

Aging Atlantic Puffins *Fratercula arctica* in summer and winter

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Abstract

Atlantic Puffins *Fratercula arctica* in summer and winter plumage can be aged as first-year, second-year, third-year, young adult and old adult using the number of grooves on the outer part of the beak. The technique is useful to bird ringers and those dealing with birds found dead in wrecks and pollution incidents where knowledge of the ages of individuals involved can help assess the likely effect on breeding populations.

Introduction

Although wrecks of seabirds after spells of severe weather occur periodically, they generally do not involve Atlantic Puffins *Fratercula arctica*. However, in March 2013 c. 4,500 dead Atlantic Puffins (hereafter 'Puffins') were washed up on the beaches of east Scotland and northeast England, and in February 2014 c. 30,000 dead and dying Puffins were counted on the shores of the Bay of Biscay, France, Portugal and southern Britain (Harris & Elkins 2013; Farque 2014; Turner 2014; H. Jessop/RSPB pers. comm.). These are among the largest wrecks of Puffins recorded and they could potentially have a serious effect on the numbers of Puffins around Britain and elsewhere, especially if mainly breeding adults were affected. Aging of Puffins during the summer using morphometric criteria is well documented (Petersen 1976; Harris 1981), but these wrecks drew attention to the lack of information on how to age Puffins during the winter (but see Camphuysen *et al.* 2007; Harris & Wanless 2011). This paper aims to fill this gap by bringing together images of Puffins in the summer and winter to highlight the key criteria used for aging throughout the year and provide a detailed description of the changes in the bill that occur during the non-breeding season.

The Puffin is immediately identifiable throughout the year due to its contrasting black-and-white plumage and more importantly the strikingly enlarged and colourful beak. However, it takes several years for an individual to reach this state (details in Petersen 1976; Harris 1981). During the first 4–5 years of life the wing length increases, the bird becomes heavier and the beak becomes deeper with the profile changing from triangular to extremely convex. As the area of the beak increases, grooves develop in the outer part, the number of which gives an indication of the age of the bird. The rate of development of the beak varies among individuals but, despite it not being possible to age any individual with 100% certainty, it is possible to classify most individuals as being in their first, second or third year of life, as a young adult (probably in its fourth or fifth year) or an old

adult. The significance of the number of grooves has not been demonstrated but as Puffins do not normally breed until they have at least two bill grooves and the bill is used in display, they presumably have some sexual importance.

Material and Methods

Information on birds during the breeding season (March–early August) comes from 242 Puffins that had been ringed as chicks on the Isle of May, southeast Scotland and handled in later years (Table 1). Forty-five of these birds were photographed each time that they were caught which allowed the development of the grooves to be documented in relation to age. Information on birds outside this period comes from photographs of the heads of c. 1,200 birds washed up dead on beaches, mainly on the coasts bordering the North Sea, and 51 shot by hunters in the Faroe Islands.

Table 1. The numbers of grooves on the beaks of Atlantic Puffins *Fratercula arctica* of known age and breeding adults on the Isle of May. *The breeding birds with less than 2 grooves had damaged or deformed beaks.

Age	Number of grooves						
	trace	<1	1	1½	2	2½	3 or more
1st year	3						
2nd year	4	16	21	9			
3rd year		1	5	55	18	2	
4th year				4	18	8	3
5th year					10	9	8
6th year					2	9	11
Older					4	15	7
Unaged breeding birds			1*	13*	343	1351	1628
Groove age	1st year	└ 2nd year ─		3rd year	Young adult	└ Old adult ─	
Age grouping	1st year	└ Immature ─			└ Adult ─		

The aging of a Puffin is based on the number of grooves on the orange or red part of the upper beak forward of the yellowish ridge (lamella) that separates this from the inner (basal) dark area (Figure 1). This number can vary from nought (at fledging) to three or more in an old adult (Figure 2). Often the third groove is indistinct and little more than some light shading due to the deposition of a pale chalk-like substance. Petersen (1976) suggested that four-year old Puffins should be separable from younger birds by the quantity of this chalk in the last groove but this remains to be confirmed. Most Puffins in Britain develop at least two complete grooves, some develop three but very few get four. In the winter, care is needed not to count the depression at the inner edge of where this lamella has been as a groove. Furthermore, in a few birds the first ridge of the orange area is pale-coloured so care is also needed not to take this as the lamella (see later, Figure 7f). The number of grooves is a better indication of age than the overall size of the beak. For instance, a bird ringed as a chick and found dead in February of its second year had a massive beak with one rather ill-defined groove whereas another ringed chick in March of its third year had a smaller beak with one and a half grooves (Figure 3).

