CAN NORWEGIAN AND RUSSIAN RAZORBILLS *ALCA TORDA* BE IDENTIFIED BY THEIR MEASUREMENTS?

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SUMMARY

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Razorbills *Alca torda* were measured in one Russian and five Norwegian colonies. A comparison with measurements from colonies in Britain, Ireland, Iceland and the Baltic Sea shows a clear correlation with the geographical position of each colony and a clinal increase in size from the south-west to north-east. Wing length and gonys depth were negatively correlated with surrounding summer sea-surface temperatures. Due to considerable overlap in measurements within the range of the cline, caution is advised when identifying geographical origins of Razorbills on the basis of their size alone.

INTRODUCTION

Although modern-day DNA analyses are helping us examine the genetic relationships between individuals of e.g. the auks (Moum *et al.* 1991, Birt-Friesen *et al.* 1992), the expense and complexities of the method prohibit their use by many ornithologists. As an alternative, body measurements have long been used to describe phenotypic variations within a species and hence to help determine the geographical origins of birds found outside their breeding areas (Oldén *et al.* 1985, Anker-Nilssen *et al.* 1988, Jones 1990, Anker-Nilssen & Lorentsen 1995). Although fraught with errors due to measurement inconsistencies (Barrett *et al.* 1989), this method has the advantage of giving immediate and inexpensive results.

For Razorbills *Alca torda*, there has been some discussion concerning the validity of Salomonsen's (1944) classification into three forms; the small *islandica* (breeding in Iceland, the Faeroes, Britain and France), the Baltic and nominate *torda* and the remainder *pica* (Norway, Russia, Greenland and Canada). Today's consensus is that the recognition of *pica* is 'not warranted' and that they should be included in the *torda* form (Cramp 1985, Bédard 1985, Jones 1990). This paper expands on Jones's (1990) analysis of Razorbill morphology and presents measurements of Razorbills from one Russian and five Norwegian colonies in an attempt to unravel his problem concerning the presence or absence of a morphological cline within *islandica* and/or *torda*.

METHODS

Razorbills were caught using either a fleyg or noose-pole during the breeding season in the Seven Islands archipelago off the Kola Peninsula and four colonies, Runde, Røst, Bleiksøya and Hornøya, in Norway (Fig. 1). At the fifth Norwegian colony, Loppa, they were retrieved drowned from salmon nets set under the colony (Bustnes *et al.* 1993). Measurements were made of body mass (±5 g), wing (maximum flattened chord ±0.5 mm), culmen and gonys (±0.25 mm) and head+bill (±0.5 mm) using the procedures described in Jones *et al.* (1982). Bill grooves in front of the white groove were scored as 0, 1, 2 and 3. Scores given for birds with incomplete grooves (½, 1½ and 2½) were raised to the nearest whole number. All measurements at all colonies except Røst and the Seven Islands were made by RTB. Measurements at Røst were made by TAN and two of his colleagues, and those at Seven Islands by YVK. An earlier control by RTB and YVK showed that there where no significant differences between their measurements of the wings, bills and head+bills of 11 large auks (Razorbills and Common Guillemots *Uria aalge*), thus eliminating any observer differences in measurements.

Comparisons were made with measurements of Razorbills caught at Latrabjärg, western Iceland by RTB, of museum specimens from Store Karlsö in the Baltic Sea listed by Salomonsen (1944) and of British, Irish, Danish and Icelandic birds listed by Jones (1990). To correct for post-mortem shrinkage, Salomonsen's measurements of wing length, culmen length and gonys depth of the Store Karlsö birds were increased by 2.0 mm, 0.5 mm and 1.0 mm, respectively (Harris 1980, Jones 1988a). When searching for patterns in body size, the mean wing lengths and gonys depths were correlated with an index of the geographical position of each colony (latitude+longitude measured to the nearest tenth of a degree) and mean surface sea temperatures in May-July (Baltic data from the Danish and Swedish Meteorological Institutes, Iceland data from Steffánsson 1969, the remainder from Levitus 1982). Statistics were carried out using Minitab (Release 10.2).

