Studying moul in pelagic seabirds in a quantified manner is difficult, since moulting birds are largely at sea, away from the breeding grounds (Nelson 1980, Nettleship & Birkhead 1985). Birds found dead during beach patrols (Cooper et al. 1991) are often used for study, although such studies may be compromised by the fact that samples are small and may not be representative of the population. Digital photography of birds at sea, however, now offers the opportunity to quantify moul of flight feathers. As an example, I report on opportunistic observations of moulting Sooty Shearwaters Puffinus griseus in the Northeast Atlantic.

The study was carried out during a dedicated marine mammal survey of deep North Atlantic waters on board R/V Mars Chaser, from 5–30 July 2007, in the area west of Scotland and northwest Ireland, roughly between 52–61°N and 4–18°W. More than 3400 km of transects were covered in 290 h of observation, but attention could be paid to birds only during off-duty hours, and observations were thus limited and non-systematic.

On 15 July we passed Rockall (57°35'48"N, 13°41'19"W), a rocky islet about 350 km west of the Scottish mainland. Here, a flock of about 500 Sooty Shearwaters was encountered, about half of which subsequently followed the ship for nearly an hour. The birds were photographed with digital cameras by several observers, and subsequent inspection showed that many were in active flight-feather moul (Fig. 1).

Sooty Shearwaters have a “normal” descendent primary moul (Cramp & Simmons 1977). Of 76 birds photographed well enough to see the primaries, 35 (46%) were in active primary moul. Primary moul was scored according to Ginn & Melville (1983) from the photographs of 27 individuals, all taken on 15 July. Of these, 15 were in active primary moul, with all 10 primaries visible in three birds, nine in three birds, eight in seven birds and seven in two birds. The moul scores of the invisible feathers were estimated. When a feather was hidden behind a covert, it was given a score 2. The resulting total moul score did not deviate more than three points from the real score.

The moul scores ranged from 32 to 43 (median 42). Twelve birds were definitely not actively moulting (moul score 0 or 50). Of the 12 birds not in moul, two were likely juveniles, as their plumage was very fresh, with no contrast in any visible feather tract (head, neck, back, rump, but especially upper wing-coverts and scapulars). The other birds had more variegated plumage, with a mixture of old and new feathers (Fig. 1) and were thus probably older. Among the birds in moul, two (10 birds), three (four birds) or four (one bird) primaries were growing at a time. The innermost growing primary was invariably almost fully grown (moul score 4).

Most Sooty Shearwaters sighted near Rockall still had yet to grow at least 10 “moul score points,” equalling primaries 8–10 and representing almost 50% of the total primary mass (Cooper et al. 1991). The mean duration of a complete moul cycle is approximately 159 d (Cooper et al. 1991); hence, the “average” Sooty Shearwater in moul near Rockall had started its primary moul about 27 April and would finish it by 2 September. As Sooty Shearwaters can migrate quickly (Shaffer et al. 2006), this would seem to be well in time for them to reach their colonies in the South Atlantic. We cannot say whether the non-moulting birds had already moulted their primaries, or had yet to start moulting, although the latter seems unlikely.

Sooty Shearwaters washed ashore in South Africa had moulted their primaries between December and June (Cooper et al. 1991), the
majority in February–May, with a mean completion date of 10 June. Three birds moulting primaries in August were considered to be “outliers” and were excluded from their calculations. The authors assumed that the actively moulting Sooty Shearwaters in South African waters were “prebreeders and failed breeders.”

Sooty Shearwaters commonly enter the North Atlantic after the breeding season (Cramp & Simmons 1977, Carboneras 1992), and as early as 30 years ago “concentrations on Rockall Bank and Faroese fishing grounds” were noted in late summer (Cramp & Simmons 1977). However, data on moulting individuals from the North Atlantic are surprisingly rare. A female found in western France on 1 November 1936 (Mayaud 1949) had a moult score close to 47, and only one of 603 individuals seen at sea on the Scotian Shelf off Atlantic Canada over 11 years was in moult (Brown 1988). Cooper et al. (1991) agreed with Brown (1988), who suggested that adult Sooty Shearwaters preferentially migrate into the North Pacific, whereas only “newly fledged juveniles [and] subadults that have already completed their moult before the start of migration” spend the austral winter in the northern Atlantic.

More probable than such a differential migrating route among age classes is a spatial segregation in wintering areas, with birds breeding in the South Pacific mainly migrating into the North Pacific (corroborated by Shaffer et al. 2006) and those of South Atlantic breeding grounds migrating into the North Atlantic. This is also supported by the few published records of ringing recoveries (see references in Cooper et al. 1991), with all occurring in the ocean of banding.

The recent opportunity to take numerous digital pictures of seabirds at sea and to scrutinize them afterwards on a computer screen gives unexpected opportunities for studying moulting seabirds. The use of digital cameras for up-close inspection of birds has already been described by Leary (2004) for waders, but as far as I know this is the first description of the use of digital photographs to study the moult of seabirds at sea.

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