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T. H. MANNING

RR 1, Merrickville, Ontario, Canada

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ABSTRACT

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Statistical comparison of the color of the underparts of 474 Nearctic and 64 western and central Palearctic sexed specimens of Long-tailed Jaegers indicates that *S. l. pallescens* Løppenthin is a valid race ranging across the Nearctic and eastern Siberia to the Indigirka River. Spitsbergen specimens are also referable to this race; Iceland specimens belong to *S. l. longicaudus*. Females are significantly darker than males. The origin and migration of the two races are discussed. Bills and wings of Nearctic males are shorter than those of females, and there are significant geographical differences within the Nearctic population. Regression and correlation statistics for wing and bill lengths are given and discussed. Thirty-two weighed specimens indicate that within populations weight is correlated with wing length but not with bill length.

GEOGRAPHICAL AND SEXUAL VARIATION
IN THE LONG-TAILED JAEGER,
STERCORARIUS LONGICAUDUS VIEILLOT

Color

Until 1932 the Long-tailed Jaeger was generally considered a monotypic species. In that year Løppenthin (1932) described a race, *Stercorarius longicaudus pallescens*, from northeast Greenland, characterized by its pale underparts. Eleven years later, with additional material, Løppenthin (1943) published a new study using 120 specimens. He concluded that *S. l. longicaudus* bred in the old world from Norway to the Lena, and *S. l. pallescens* in Greenland, northern Canada, Alaska, and eastern Siberia west to the Indigirka River. A single specimen from Spitsbergen, where the Long-tailed Jaeger probably does not nest regularly, was typical of the pale form. Migrants from Iceland and the Faroe Islands were, however, clearly referable to *S. l. longicaudus*. A similar breeding distribution is given in Dementiev et al. (1951).

Salomonsen (1950-1951), like Dementiev (Dementiev et al., 1951), recognized *S. l. pallescens*, and Shortt (1951) agreed with him on the basis of material in the Royal Ontario Museum. More recently, Johansen (1958) remarks that the species can clearly be divided into an Atlantic and a Pacific race. However, the division was not accepted by Witherby et al. (1948) nor by the American Ornithologists' Union (1957). In an earlier paper (Manning et al., 1956) it was pointed out that, although when taken at face value Løppenthin's figures justified recognition of two forms, the Nearctic material in the National Museum of Canada indicated that females averaged darker than the males, and if there had been a high proportion of the latter in Løppenthin's Palearctic series, the comparison might have been biased. In 1957 Dr. Løppenthin kindly sent me a list of dates and sexes of the series used in his original description. Of those sexed, there were in the Greenland series 19 males and 13 females, and in the Palearctic series, nine males and 12 females. Clearly the difference in proportion is no greater than might be expected in a small random series.

In the present study, specimens were divided into seven grades by matching them with the excellent plate of color types in Løppenthin (1943). Grade 1 corresponded to his A, and 7 to his D, 2, 4, 6 being intermediate between A-B, B-C, and C-D respectively. A more precise result could

have been obtained by direct comparison with seven or, preferably, more color types; or, better still, by assembling the whole series and dividing it into seven or more groups; but as the comparisons had to be made in a large number of different museums, visited mainly for other reasons, neither of these methods was practicable. That the method used is reasonably accurate is shown by 19 Nearctic and 18 Palearctic specimens which were graded by Løppenthin in 1931 for his original study and again by me without any reference to his list. In no case did the two rankings differ by more than one grade. In the Palearctic series the six differences between the two rankings cancelled out; in the Nearctic, I graded three specimens higher and two lower than Løppenthin had. There is also good agreement between the mean Nearctic and Palearctic color grades given below (p. 5) and those obtained from Løppenthin's figures. A greater difference is evident between the present grading and that previously done by me on National Museum material (Manning et al., 1956, Table XXXII).

