: (a) to attract tubenoses for the thrill of seeing them close up; (b) to assist photographers; and (c) to facilitate detailed examination and learning about identification. The original purpose of chumming was quite different, that being to aid collection of specimens for scientific study by attracting storm-petrels close enough to a ship to shoot them. Thus, although the purpose has changed, chumming is not a modern idea. For example, during the cruise of the whaler MV *Daisy* 1912–13, Murphy (1915), seeking to collect Leach's Storm-petrels, spent an hour 'chumming for the birds with grease'.

The basic principle of chumming is simple. Storm-petrels can be attracted by a concoction of smelly, fishy substances ('chum') that corresponds to a natural food source. 'Soft' chum, as used off Scilly, comprises ingredients like ground fresh fish, mashed rotten fish (the smell is disgusting), fish guts (the sight is disgusting), fish liver (excellent), fish oil concentrate (mainly cod liver oil, excellent), and canned sardines or pilchards on rare occasions when short of the above ingredients. These ingredients are easily mixed and pulverised. 'Hard' chum includes fresh fish bones and fish heads. However, the best recipe for a chum mix remains a matter of conjecture and we do not claim to have solved the puzzle.

Storm-petrels are surface-feeders and it is important to keep chum on or near the surface. Popcorn is an effective float, so we mix popcorn with soft chum to keep the chum on the surface. Fish liver broken into tiny pieces floats naturally and storm-petrels relish it. An excellent investment has been the purchase of heavy-duty chum grinders that grind together ingredients and crush popcorn to tiny pieces, infusing popcorn pieces with 'eau de chum'; tiny pieces are more suitable to feeding

storm-petrels. Acquiring an effective chum-grinder is difficult; we have imported manual machines from the USA, while motorised grinders are also available from the USA at a premium.

Our preferred strategy is to steam to a suitable location and, on arrival, turn off engines, so that we drift with wind and tide. We place a soft chum mix in an onion bag tied at the top, then drop the bag over the side of the vessel just below the sea surface and secure it, allowing the contents to disperse slowly. The smell attracts storm-petrels from downwind, while the oily slick that forms upwind is ideal for storm-petrels to pick over; it holds storm-petrels close to the vessel, permitting thrilling views, close-up photography, and study of identification characteristics.

DMS (dimethylsulphide) has been used by some organisers of pelagic trips to attract storm-petrels. DMS is 'a chemical released when phytoplankton are grazed by zooplankton ... attractive to some storm-petrels' (Brooke 2004). In special circumstances, concentrated DMS can be purchased via marine research centres or their suppliers. We do not use DMS since, although we have no primary source evidence, we have been warned that it is carcinogenic and in concentration harms seabirds. We are not prepared to risk poisoning seabirds or ourselves.



179. Skipper of MV *Kingfisher* Alec Hicks using heavy-duty manual chum-grinder imported from USA.

Robert L. Flood

Identification of 'black-and-white' storm-petrels



Robert L. Flood

180. Seven Stones Reef, c. 20 km northeast of St Mary's, Scilly. The sea surface over the reef at Seven Stones is always more turbulent than proximate waters and, when the tide runs, the sea surface over the reef seemingly 'boils'. Upwellings and eddies bring food items to the surface and enhance food production. In season, European Storm-petrels *Hydrobates pelagicus* routinely frequent Seven Stones reef and the location in season is good for Wilson's Storm-petrels *Oceanites oceanicus*.