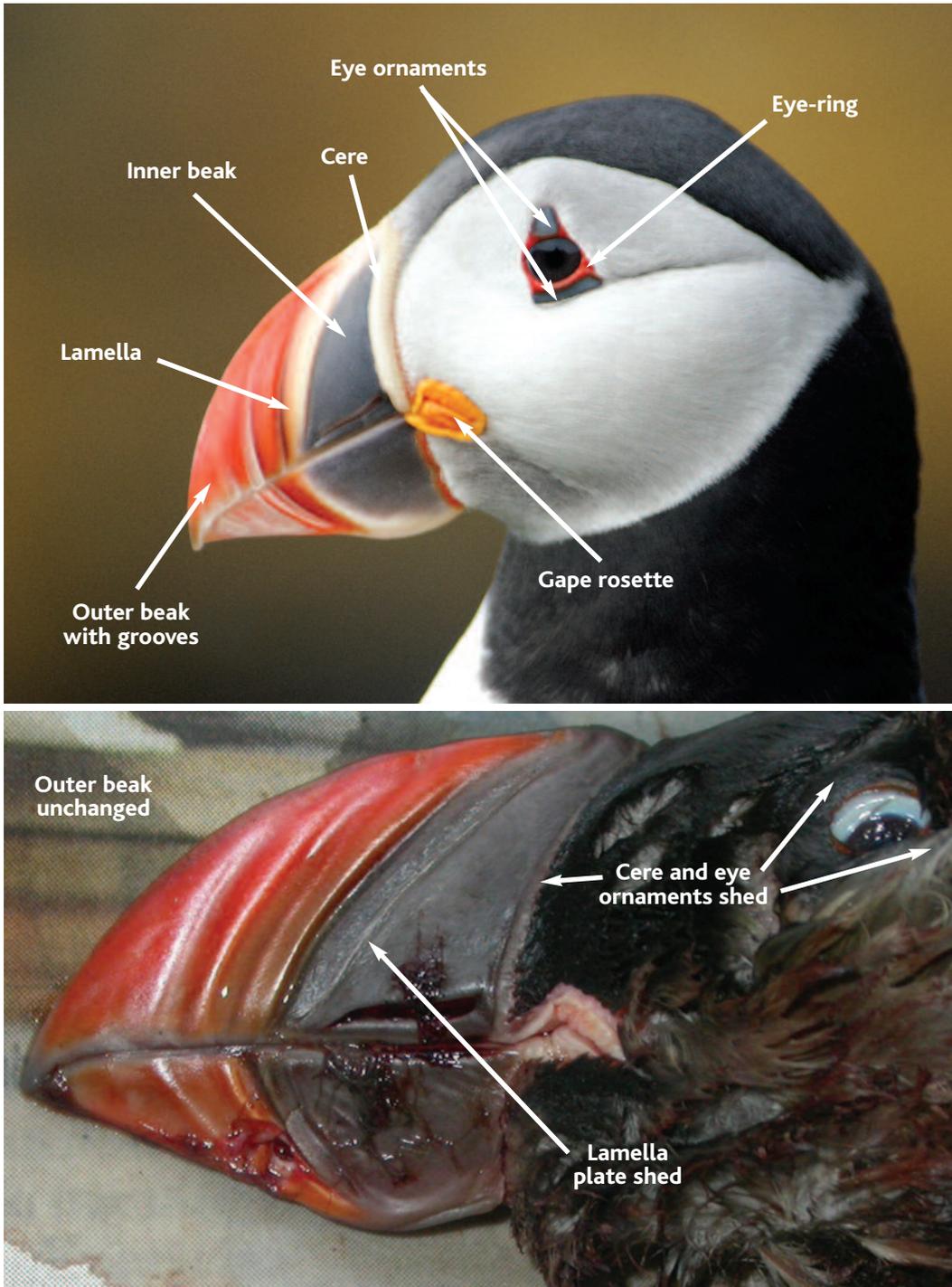


Figure 1. Heads of adult Atlantic Puffins *Fratercula arctica* in summer (upper) and winter (lower) showing the main terms used in this paper and the changes in the beak that occur after the breeding season. © Anke Addy (upper), © Jens-Kjeld Jensen (lower)

Although a Puffin in captivity laid an egg when in its third year of life, the median age of first breeding on the Isle of May is seven years ($n = 148$ birds) and only 21% bred in their fourth or fifth years of life (Swennen 1977; Harris & Wanless 2011). Thus 'young adults' can be considered mature, although many, and perhaps most, will not yet have bred.

On average, male Puffins have larger beaks than do females but, at least in the breeding season, there are no detectable differences in the colouration, although the yellow-orange gape-rosette is larger in males (Doutrelant *et al.* 2013). Therefore it is assumed that there is no difference between the sexes in the pattern of beak development. For simplicity, I use the term first-year for a bird between fledging and 31 July of the second calendar year of life, second-year for the next 12 months and so on, and winter for the period between breeding seasons.