Figure 1. Bar diagram of color grades of *Stercorarius longicaudus* specimens. White and black bars represent respectively male and female Nearctic specimens; striped and stippled bars, males and females for combined western and central Palearctic. The frequencies at the left are percentages of the total number in each of the four categories; these totals are: Nearctic male 265, female 209; Palearctic male 33, female 31.

The positive skewness of the Nearctic series is thought to result from a slightly larger gap between A - B than between B - C and C - D in Løppenthin's figure. An extra grade between A - B would have simplified the grading and eliminated the skewness. It would also probably have slightly increased the joint non-overlap.

This, at least in part, is due to omission or lower grading of soiled specimens after a few had been cleaned and found to be considerably paler than I had expected. (See Figure 1.)

For the main color comparison between the Nearctic population and the western Palearctic population, 265 males and 209 females were available from the Alaskan mainland, northern Canada, and northwestern and eastern Greenland, and 33 males and 31 females from Scandinavia and the U.S.S.R. east to the Taymyr Peninsula.

The Nearctic population was broken down into areas as shown in Figure 2, and the appropriate analysis of variance (Snedecor, 1950:289) used to test the significance of interaction and of differences due to locality and sex. There was no significant interaction or difference due to locality.

Figure 2. Map of the Nearctic region. The size (area) of the dots which mark the origin of specimens of *Stercorarius longicaudus pallescens* is proportional to the number of specimens from the area. Sixteen Alaska mainland specimens were from the southwestern area not included on the map, and the exact provenance of 13 other Alaskan specimens could not be determined. The circles enclose and distinguish the samples from the nine populations but are not intended as population boundaries. The solid bar gives the mean wing length, and the striped bar the mean bill length for each sample in standard measure plus one to avoid minus quantities.

However, the females were darker than the males, and the unbiased mean difference of .42 was highly significant ($F = 18.2$, $d.f. 448:1$, $P < .001$). As some intergradation might be expected in northeast Greenland, and as specimens from there did, in fact, average slightly darker (Table 1), it

Table 1. *Numbers, means, sums, and sums of squares (unadjusted for mean) for color grades of Stercorarius longicaudus by localities and sexes.*

Locality	N	♂ ♂			N	♀ ♀		
		$\bar{x}$	SX	SX ²		$\bar{x}$	SX	SX ²
1. Hudson Bay	31	2.42	75	207	19	3.16	60	208
2. Alaska mainland	93	2.53	235	687	78	2.89	225	737
3. Prince Patrick & Melville Is.	23	2.30	53	135	15	3.47	52	210
4. Western Arctic	21	2.29	48	132	14	2.50	35	95
5. Adelaide Pen.	10	2.90	29	95	8	3.25	26	90
6. Prince of Wales I.	11	2.55	28	84	7	2.57	18	54
7. Baffin I., Melville Pen.	15	2.33	35	97	14	2.50	35	101
8. Ellesmere & Devon Is., NW Greenland	14	2.43	34	92	19	2.68	51	155
9. NE Greenland	42	2.69	113	351	32	3.03	97	341
10. Spitsbergen	2	3.50	7	29	3	3.00	9	29
11. Western Palearctic	22	4.82	106	546	19	5.11	97	513
12. Central Palearctic	11	4.73	52	258	12	5.67	68	390
13. Iceland	3	5.00	15	75	6	5.83	35	207

Localities 1 - 9 are shown on the map, Figure 2.

The variance in the Nearctic female sample is higher than that in the male, but this is reversed in the Palearctic series. Neither difference is significant, nor is the difference between the variances of the Nearctic and Palearctic series. The variance for individuals within the Nearctic and Palearctic populations and sexes is 1.08, standard deviation, $1.04 \pm .034$.

seemed proper to see if there was a significant difference between the northeast Greenland sample and that for the combined Canadian and northwest Greenland series including five males and three females from scattered localities in northern Canada not listed in Table 1. The difference was not significant, and there seemed to be no other reason against pooling the whole Nearctic series.