Weather conditions can foil a chum-and-drift [Earlier the paper refers to 'chum-and-drift' so best to be consistent, I think.] strategy. Without a breeze, the smell of chum cannot disperse and the vessel will hardly drift, resulting in an oily sea surface around the vessel, but no slick. The vessel is not able to 'advertise' itself to storm-petrels and very few will be present. Not surprisingly, when steaming in calm conditions off Scilly we regularly encounter small flocks of storm-petrels sat on the sea surface, something rarely witnessed in breezy conditions. When there is no breeze, the smell of food is not distributed and temporarily the storm-petrels' extra-sensitive smelling capabilities are rendered redundant. Furthermore, flight without breeze is relatively inefficient, since storm-petrels harness wind energy to fly (Brooke 2004). Without a breeze, a storm-petrel randomly traversing the sea surface in laboured flight searching for food would expend much energy with a much reduced likelihood of locating food. In calm conditions, it thus makes sense for storm-petrels to sit tight and conserve energy. An exception to this rule occurs when storm-petrels know where there is an upwelling driven by sea currents that produces food (see below). Conversely, a wind of force 6 or more will fragment the slick, resulting in pockets of storm-petrels all over the place, making it difficult to observe and photograph them. Another problem arises when, as a result of wind direc-

tion and sea currents, a slick 'runs away' in the direction of the sun, which severely hampers photography. In such circumstances, steaming slowly at no more than two knots in the direction of the sun creates a slick in the wake of the vessel, away from the sun. Low speed is essential, to keep the petrels within close range and to prevent chum washing out of the bags too quickly. In contrast, hard chum is ineffective at low speeds since the drag is insufficient to pull morsels away from fish bones.

When steaming out to sea, or from one location to another, we often tow hard chum held in three onion bags, one inside the other for strength, secured to the vessel. As morsels slowly wash out, the vessel leaves a trail and is continually

'advertising' itself to tubenoses. In addition, gulls soon start to follow, acting as a visual signal that the vessel is a food source, which brings in other seabirds. In the South Atlantic, we towed a large tuna (*Scombridae*) head, attached bones and tail, which kept (probable, see Appendix 5) White-bellied Storm-petrels in attendance for many hours. Applying the same principle, sometimes we throw small amounts of soft chum over the stern on a regular basis when steaming.

Drifting and chumming is more successful when carried out over a natural feeding location that attracts storm-petrels in its own right, such as an upwelling over a reef, a seamount, or a continental shelf where eddies might form. We visit two main reefs within easy reach of Scilly: Seven Stones reef, c. 20 km northeast of St Mary's quay (where *MV Torrey Canyon* was wrecked) and Poll Bank c. 5 km southwest of Bishop Rock. The sea surface at these locations is visibly more turbulent than is the case in surrounding waters, seemingly boiling when there is strong tidal flow. Storm-petrels are attracted to sea currents that bring food items to the surface and churn up nutrients, facilitating greater food productivity (see Haney 1985 for discussion of occurrence of Madeiran Storm-petrels in relation to upwelling off the coast of southeastern USA).

Owing to the threats of predation, storm-petrels tend to be active around breeding

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colonies at dusk or after dark. During the breeding season, many storm-petrel species disperse widely from colonies before dawn. Consequently, drifting and chumming at dusk close to an island colony will attract plenty of storm-petrels, on their way back to the colony,

although dim light means that photographic opportunities are limited. Great care should be taken after dark to avoid the possibility of storm-petrels and other tubenoses being attracted to a vessel's lights and colliding with the ship, especially near breeding colonies.

Appendix 3. Dispelling myths.

Several myths about storm-petrels seem to persist. One is that storm-petrels are afraid to approach a vessel if there are gulls in attendance. However, in reality, an actively feeding group of gulls is a visual signal of food source to other seabirds. Shearwaters, *Pterodroma* petrels, skuas and even storm-petrels all use sight to some extent to locate food and, in our experience, all storm-petrel species come to chum whether gulls are present or not.

Another apparent myth is that only certain species of storm-petrel come to chum. For example, Harrison (1983b) says that Madeirans are timid at sea, show no interest in following in the wake of vessels, and that he has never been able 'to "chum" them up from a small boat'. In our admittedly somewhat limited experience with Madeirans, we found that they associate with small fishing vessels, occasionally follow other ships and, off St Helena, we experienced

no difficulty in attracting Madeirans using the chumming techniques described in Appendix 2.