TABLE 1

Mass and measurement (mean ± SD) of Razorbills from Hornøya in relation to numbers of bill grooves

	No. of bill grooves				
	0	**1**	**2**	**3**	***F* (ANOVA)**
Sample size	4–6	25–27	98–104	16–19	
Mass (g)	662.5±23.2	719.0±44.6	741.5±55.9	746.2±60.5	5.12*
Wing (mm)	210.7±5.2	211.3±5.6	213.1±5.9	212.5±7.5	0.86
Culmen (mm)	34.4±1.2	34.1±2.0	34.5±1.9	34.5±1.3	0.28
Gonys (mm)	2.1±2.3	23.1±1.0	23.4±1.1	23.0±1.0	8.68*
Head+bill (mm)	93.5±2.1	95.9±2.8	96.2±2.8	96.2±2.3	1.3

* = $P < 0.01$

RESULTS

There was evidence (ANOVA tests) of an age-related variation in the measurements of Razorbills, with immatures; (with no bill grooves) being lighter and having a smaller gonys than older birds (with one or more grooves) (Table 1). All subsequent analyses thus excluded birds with no bill grooves.

ANOVA tests also showed clear and significant differences in measurements of Razorbills in the five Norwegian and one Russian colonies with a general decrease in size along the coast from north-east to south-west (Table 2). That the decrease in size continues farther south-westwards is evident when mean wing-length or bill-depth (gonys) measurements are correlated with the position of the colonies for which data for these two parameters exist (Fig. 2). The correlations were very significant ($P < 0.001$) and the sum of the geographical coordinates explained 85% and 66% of the variation in the two measurements, respectively. Two conspicuous outliers along this apparent cline are the two Baltic colonies (Graesholmen (col. 11) and Store Karlsö (col. 12)). This is evident in Figure 2a where their wing lengths approach those of North Norwegian birds. It is even more evident in Figure 2b where their bill measurements are similar to those of Razorbills from North Norway and the Kola Peninsula. Furthermore, the mean culmen length of the Store Karlsö birds (34.6±1.1 mm, n = 17) was similar to those of Loppa, Hornøya and Seven Islands birds (t-test, t = 0.7–0.8, $P > 0.47$) and larger than those of Runde, Røst and Bleiksøya birds (t = 2.8–6.0, $P < 0.01$).

The correlations of wing length and gonys depth against mean May–July sea-surface temperatures at each colony were lower than above (r^2 = 0.58, $P < 0.001$ and 0.32, $P = 0.067$, respectively). However, the two Baltic colonies were again clear outsiders (Fig. 3) and when removed, the correlation coefficients increased both numerically and in significance (0.76 and 0.84, respectively, $P < 0.001$).

DISCUSSION

Jones (1990) suggested that there was a certain amount of homogeneity in the measurements of *islandica* Razorbills in Britain, Ireland and Iceland and that there was a possible cline among the *pica* birds of Norway and Russia. The little data we add from the Iceland colony at Latrabjärg (col.1, Fig. 2) can well be interpreted as support for the first suggestion whereas our data from Norway and Russia fill the gaps noted by Jones and confirm the notion of a cline in the northern population (but see next paragraph). The cline is, however, far from perfect as seen in e.g. the inconsistency of the Bleiksøya (col. 14) measurements which are much smaller than those from the more southerly colony, Røst (col. 13) and similar to those from Runde (col. 10). The shortest wings on Bleiksøya (185 mm) even approach the shortest ones measured among the *islandica* part of the population (Fig. 4). This, of course, may be a result of inter-observer differences in measuring techniques (Barren *et al.* 1989) or age-related differences. The Razorbills on Røst were measured in 1980–1983, a period when auks (Atlantic Puffins *Fratercula arctica* especially, but also Common Guillemots and Razorbills) were suffering from breeding and recruitment failures (Røv *et al.* 1984) such that those measured may have been old birds. It is possible that the relatively high means of body measurements relative to those from Bleiksøya where recruitment was better (Barrett *et al.* 1987) are an artefact of older birds being larger than young ones. This has been

TABLE 2

Mass and mean measurements (Mean ± SD) of Razorbills from one Russian and five Norwegian colonies. – = no data. $P < 0.001$ in all cases