The 64 Palearctic specimens from the Taymyr Peninsula westward were arbitrarily divided into a western Palearctic series of 41 Scandinavian specimens and a central Palearctic series of 23 Russian specimens. Analysis showed that there was no significant difference between these series. The sex difference, .52, was slightly greater than that in the Nearctic series,

but not quite significant in this comparatively small sample ($F = 3.9$, *d.f.* 62:1, $P > .05$).

The mean color grades for the Nearctic series were: ♂♂ 2.49, ♀♀ 2.91; for the Palearctic: ♂♂ 4.79, ♀♀ 5.32. The unbiased mean difference between the two population series was 2.35, and between the two sex series .43. The significance of these differences was measured by $F = 283$, *d.f.* 534:1, $P < .001$ for population, and $F = 23$, $P < .001$ for sexes. Interaction was negligible.

The coefficient of difference (Mayr et al., 1953), calculated from the mean population difference given above, and from the pooled sums of squares of individuals, was 1.12. This is equivalent to a joint non-overlap of 87%. Actually, the variance due to sex adds little to total variance, and, as the sexes are roughly proportional in the two series, the joint non-overlap would be changed by less than 1% if sexual difference had been ignored. Løppenthin's treatment is therefore justified.

The difference between the migrant Iceland series (Table 1) and the combined Nearctic series is highly significant ($P < .001$). Moreover, the rather uniform Iceland series shows no indication of intergradation or mixture with the east Greenland population in spite of the proximity of the two areas. Seven migrants from the Faroe Islands and one from the Orkney Islands were graded 4 to 7 (mean, 5.5), and, as might be expected, are referable to the Palearctic population. A female taken in Denmark Strait, 25 July 1933, is also dark (grade 7). On the other hand, two males and three females from Spitsbergen, where the species may nest occasionally, had a mean grade of 3.2, which does not differ significantly from that of the Nearctic series but does differ significantly from the Palearctic ($F = 13.8$, *d.f.* 65:1, $P < .001$). Probably all five specimens (grades 2 to 5) belonged to the Nearctic population (Cf. Løppenthin, 1943: 10).

Specimens from west Greenland south of Melville Bay, southeast Greenland, and the Labrador coast, all places outside the normal breeding range of the Long-tailed Jaeger (Salomonsen, 1950-1951; Austin, 1932), appear to be representatives of the Nearctic population. Thus the six males, three females, and five unsexed specimens from west Greenland were graded 2 to 6 (mean, 3.1); the single unsexed specimen from southeast Greenland (Angmagssalik) was graded 2, and three males from the Labrador coast taken between 30 August and 4 September, were graded 1, 2, 2. Three male wanderers or migrants in the Museum of Comparative Zoology, taken between 21 and 26 September on the Newfoundland Banks, are also pale (grades 1, 2, 3).

Four males and four females and one unsexed specimen from northeast Siberia (Anadyr River, Nizhne Kolymsk, Cape Serdtse Kamen, and Wrangel Island) east of the Indigirka River, average pale (grades 2 to 5, mean 2.7). A single male from the New Siberian Islands, where intergradation is said to occur (Dementiev et al., 1951:410), was graded 4. No specimens from the Aleutian Islands have been seen, but eight males and seven females from St. Lawrence Island, the Pribilof Islands, and the Commander Islands graded from 1 to 5, mean 2.9. Three specimens in the United States National Museum from Hokkaido, Japan, taken on 30 May, were graded 1, 2, 4, but a fourth, taken 28 May, was graded 7. A single specimen in the British Museum from Amur Land in southeast Siberia was graded 7.

From the foregoing it is clear that the species, *Stercorarius longicaudus*, is divisible on the degree of pigmentation of the underparts into two populations which, for this character, are uniform over most of their ranges. Intergradation occurs where the two forms meet on the north Siberian coast, but there is little or no evidence of intergradation on their Atlantic boundary although Palearctic migrants appear to be fairly numerous within 300 miles of the eastern limit of the Nearctic breeding area. Under such circumstances, an 87% separation of a large sample taken over the major portion of the breeding range of both forms appears ample justification for subspecific recognition.