All storm-petrel species that we have targeted have come to chum, although some species seem to stay longer than others. In addition to the six species dealt with here, we have attracted White-vented, Swinhoe's, Black *Oceanodroma melania*, Markham's *O. markhami*, Hornby's *O. hornbyi*, Grey-backed *Garrodia nereis* and White-faced Storm-petrels *Pelagodroma marina* using chum. Our list also includes New Zealand Storm-petrel *Pealeornis maoriana*, until recently presumed extinct (Flood 2003; Saville *et al.* 2003). We believe that our chum and chumming techniques employed in the Hauraki Gulf, New Zealand, in November 2003 were prime factors that enticed New Zealand Storm-petrels close to our vessel, enabling us to study and photograph them and, for the first time ever, to positively identify and locate a population of this species.

Appendix 4. Madeiran Storm-petrel vagrancy in Europe (excluding Portugal and the Canary Islands).

Finland

- January 1993, Suonenjoki, Iisvesi. One wrecked found in poor health on lake ice, and subsequently died; skin preserved in Kuopio Museum (Juppinen & Collanus 1994).

France

- October 1984, Chomeac, Ardeche, central France. One wrecked found dead (Dubois *et al.* 2001).
- October 1987, near Hoedic Island, Morbihan, southern Brittany. One at sea (Dubois *et al.* 2001).
- August 1988, off the Sables d'Olonne, Vendee, western France. One at sea (Dubois *et al.* 2001).

Ireland

- October 1931, Blackrock Lighthouse, Co. Mayo. Female died after striking lighthouse

(Kennedy *et al.* 1954).

Spain

(earliest three records precede establishment of national rarities committee)

- November 1951, Huelva. One storm-driven (Anon. 1951).
- February 1970, Badajoz. One wrecked (Anon. 1970).
- January 1982, Huelva. One storm-driven (Anon. 1982).
- July 1994, Pontevedra, Baiona, cabo Silleiro. One trapped for ringing on three nights (Costas *et al.* 1996).
- July 1994, Pontevedra, Baiona, cabo Silleiro. One, possibly female (sexed by biometrics) trapped for ringing (Costas *et al.* 1996).
- June 1997, Alicante, Denia. One at sea near harbour (Koppejan 2001).

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Table 5. Frequency of occurrence by month of vagrant Madeiran Storm-petrels *Oceanodroma castro* in Europe and Scandinavia (excluding Portugal and the Canary Islands).

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2	1	0	0	0	1	2	1	0	3	2	1

Switzerland

- December 1999, Sion Wallis. One wrecked (Maumary & Baudraz 2000).

UK

- November 1911, Milford, Hampshire. One found dead (BOU 1971).

In addition, one is included by Brereton *et al.* (2003) in the list of species seen during

1995–2001 at sea in the Bay of Biscay from MV *Pride of Bilbao*, operating between Portsmouth and Bilbao, but as far as we know this record has not been assessed by a national rarities committee. Another individual was widely reported at sea c. 250 km west of St Mary's, Scilly, in July 2000. We have been unable to trace the origin and check the authenticity of this report.

Appendix 5. Field identification of white-bellied *Fregetta* storm-petrels breeding in the Tristan da Cunha group, South Atlantic.

Current literature suggests that both White-bellied *Fregetta grallaria leucogaster* and Black-bellied Storm-petrels *F. tropica melanoleuca* breed in the Tristan da Cunha group in the South Atlantic (this taxonomy is cautiously followed here). The latter taxon shows a white belly and, not surprisingly, this has led to confusion over its taxonomic status (Marchant & Higgins 1990). Some authorities consider *melanoleuca* a subspecies of White-bellied Storm-petrel, while others treat it as a subspecies of Black-bellied. Moreover, some researchers claim that only White-bellied occurs in the Tristan da Cunha group, others claim that both occur and breed side by side (based on measurements of size, relative proportions, reticulation of tarsus, shape of toe nails, and relative length of central toe, K. Roselaar pers. comm.).