Results

The summer beak: Most Puffins remain at sea during their first year and the few that do come to the colonies have drab coloured beaks, small eye ornaments, grey or slightly orange eye-rings and sometimes dusky face patches. In contrast, the vast majority of older birds at the colonies have brightly coloured beaks and red eye-rings and well-developed ornaments above and below the eyes. Examples of known-aged birds are shown in Figure 2. Typically, in summer a bird in its first year has a trace of a bill groove, a second-year bird has one groove (although this is sometimes ill-defined, a third-year bird has one and a half grooves, and a fourth-year bird has two complete grooves (Table 1). A very few individuals never develop more than two grooves but most older birds have two complete grooves and at least a trace of a third and a more uniformly convex profiled beak than an immature. Many birds in their second and third years and a few in their fourth year have an irregular outline of the top of the bill.

Transition from summer to winter: At the very end of the breeding season or just after the birds leave the colony, the hard dermal plates that cover the inner part of the upper and lower beak and the eye ornaments flake off and the face becomes black, especially in front of, and just around, the eye (Figure 4). The beak looks somewhat odd because it is constricted vertically at its base. The assertion that the outer beak is less brightly coloured outside the breeding season (Bureau 1877; Harris & Wanless 2011) seems to be an error due to the material examined being not completely fresh. The shedding of the eye ornaments and the shrinking and loss of colour in the eye-ring results in the bird having a 'wide-eyed' expression. The legs and feet change from orange to pale yellow and the rosette at the gape becomes smaller and paler. These changes are so dramatic that until the 1870s summer and winter Puffins were thought to be separate species.

The changes in the Puffin's beak were meticulously described by Bureau (1877, 1878, 1879; see Figure 5) who correctly described how the transformation from summer to winter was mainly a result of the shedding of horny or scaly plates on the inner part of the beak. In the summer the upper beak has a horny rim or cere,