We therefore have *S. l. longicaudus* Vieillot breeding from Norway east probably to the Lena River, and *S. l. pallescens* Løppenthin breeding from northeast Greenland across the Nearctic and westward in Siberia to the Indigirka River. On the Atlantic side, *S. l. longicaudus* regularly migrates through Iceland, but the normal wanderer, and perhaps occasional breeder, in Spitsbergen appears to be *S. l. pallescens*.

The present distribution of *S. l. longicaudus* and *S. l. pallescens* makes it reasonable to suppose that they evolved respectively in the Atlantic and Pacific areas during the Pleistocene epoch. The populations were probably separated during the Wisconsin glaciation, when the rapidly advancing ice sheets overran the tundra, reducing the area suitable for the nesting of jaegers and perhaps even eliminating it in eastern North America. If this hypothesis is correct, *S. l. pallescens* must have spread eastward from Beringia to occupy the tundra uncovered by the retreating ice, whereas *S. l. longicaudus* failed to colonize the more slowly exposed land in eastern North America. Løppenthin (in litt.) believed that the northeast Greenland birds still migrated west across the ice cap, and certainly they have been seen long distances inland (Salomonsen, 1950-1951:284). However, the

occurrence of pale Long-tailed Jaegers in Labrador and over the Newfoundland Banks suggests that some Nearctic birds now migrate southward over the Atlantic. More specimens in migration and from their wintering grounds are badly needed.

On geographical grounds it is unlikely that *S. l. longicaudus* regularly migrates to the Pacific, yet of the very few specimens seen from the Asiatic coast two (one from Japan, one from Amur Land) are exceptionally dark (grade 7). Possibly they were strays, a suggestion supported by the apparent scarcity of the species along this and other coasts in winter or during migration.

Wing and Bill Measurements

The "flattened" wing lengths were obtained by straightening and bending the primaries outward with the left hand to obtain a maximum measurement (Manning et al., 1956:4). This measurement was taken with calipers to the nearest millimeter. The result is very similar to that found by flattening the wing along a ruler, but the method here used is considered easier, particularly on specimens whose wings are fastened tightly to the body.

No really satisfactory bill measurement could be found. In jaegers, the exposed culmen measurement varies greatly according to the set and wear of the feathers, and it seems probable that there might be a seasonal bias. The external nares, which form a convenient proximal point for bill measurements in some birds, are, in jaegers, so close to the tip that only about a third of the bill could be measured. The measurement finally adopted was the distance between the tip of the bill and a point on the lateral feathering half way between the lower edge and the dorsal surface of the upper mandible. This is often the point where a slight groove in the mandible reaches the lateral feathering. It is certainly not an ideal measurement as the lateral feathering slopes steeply, and any error in judging the mid-point has a marked effect. However, there should be little or no seasonal bias. Bills were measured to the nearest .1 mm with dial calipers.

All measurements, both wing and bill, were taken on the left side unless that side was damaged. They were repeated once. A discrepancy of more than 3 mm in wing, and more than .3 mm in bill length was re-checked.

The wing and bill measurements of the Nearctic series (Table 2) were analyzed in the same manner as those for color to test for differences among localities and between sexes. There was no significant interaction between sex and locality for either measurement, but the females had

Table 2. Numbers, means, sums, sums of squares, and sums of products (adjusted for mean) for wing and bill by localities and sexes for *Stercorarius longicaudus*.