Some specimens of *Fregetta* storm-petrels from the Tristan da Cunha group housed in the British Natural History Museum are presently considered to be White-bellied Storm-petrels. However, these are currently undergoing molecular analysis to resolve debate over the relationship between these and *melanoleuca* and *leucogaster* (B. Stephenson pers. comm.). Until resolved, field identification of any white-bellied *Fregetta* storm-petrel in the North Atlantic remains problematic (and molecular resolution may well not solve the problem of field identification). Thus, some authorities, including BWPI, consider the White-bellied Storm-petrel claim north of Cape Verde Islands

on 17th August 1986 to be unsafe. Conversely, the black belly-stripe of Black-bellied Storm-petrel is diagnostic, so the two records off North Carolina, both photographed and clearly showing this plumage feature, are irrefutable.

At present, if a white-bellied *Fregetta* storm-petrel were to be encountered in the North Atlantic, the best course of action would be to document the event thoroughly then sit back and watch the taxonomic developments. Ideally, documentation should include detailed notes and a portfolio of illustrations. On the basis of extant literature concerning the separation of the two species, it is especially important to document the following:

- Back and upperwing colour and colour tones: these are darker and warmer brown in Black-bellied, paler and greyer in White-bellied (Shirihai 2002).
- Toe projection: the two species are apparently separable by the position of the feet in relation to the tail (Marchant & Higgins 1990), the toes projecting noticeably beyond the end of the tail in Black-bellied, but at most only marginally in White-bellied.
- White fringes of back and scapulars: White-bellied shows fringes c. 2.0 mm wide in fresh plumage, and the covert bars are more conspicuous than those of Black-bellied, which shows narrower fringes c. 0.5 mm wide in fresh plumage (K. Roselaar pers. comm.). Caution is required here since white fringes abrade over time.

Appendix 6. Wear, moult and bleaching.

Identification pitfalls arise when a storm-petrel's remiges are heavily worn and/or in moult. Timing of moult depends on age and is species-dependent. The flight action and jizz of a storm-petrel with heavily worn and moulting flight feathers is different from that of the same species with fresh flight feathers. For example, during a southwest gale in September 1978, at Morecambe Bay, Lancashire, Marsh (1980) observed the flight action and jizz of a Leach's Storm-petrel sufficiently altered by moult that it could easily have been misidentified:

The odd bird appeared noticeably round-winged and consequently straighter-forewinged than a typical Leach's; its tail appeared to be shorter and more square-ended than Leach's; and it possessed the faintest greater-covert bar of all the petrels seen that day; rather like a typical [European] Storm-petrel and thus invisible at a range of over 100 m. Any excitement was dampened by the fact it was obviously the same size as the accompanying Leach's Petrel and their white rumps appeared identical ... I was able to observe it flying some 5 m below me... I was able to see a gap in the wing about halfway along the secondaries and note the tail as scruffy and irregular: characteristic of active moult. ... The round wings were still obvious, but could surely be explained by a bird still re-growing its outer primaries.

It is conceivable that this storm-petrel could have been mistaken for a Madeiran at distance. It looked strange among Leach's, but was also rounder-winged with straighter forewings, had a shorter, more square-ended tail, and showed only a faint greater-covert bar on the upperwing. Such characteristics on paper better portray Madeiran than Leach's.

This incident parallels our experiences off Scilly with Wilson's Storm-petrels. Adult Wilson's moult their flight and body feathers during May–September, when present in Scillonian waters (moult timing and strategy of immatures between their second calendar-year and adulthood has not been published). Consequently, especially early in the 'Wilson's season', we see adult and presumably immature (not juvenile)

Wilson's that are heavily worn and others that are in moult, with a mixture of worn and fresh feathers (e.g. plate 177 in Boswall 1979; Sibley 2000), as well as presumed juveniles that have fresh flight and body feathers (H. Shirihai pers. comm.). The flight action and jizz of Wilson's when heavily worn or in moult looks decidedly unlike that of birds with a full set of fresh flight feathers. Heavily worn and moulting Wilson's tend to be less stylish, less accomplished; their flight becomes more fluttering and can even convey the feel of European Storm-petrel.