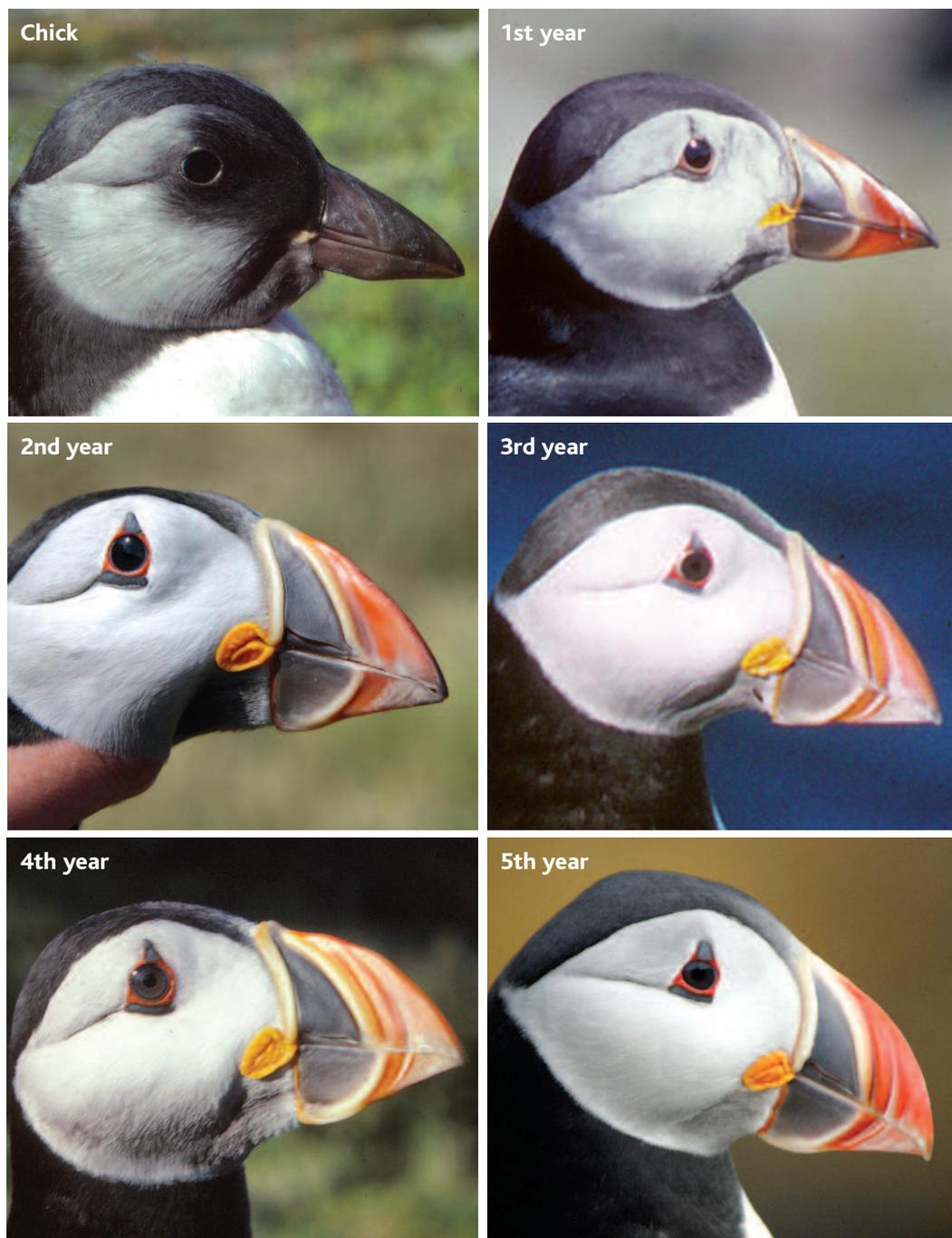


Figure 2. The development of the beak of the Atlantic Puffin *Fratercula arctica* as shown by birds ringed as chicks and subsequently seen in the breeding colony. Typically, a bird in its first year has a trace of a bill groove, in its second year one sometimes ill-defined groove, in its third year one and a half grooves, and in its fourth year two complete grooves. A few individuals never develop more than two grooves but most older birds have two complete grooves and at least a trace of a third groove. © Mike P. Harris



Figure 3. Beaks of known aged Atlantic Puffins *Fratercula arctica* outside the breeding season. The upper bird was in its second year and had a large bill with one indistinct groove, while the lower bird was in its third year and had a smaller and more pointed bill but with one and a half grooves. © Pierre Sauve (upper), © Mel Froude (lower)



Figure 4. Adult Atlantic Puffins *Fratercula arctica* on the Isle of May in summer (upper) and winter plumage (lower). © Anke Addy (upper), © Mike P. Harris (lower)

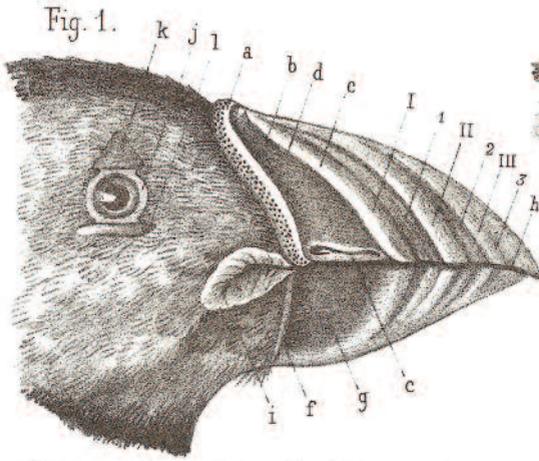
a nasal shield, two sub-nasal plates and two yellowish or transparent lamellae that overlap the hind edge of the first bill ridge (Figure 6). The horny rim on the border between the upper bill and the plumage is shaped like an inverted U. It is pierced by numerous evenly spaced holes through which poke rudimentary feathers. Early in the breeding season this horny rim is translucent and skin-coloured but at the end of the breeding season it becomes yellow and dead looking. The underlying skin, which is exposed when the dermal plates fall off, is black and membranous. In the spring the nasal shield and two sub-nasal plates are lead-blue but by the end of the breeding season they have lost their sheen and fall off to expose much darker skin below. The lower mandible has two border pieces and a chin plate. In spring, the border pieces are bright orange, but when they fall off in the late summer, they expose a yellow membranous posterior margin that soon darkens and shrinks, which contributes to the pinched appearance of the base of the beak.

The winter beak: Despite these seasonal changes, the outer part of the beak with the grooves remains essentially unchanged throughout the year and it is unclear whether the development of the grooves occurs during the winter or summer or is a continual process. However, in winter the number of bill grooves is less easy to determine since, with the shedding of the yellowish lamellae that form the pale diagonal, the division between the inner and outer beak is less obvious (Figure 7). Care is needed not to count the depression at the inner edge of where this lamella has been as a groove.

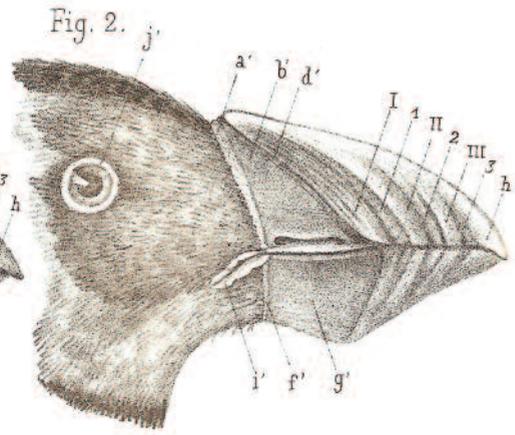
Typically in winter, a first-year bird is noticeably smaller than older birds and the beak has no groove. A second-year bird has one groove, a third-year bird has one and a half grooves, a young adult has two grooves and an old adult has more than two grooves (Figure 8). During the first few years of life there is considerable individual variation in the rate of development of the beak, which seems to be more apparent in winter than in summer, so that aging of a single individual can be difficult, especially for those who have had limited experience or when the bird has been dead some time. However, when the photographs of birds found dead during the recent major wrecks are compared they fall into groupings similar to those of summer birds. Beaks of presumed first- and second-year birds in March 2013 are shown in Figures 9 and 10. When dead birds are poorly preserved it is probably wise just to classify them as first-year, immature (second- and third-year) or adult. In all cases it is desirable to photograph the beaks so that agings can be checked subsequently.