Colony	**Runde 62°25'N, 05°38'E**	**Røst 67°26'N, 11°52'E**	**Bleiksøya 69°17'N, 15°52'E**	**Loppa 70°22'N, 21°25'E**	**Hornøya 70°23'N, 31°09'E**	**Seven Islands 68°49'N, 37°20'E**	***F* (ANOVA)**
Sample size	21	41	57–58	7	139–178	17	
Mass (g)	641.7±61.0	–	649.2±69.0	–	738.0±55.0	718.5±76.2	32.3
Wing (mm)	201.8±6.2	208.6±5.8	202.6±9.1	214.1±3.7	212.7±6.1	211.9±6.8	25.5
Culmen (mm)	32.5±1.1	33.6±1.7	32.6±1.9	34.2±1.3	34.4±1.8	35.0±1.8	12.3
Gonys (mm)	21.1±1.0	22.2±1.4	21.9±1.2	23.6±0.9	23.3±l.2	23.9±1.2	27.5
Head+bill (mm)	92.4±2.5	95.3±2.6	92.3±3.3	96.6±2.0	96.1±2.7	98.0±3.7	21.5

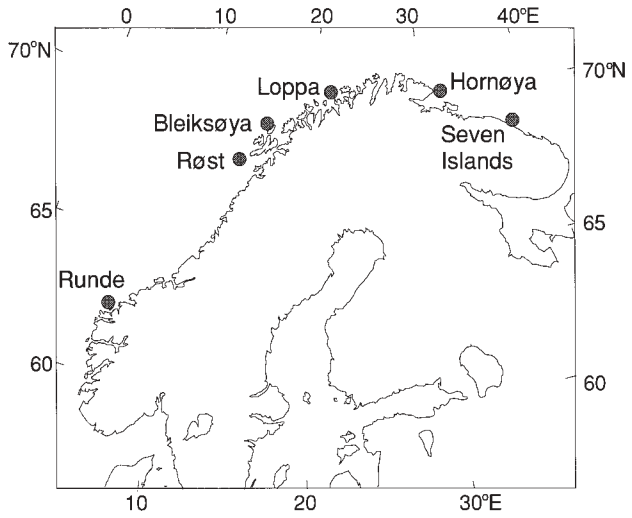

Fig. 1. *Distribution of Norwegian and Russian colonies on which Razorbills were measured for this study.*

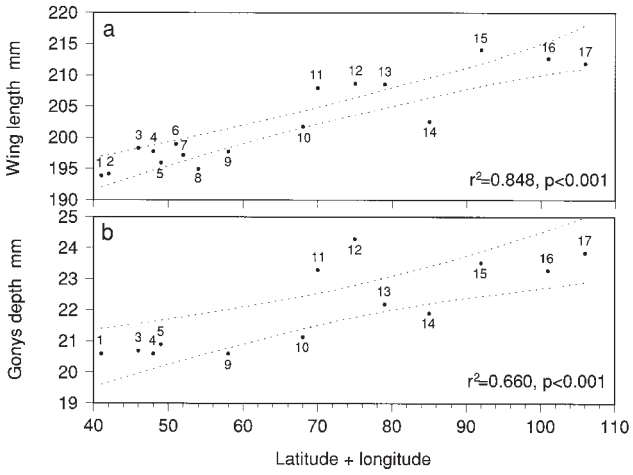

Fig. 2. *Plots of wing length and gonys depth of European Razorbills in relation to position of colony (longitude & latitude index). 95% confidence limits of the regression lines are shown. Data from Salomonsen (1944), Jones (1990) and this study.* ***1*** *Latrabjärg,* ***2*** *Kerry,* ***3*** *Great Saltee,* ***4*** *Bardsey,* ***5*** *Grimsey,* ***6*** *Canna,* ***7*** *Shiants,* ***8*** *Isle of May,* ***9*** *Foula,* ***10*** *Runde,* ***11*** *Graesholmen,* ***12*** *Store Karlsö,* ***13*** *Røst,* ***14*** *Bleiksøya,* ***15*** *Loppa,* ***16*** *Hornoya,* ***17*** *Seven Islands.*

found among Herring Gulls *Larus argentatus* by Coulson *et al.* (1981) and also discussed for Razorbills by Jones (1991). Although he concluded that 'older birds are not necessarily longer-winged than younger ones', birds with W+2 bill grooves did have significantly longer wings than did those with W+1 grooves. On the other hand, Atlantic Puffins measured on Bleiksøya were also smaller than those measured by the same person (RTB) on nearby islands (Anda and Sør-Fugløy, Barrett *et al*. 1985) at a time when recruitment rates were similar on all three colonies (Barrett *et al.* 1987) which, in their case, rules out possible age-structure differences. Similar phenotypic variation among auks within a limited geographical area has also been demonstrated for Brünnich's Guillemots *Uria lomvia* by Gaston *et al.* (1984) who speculated that it was due to differences in founder gene pools and restricted gene flow between colonies.