Plumage is also affected by wear and bleaching, so that black-brown becomes virtually brown. Wear has a strong influence on the visibility of certain plumage characteristics, especially the greater-covert bars of Wilson's, which become paler through bleaching but less extensive through feather wear. A Wilson's with reduced greater-covert bar and heavily worn flight feathers may convey the jizz and feel of a European Storm-petrel and can be misidentified, especially if the legs are retracted! Conversely, bleached brown greater coverts on an adult European Storm-petrel may suggest dull wing-covert bars, while at the same time underwing-covert panels are worn and hard to observe. Occasionally, a European will glide more than usual and, if showing a dull upperwing-covert bar and apparent lack of white underwing panels, it could be misidentified as a Wilson's!



Bryan Thomas

181. European Storm-petrel *Hydrobates pelagicus*, off Scilly, August 2003. It is incredible just how worn a storm-petrel can become during the breeding season and still be able to fly. This European was very heavily worn, which strongly affected its flight behaviour.

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Bryan Thomas

019. Wilson's Storm-petrel *Oceanites oceanicus*, off Scilly, July 2005. This Wilson's is in moult and has dropped all its old primaries bar P8–10 on the left wing and P7–10 on the right wing. Note the moult contrast between old, bleached brownish outer primaries and fresh dark-looking black-brown inner primaries. The flight of a Wilson's in extensive primary moult, and/or with heavily worn primaries, is less accomplished and more fluttering, to some extent conveying the jizz of a European Storm-petrel *Hydrobates pelagicus*. A fluttering Wilson's that also shows significantly reduced greater-covert bars and has its legs retracted or minimal toe projection, like this one, can be misidentified as a European Storm-petrel!

Other examples of the effects of bleaching and wear include the increasingly pale greater-covert bars of Leach's that eventually start to disappear with wear, and the similar effects on the white greater-covert pencil lines of

Madeiran and pale mantle and scapular feather fringes of White-bellied and Black-bellied Storm-petrels.

Awareness of the timing of moult is important. It highlights potential identification errors

Table 6. Timing of moult of flight feathers for adult (Ad) and second-calendar-year (2CY) European *Hydrobates pelagicus*, Leach's *Oceanodroma leucorhoa*, and Wilson's Storm-petrels *Oceanites oceanicus*: dark grey = main period of moult, light grey = marginal period of moult, white = normally not moulting. Sources: BWPI 2006 and our own observations of European and Wilson's off Scilly. Note that adult and second-calendar-year moult cycles are not synchronised. Moult begins progressively later in years following the second calendar-year. Storm-petrels start to breed at four or five years old, by which time moult is synchronised with that of adults.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec				
European Ad																
2CY																
Leach's Ad																
2CY																
					May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Wilson's																
Ad																
2CY																

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caused by moult and wear and suggests likely species for the time of year. Table 6 summarises timing of flight-feather moult of European, Leach's and Wilson's Storm-petrels. Madeiran is excluded because of complications of the 'time-

share' breeders on the Azores, while Black-bellied and White-bellied Storm-petrels are obviously different from the other four species discussed here.

Appendix 7. Size illusion and exaggeration.

On short-range pelagic trips from Scilly we have watched many Wilson's Storm-petrels, at all visible ranges and often for hours alongside European Storm-petrels, feeding over oily slicks and around the vessel. Given suitable conditions, we can pick out Wilson's from European at 400 m on size (Wilson's looks noticeably larger than European), as well as on flight action and various flight profiles. Wilson's *appear* larger than Europeans than ratio comparisons of body length and wingspan suggest is actually the case. Participants on our pelagic trips typically estimate Wilson's as up to half as large again as European (i.e. perceived wingspan ratio up to 1.5), whereas the actual wingspan ratio is around 1.05 (table 2).