Rarely, a bird at the colony still has a winter bill. An adult that has returned to the Isle of May for six consecutive summers without breeding is shown in Figure 4. Eighteen such birds killed by bird-fowlers in the Faroes were all old females with undeveloped ovaries that suggested some hormonal imbalance (Jensen 2010). Immatures with winter bills are even rarer (Figure 11).

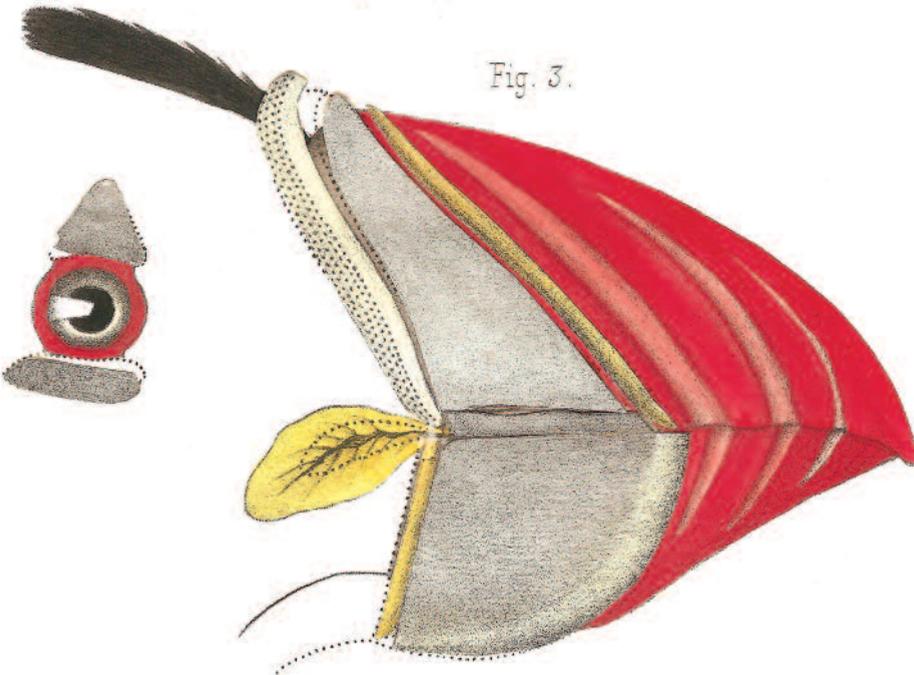
Figure 5 (overleaf). Figure from the paper by Bureau (1877), who first described the seasonal changes in the beak of the Atlantic Puffin *Fratercula arctica*. In the original, the coloured eye-ornaments, cere, basal dermal plates and the yellow lamella can be lifted up to show their winter colours.



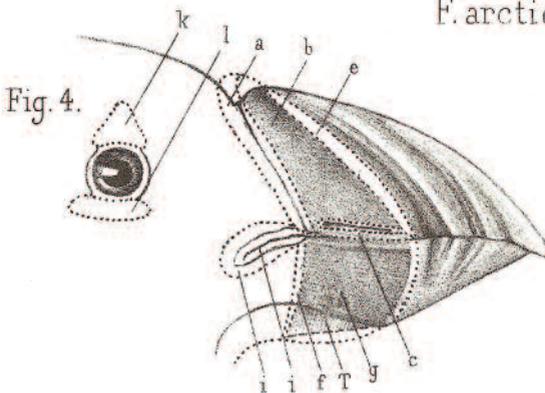
Fratercula arctica, ♂ adulte au printemps.



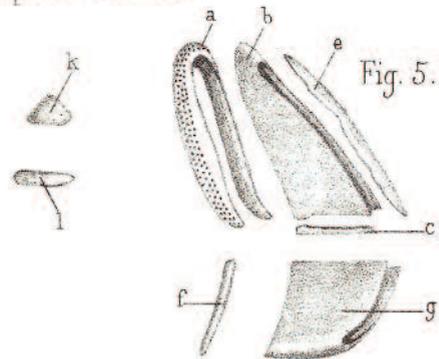
F. arctica, ♂ adulte en hiver.



F. arctica opérant sa mue.



F. arctica.— Schema de l'adulte prenant les ornements des noces.



Pièces cornées tombant après les noces.