Although Jones (1990) suggests that British and Icelandic Razorbills are non-clinal *islandica* birds, there is such considerable overlap between our measurements and those presented by Jones from Britain and Iceland (Fig. 4) that any separation of the *islandica*, *torda* and *pica* groups is, in our opinion, virtually impossible. Furthermore, the high and very significant correlations between the geographical coordinates and the wing and gonys measurements support the suggestion that the cline is continuous from the most south-westerly colonies to the northeastern edge of the Razorbill's distribution. Similar clines have been demonstrated for Common Guillemots and Atlantic Puffins in the same geographical region (Barrett *et al.* 1985, Jones 1988b). The only possible exception to the Razorbill cline are the Baltic birds which appear to be much larger than would be expected from their geographical position or from surrounding sea temperatures (Figs 2 & 3).

The cline demonstrated here complicates the determination of the origins of individuals found in mortality incidents. For example, this study shows that the degree of wing length

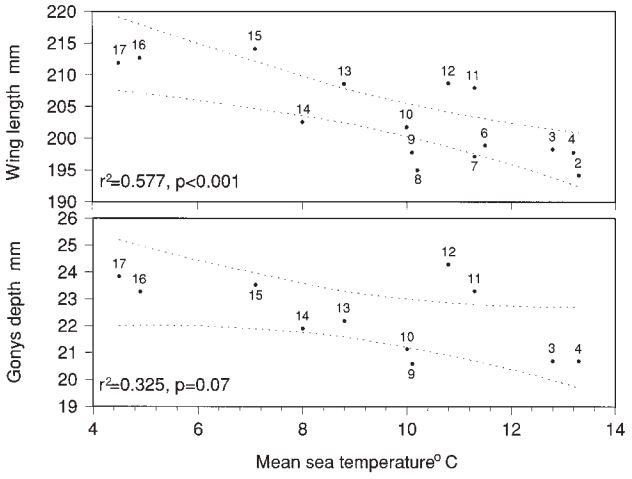

Fig. 3. *Plots of wing length and gonys depth from European Razorbills in relation to mean sea surface temperature in May-July. 95% confidence limits of the regression lines are shown. Data from Salomonsen (1944), Jones (1990) and this study. Colony numbers as in Fig. 2.*

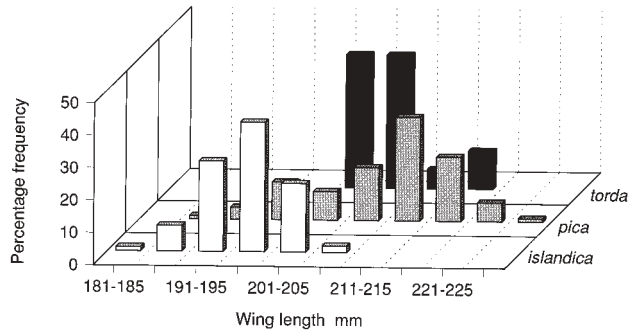

Fig. 4. *Percentage frequency distribution of wing length data from Store Karlsö (=*torda*, from Salmonson 1944, n = 17), Norway and Russia (=*pica*, from this study, n = 294) and Britain and Iceland (=*islandica*, from Jones 1990, n = 338).*

overlap between *islandica*, *pica* and *torda* (185–206 mm, Fig. 4) is much greater than that described by Anker-NiIssen *et al.* (1988) and Jones (1990). Although we agree with Jones' (1990) suggestion of a wing length cut-off point at 208 mm, above which birds could be described as 'northern' or 'large' Scandinavian *pica* or *torda*, we do point out that 34% of the wings we measured in Norway and Russia were less than 208 mm long. As a result, a large proportion of genuine 'northern' (Norwegian and Russian) birds found in an incident would, using Jones' definition, be misidentified.

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