Moreover, we have observed several Leach's

alongside European Storm-petrels. An overall *impression* is that Leach's approach twice the size of European (i.e. perceived wingspan ratio up to 2.0) but, as with Wilson's, the actual wingspan ratio is significantly less, around 1.21. In our experience, there seems to be a relative size illusion between storm-petrel species when observed together at sea and so conscious awareness of this phenomenon when faced with 'something different' is important in preventing size exaggeration. Size illusion may have played a part in the perceived size of the 'Chalice petrel' and is relevant to the debate on the identification of that bird (e.g. British Birds Rarities Committee's files 1997; Force 1997; Young & King 1997; Garner & Mullarney 2004).

Appendix 8. Factors of scale.

Something to be considered when judging the size of storm-petrels at sea is *apparent* size variation resulting from scale. Scale is determined by two factors: (a) the size of vessel from which observations are made, and (b) the size of proximate seabirds. To us, Wilson's Storm-petrel off Scilly appears as an intermediate-sized storm-petrel and never small. Our vessels MV *Kingfisher* and MV *Sapphire* are about 16 m in length and 6 m across the beam, eye-level is about 4 m above the sea surface and distance of Wilson's from the vessel often about 10–20 m. Nearby seabirds range in size from European Storm-petrel to Northern Gannet *Morus bassanus* (e.g. wingspan range from c. 380 mm to 1,720 mm), and Wilson's is therefore not the smallest species present.

However, Wilson's appears small, even miniature when the vessel and proximate seabirds are on a grander scale. Observing Wilson's from the bridge and upper decks of MV *Professor Molchanov* in the South Atlantic in 2006 was a reminder of this phenomenon.

This boat is 71.6 m in length and 12.8 m across the beam, eye-level is about 20 m above sea level, and distance of Wilson's from the vessel often 60 m or more. Nearby seabirds range in size from Black-bellied Storm-petrel to Wandering Albatross *Diomedea exulans* (e.g. wingspan range from c. 400 mm to 3,500 mm), where Wilson's was indeed the smallest species present). Wilson's *seemed* to be much smaller in the southern oceans than off Scilly in the context of this grander scale.

The point that we wish to emphasise is that Wilson's Storm-petrel can *appear* as an intermediate-sized storm-petrel *and* as a small storm-petrel, depending on prevailing factors of scale. Such a phenomenon of course applies to all storm-petrels under consideration in this article. For example, we venture to suggest that Shirihai's (2002) observation that Black-bellied Storm-petrel's 'size at sea never appears as large as measurements suggest' is, in part at least, a result of factors of scale.

Appendix 9. Terminology used to describe flight behaviour of storm-petrels.