Discussion

The use of the bill to separate immature from older Puffins during the summer was first suggested to the ornithological community by H.B. Knox in 1891–3 on museum labels that he attached to specimens of Puffins that he shot at sea. However, bird fowling had clearly known of these differences prior to this although without formally recording the criteria (Williamson 1970). Petersen (1976) was the first to provide definitive evidence using ringed birds. With experience, or when a series of birds or photographs are available, in summer it is fairly easy to age a Puffin as first-year (that is 9–12 months old), second-year, third-year, young adult or old adult with some confidence. This is useful when ringing birds at colonies since during their first three years of life Puffins regularly visit colonies other than where they were born and/or later breed (Harris & Wanless 2011). In comparison, adults with more than two grooves caught at a colony can safely be assumed to be breeding and be used for studies of adult survival or investigating natal or breeding dispersal. Birds with two bill grooves are probably best considered separately since these will include both breeders and pre-breeders that may or may not recruit into



Figure 6. Adult Atlantic Puffin *Fratercula arctica* on the Isle of May in early August. The bird has already shed its eye ornaments and cere. The plates on the inner upper and lower beak and the pale lamella running diagonally across the upper beak are just starting to be shed. © Mike P. Harris

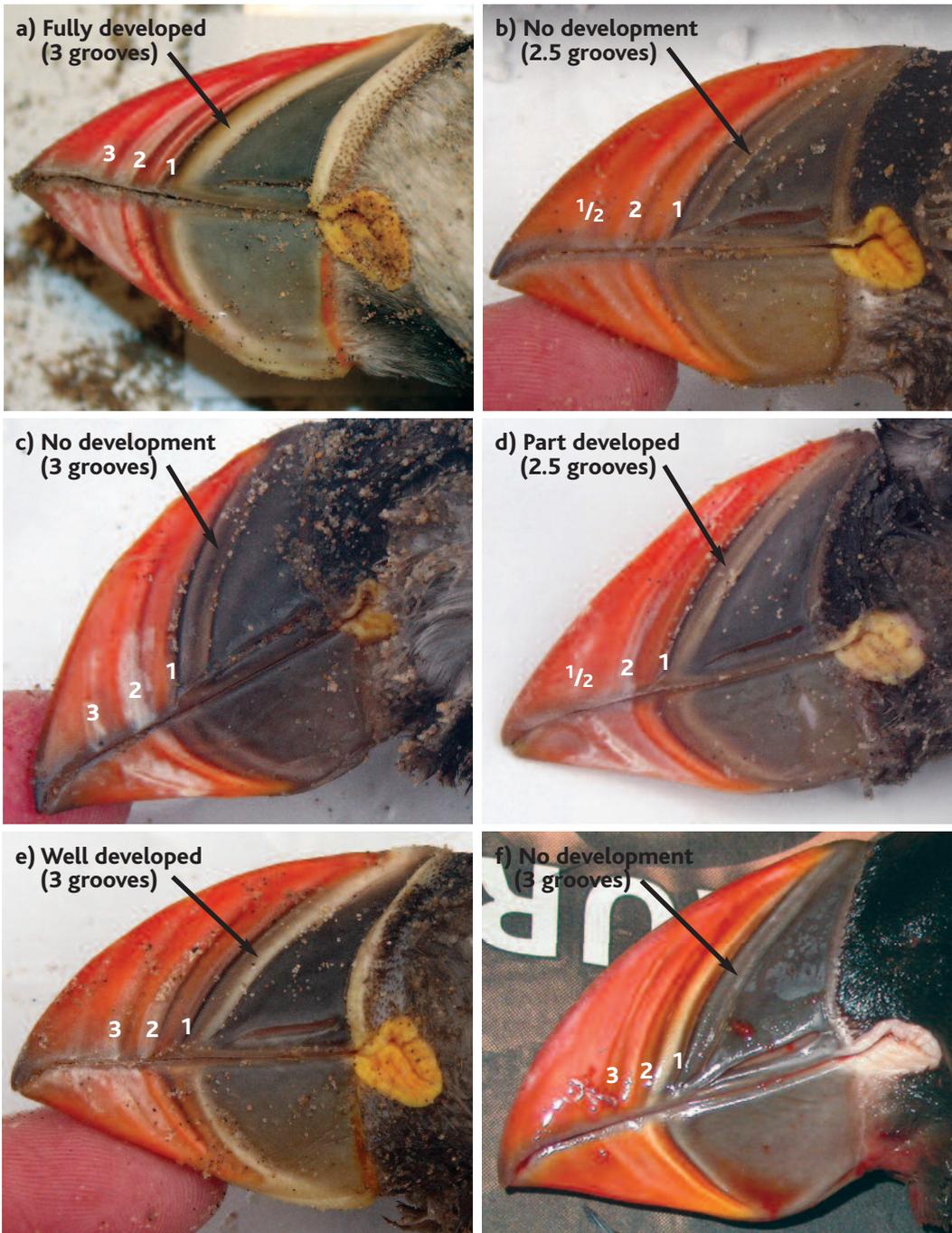


Figure 7. Aging of Atlantic Puffins *Fratercula arctica* is based largely on the number of bill grooves in front of the diagonal yellowish lamella that in the summer plumage (a) separates the brightly-coloured outer part of the bill with the grooves from the dark, and in winter leathery, inner area. This diagonal is not obvious in some winter-plumaged birds (b,c) and in these care must be taken not to assume that this is the first ridge of the orange area which in some individuals (f) is light coloured. © Mel Froude (a), Daniel M. Turner (b–e), Jens-Kjeld Jensen (f)