- Arcing back** Typical feeding behaviour of Wilson's, after slowly working and feeding its way forward into the wind over a food source; it doubles-back on itself to the origin of the food source by flying a wide arc close to the sea surface, then starts feeding again.
- Bouncing** Typical feeding behaviour of Wilson's, comical bouncing up and down on springy legs as if on a pogo stick, whilst manoeuvring over food source.
- Bounding** Typical flight behaviour of Leach's, a springy wing-and-body movement upwards and/or forwards.
- Bowed wings** Structural characteristic of European, Leach's and Madeiran, holding each wing in a shallow bow-like concave curve, so that the two wings form a shallow-M profile when seen head-on or tail-on; the depth of the 'M' is always shallow, but varies to some extent among species.
- Buoyant** Typical flight behaviour of Leach's that makes it seemingly float in the air.
- Dancing** Typical feeding behaviour of Wilson's, in what seems to be choreographed steps and body movements whilst manoeuvring over food source and taking food items.
- Darting** Typical flight behaviour of Leach's, much less so Madeiran and Wilson's, suddenly dashing off in an apparently random direction.
- Dead halt** Ability of storm-petrels to stop almost instantly when locating a food item. The energy of forward motion is dissipated, forcing the storm-petrel upwards before dropping down directly over food item.
- Deep wingbeats** Most typical of Leach's, where wings are raised high on the upbeat and depressed low on the downbeat.
- Dipping head** Characteristic food-gathering action of all storm-petrels, where the head is quickly moved down to the sea surface to seize or snatch a food item, then lifted back up again.
- Direct** Most typical of travelling Wilson's, flying purposefully forwards for some time as if flying along an imaginary straight line.
- Diving** Behaviour of European, Wilson's, and Madeiran (and possibly the three other species), diving below sea surface to collect food item, probably no deeper than 1 m, for just a short period of time, using wings to swim underwater.
- Elastic wings** Typical of Leach's, where flexible use of springy wings makes the wings appear as if made of elastic.
- Erratic** Typical flight behaviour of Leach's, where progress forwards appears disorderly with unpredictable changes of speed and/or direction.
- Fluttering** Typical flight behaviour of European, far less so of Wilson's, in utilising rapid, shallow, flickering wingbeats.
- Following** Typical of European, Wilson's, and the two *Fregetta* species, less typical of Leach's and Madeiran, following vessels and associating with feeding cetaceans, benefiting from food scraps (a) brought to surface by a vessel's propellers and bow wave, (b) fish waste from trawlers, and (c) fish debris and leftover minutiae from feeding cetaceans.
- Foot-pattering** Typical feeding behaviour of storm-petrels (although much less so in the case of Madeiran and the two *Fregetta* species), where legs and feet work rapidly 'running-on-the-spot' over a food item, accompanied by wing actions helping a storm-petrel to remain level and stable, and to hover or hang over food items in order to seize or snatch them.
- Gliding** Typical flight behaviour of storm-petrel species (but less so for European), where the wings are held outstretched and roughly horizontal and the aerodynamics of the wings and wind over the water are used to allow a bird to glide over the sea surface.
- Hanging** Typical flight behaviour of feeding Wilson's and Leach's, possibly others, whereby the wings are held outstretched but still and the wind is utilised to maintain a steady position over a food source (employing the same principle as hang-gliders).
- Hopping** Typical flight behaviour of Wilson's and the two *Fregetta* species; whilst gliding and skimming, using one foot on an outstretched leg to hop over the sea surface to maintain height and momentum and assist with direction changes.
- Hovering** Typical flight behaviour of feeding European, Leach's and, to some extent, Madeiran, less so for other species, flapping

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wings to maintain a steady position over a food source.

Hugging Typical flight behaviour of *Fregetta* species, which consistently hug the sea surface, skilfully traversing wave contours.

Leaping Typical flight behaviour of Leach's and to a much lesser extent Madeiran; like bounding, with a springy wing-and-body movement upwards and/or forwards, but sudden and startling as if jumping an imaginary hurdle unexpectedly encountered.

Purposeful Flying in a determined fashion as if heading to a predetermined destination.

Running Typical feeding behaviour of Wilson's, possibly others; while gliding, the bird runs along the sea surface with wings outstretched dipping head to seize food items.

Seizing food items Essential feeding behaviour of all storm-petrels whereby the head is dipped and the bill used to seize, snatch, or even to pull at food items on the sea surface.

Series of wingbeats A definite number of wingbeats.

Shallow wingbeats Typical of European, Wilson's, and Madeiran at least, where the wings are raised only slightly above the horizontal on the upbeat and depressed only a little below the horizontal on the downbeat.

Shearing Typical travelling flight of storm-petrels in strong winds, although less so in European, tilting one way and then another, whilst gliding on stiff-looking wings, rather like a small *Puffinus* shearwater.

Skimming Typical flight behaviour of Wilson's and the two *Fregetta* species, gliding low over and indeed nearly touching sea surface, facilitating hopping, running and skipping.

Skipping Typical flight behaviour of Wilson's and the two *Fregetta* species; as hopping, but using left and right legs and feet to skip over the sea surface to maintain height and momentum.

Snatching Typical feeding behaviour of storm-petrels, although less so for European; whilst skimming, the bird dips its head and snatches a food item from the sea surface in its bill.

Splashing Typical feeding behaviour of the two *Fregetta* species and sometimes Wilson's, whereby the breast is used rather than the legs and feet in skimming flight to splash (bounce) the bird off the sea surface.

Steady wingbeats Regular unchanging wingbeats.