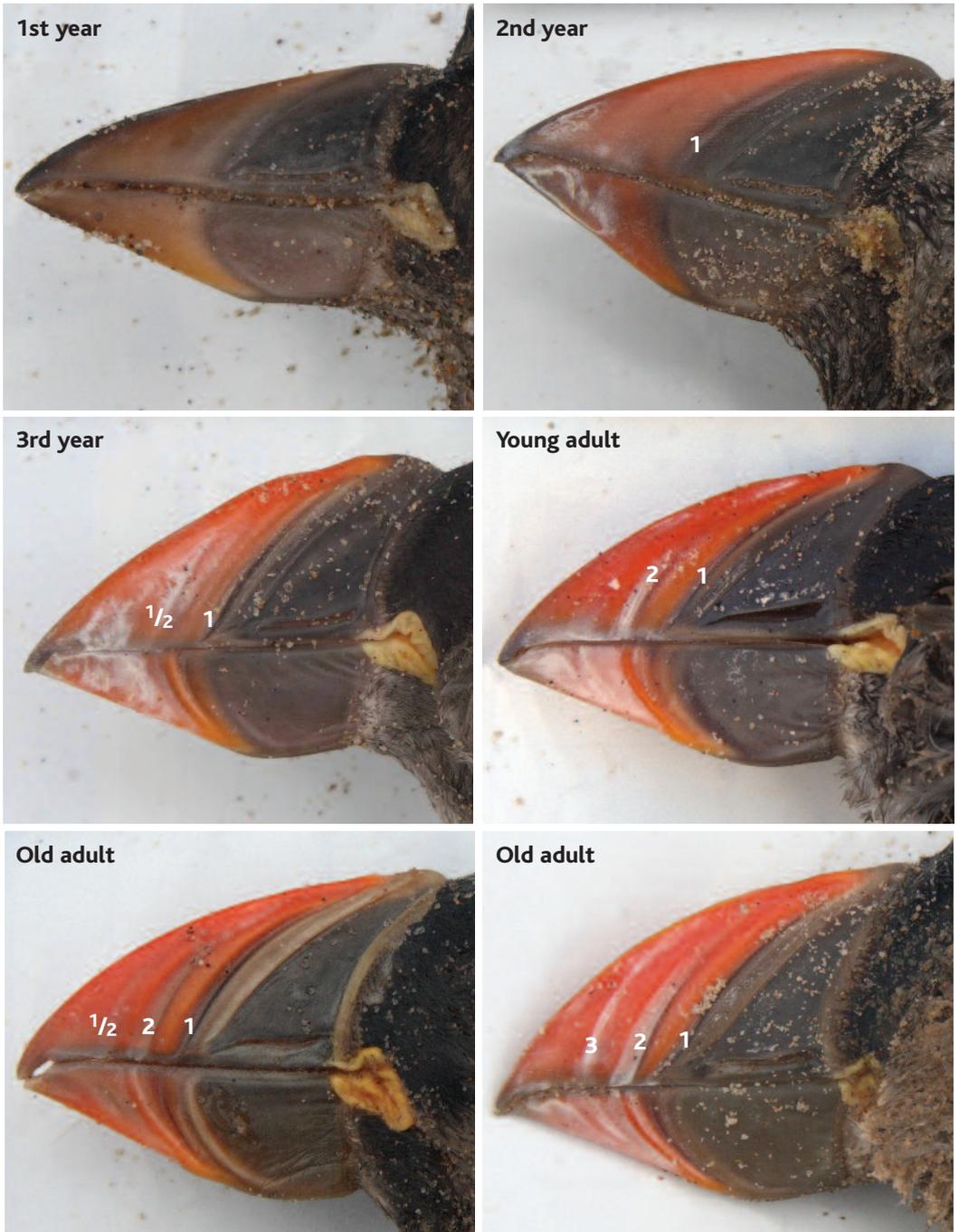


Figure 8. Age classes and the number of bill grooves of Atlantic Puffins *Fratercula arctica* during the winter. © Daniel M. Turner

Figure 9 (double-page spread overleaf). Sixteen probable first-year Atlantic Puffins *Fratercula arctica* found dead in March 2013. © Mel Froude

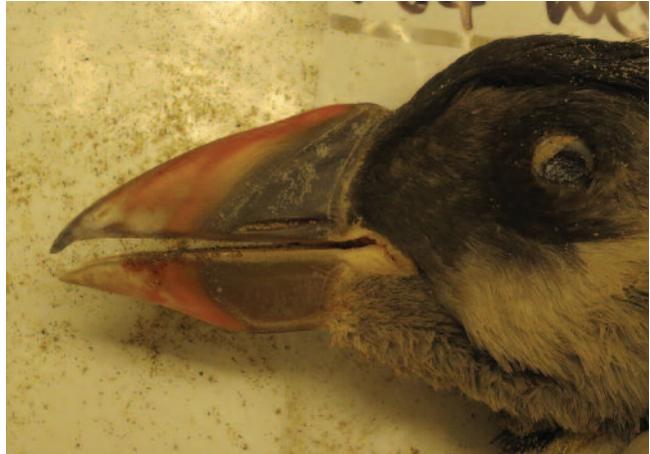








Figure 10 (previous double-page spread). Sixteen probable second-year Atlantic Puffins *Fratercula arctica* found dead in March 2013. © Mel Froude

the local population. Being able to age individuals can also be useful at colonies where substantial numbers of Puffins are killed by avian predators such as Great Black-backed Gulls *Larus marinus* and Great Skuas *Stercorarius skua*, in order to quantify the impact on the breeding and non-breeding components of the population. Aging of 6,922 Puffins killed by Great Black-backed Gulls on St Kilda, Outer Hebrides found that 43% were likely to have been non-breeders and thus predation was affecting both the current breeding population and potential recruits (Harris 1980). Similarly, aging of Puffins taken by hunters indicates that they kill a high proportion of immatures (Petersen 1976; Jensen 2010).

Outside the breeding season, it is easy to assign an age to adults and first-year birds. However, aging is sometimes more problematic for second- and third-year individuals; pragmatically, the best approach is if there is any doubt such birds should be classified as immature. Being able to age Puffins at this time is again useful as it allows an assessment to be made of the likely impact of a major natural wreck resulting from severe weather, or a man-induced mortality such as an oiling incident. Puffins are very long-lived birds so a single large mortality of first-year or



Figure 11. An immature Atlantic Puffin *Fratercula arctica* with a winter bill at Sumburgh Head, Shetland in July 2014. This individual has one complete and one almost complete second groove and a rather triangular bill that suggest that it is in its third summer. The very worn plumage suggests that it had not attained summer plumage in 2014. © Richard Ashbee

immature birds will have few short-term effects on breeding populations whereas a mortality of adults could potentially have much more serious consequences. For instance, in a wreck of Puffins in Shetland in the middle of the 1990–91 winter, the age structure of 98 beached birds was 17.3% first-year, 21.4% immature, 10.2% young adults and 51.1% old adults. This age distribution did not differ significantly from the ages of birds calculated to be alive at the end of the 1990 season which suggested that all age classes were equally affected (Harris *et al.* 1991). A similar age distribution was found for 1,148 corpses examined following the major wreck in east Scotland and northeast England in March 2013 (9.0% first-year, 24.0% immature, 11.2% young adult and 55.8% old adults). Breeding success of Puffins on the Isle of May in 2012 (the colony where many of the dead birds came from) was 0.57 chicks per pair that laid an egg (www.ceh.ac.uk/sci_programmes/2012-seabird-breeding-isleofmay.html). Assuming that 10% of adults did not breed, in August 2012 the ratio of adults to first-years in the population would have been 3.9:1. In contrast, the ratio for the birds found dead in March was 7.4:1. This could be interpreted as indicating a higher mortality of adults, or that many first-year birds had died earlier in the winter or were outside the area of the wreck at the time. Work is currently in progress to refine this estimate by constructing an integrated population model to estimate the numbers of Puffins of various ages that would have been at risk in the 2012–13 winter and hence assess the effect that the wreck might have on the breeding population in the North Sea over the coming years.

Relatively little is known of when Puffins replace their wing feathers, a process during which they are flightless for several weeks. The available evidence suggests that immature individuals moult appreciably later in the winter than older birds (Harris *et al.* 2014). However, sample sizes of birds examined, particularly in some months, are very small so ensuring that all birds examined for moult are aged would be a major advantage. It is hoped that this guide will help those finding dead Puffins in aging such birds.

This paper has focussed on external features, in particular the bill. However, more information on age can be obtained by scoring the presence or absence of the bursa Fabricii (a gland of the endocrine system that is visible as a pouch off the cloaca in young birds but disappears within a few years) and for females whether the oviduct is straight or convoluted (the latter indicates the bird has bred). However, both these features need dissection facilities, considerable experience and reasonably fresh corpses so are only assessed in a minority of cases as part of detailed studies (Petersen 1976; Camphuysen & van Franeker 2007).

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