Stiff wings Typical of Wilson's, where apparent inflexibility of wings makes them appear as if without working joints.

Strong flight Typical flight impression given by larger storm-petrels, when they look vigorous, energetic, and powerful for their size; often observed in strong winds.

Swooping Typical feeding behaviour of Leach's, involving swoops back and forth over food item whilst lunging at it.

Weak flight Typical flight impression given by European, appearing feeble, but actually surprisingly robust in strong winds.

Zigzagging Typical flight behaviour of European, Madeiran, and two *Fregetta* species; forward progression is accomplished by first banking to the left, then to the right, and so on, as if following an imaginary criss-cross path.

Appendix 10. Angle of view.

The angle of view is particularly relevant to storm-petrel identification, since the birds occupy the lowest 10-m band of airspace above the sea surface, with most rarely rising above 5 m (and often remaining below 2 m). The total experience of a storm-petrel from larger vessels like RMS *Scillonian III* is different from that from smaller vessels like MV *Sapphire*, used for pelagic trips off Scilly.

Estimating the angle of view is helpful in storm-petrel identification since it determines what an observer might be expected to see on the bird (also determined by range, duration of observation, and flight behaviour, of course).

Imagine you are observer (a) in fig. 1, where the angle of view is shallow, watching a North Atlantic *Oceanodroma* and you observe that white in the region of the tail is seemingly always in view. Such an observation strongly suggests you are watching a Madeiran Storm-petrel. Leach's has minimal white extensions from the rump to undertail-coverts and rear flanks, and the white rump-patch is often difficult to see, even at close range. However, with Madeiran, white wraps around the rump to the undertail-coverts and rear flanks, which is relatively easy to see even over a considerable range (pers. obs.).

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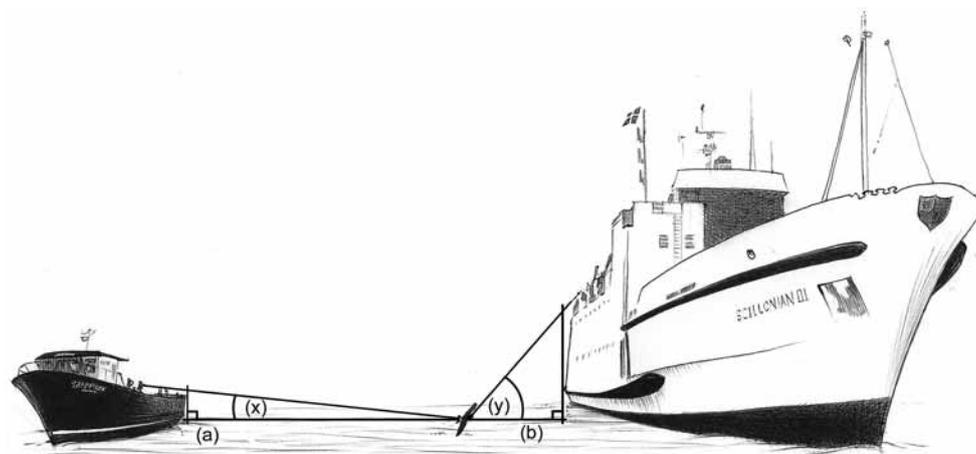


Fig. 1. An observer aboard MV *Sapphire* (left) has a shallow angle of view ('x') to the storm-petrel, while an observer aboard RMV *Scillonian III* (right vessel) is higher above the sea surface and closer to the storm-petrel resulting in a deeper viewing angle ('y').

Angle of view will affect the relative ease with which certain important features can be seen and documented. A shallow angle of view makes the following relatively difficult to see:

- structure: travelling wing shape, tail shape and toe projection;
- plumage: wing-covert bars and white on rump and uppertail-coverts; and

- moult and wear of remiges and rectrices.
- A deeper angle of view makes the following relatively difficult to see:
- structure: bill shape and proportions;
 - plumage: underwing-covert and axillary panels and extent of white on undertail-coverts and rear flanks, and white on belly.