Locality	"Flattened" wing						Bill						Wing $\times$ bill					
	N	$\bar{x}$	SX	Sx ²	N	$\bar{x}$	SX	Sx ²	N	$\bar{x}$	SX	Sx ²	$\bar{\delta}$	$\bar{\delta}$	Sxy			
1.	13	308.2	1406	470	13	314.2	1485	1524	13	25.66	73.6	7.35	13	25.55	72.1	4.67	31.2	38.2
2.	80	306.1	8485	4375	68	312.1	7620	3708	80	25.61	448.6	64.56	68	25.87	399.3	59.52	76.8	71.4
3.	22	305.3	2316	870	14	311.1	1556	506	22	25.48	120.5	15.76	14	25.83	81.6	12.15	16.3	25.3
4.	17	309.1	1855	880	12	309.3	1311	564	17	25.23	88.9	16.28	12	25.46	65.5	10.11	4.1	—3.9
5.	10	305.9	1059	501	8	311.8	894	397	10	25.04	50.4	2.82	8	25.49	43.9	2.45	—7.7	—0.4
6.	10	301.9	1019	237	7	314.7	803	745	10	25.25	52.5	8.90	7	25.24	36.7	1.48	19.1	—2.0
7.	14	307.1	1500	1282	13	309.0	1417	480	14	24.88	68.3	8.90	13	25.43	70.6	17.47	14.8	—6.0
8.	12	305.4	1265	343	20	304.8	2095	1150	12	24.72	56.7	18.90	20	25.26	105.2	22.31	50.6	41.7
9.	39	301.6	3962	2199	29	305.4	3056	1509	39	24.71	183.8	47.84	29	24.53	131.5	33.29	33.4	77.8
10.	22	306.7	2347	737	16	309.5	1752	700	22	25.20	114.5	11.21	16	25.23	83.7	16.33		
11.	11	306.3	1169	1224	12	308.7	1304	929	11	25.85	64.3	8.69	12	25.37	64.4	22.27		

The sums given are the result of coding the wing measurements by subtracting 200 mm and the bill measurements by subtracting 20 mm. The areas corresponding to the locality numbers are listed in Table 1. (See also Fig. 2.)

significantly longer wings and bills. The unbiased difference between males and females was 4.69 mm ($F = 38.0$, *d.f.* 383:1, $P < .001$) for wings, and .205 mm ($F = 4.5$, *d.f.* 383:1, $.05 > P < .01$) for bills. There were also significant differences among the populations shown in Figure 2. (Wings, $F = 4.9$, *d.f.* 383:8, $P < .001$; bills, $F = 8.7$, *d.f.* 383:8, $P < .001$).

Duncan's multiple range test (Duncan, 1951) was used to determine the significance of the difference between individual populations. The results given in Table 3 indicate fair uniformity over the central area of the map

Table 3. Means of males and females combined after the female measurements had been reduced to the equivalent male values (*Stercorarius longicaudus*).

Wing Locality	Mean±SE	Bill Locality	Mean±SE
1.	308.8±1.54	2.	25.64±.090
4.	307.2±1.45	3.	25.53±.163
2.	305.7±0.72	1.	25.50±.193
5. •	306.4±1.82	4.	25.24±.181
7.	305.8±1.51	6.	25.16±.235
3.	305.7±1.30	5.	25.15±.229
6.	305.2±1.87	7.	25.04±.189
8.	302.1±1.42	8.	24.93±.179
9.	301.2±0.98	9.	24.55±.123

The vertical lines embrace those samples which are shown by Duncan's multiple range test not to differ at the 5% level. The means are in order of decreasing size of wing and bill respectively. If they had been in order of decreasing size of these two characters combined after reduction to standard measure, the population numbers would have been consecutive (see Fig. 2).

(Fig. 2), or at least that the available samples are insufficient to demonstrate differences. Nevertheless, there is a distinct indication, particularly in the bill measurements, of a south-north, and perhaps of a west-east, cline of decreasing size. This is shown on the map, where the populations are numbered (the same numbering is used in all tables) according to the decreasing size of the value obtained when the means, reduced to standard measure, of wing and bill are combined. All differences in the order of wing and bill means occur among those samples which do not differ significantly.

Differences between the two geographical series or between the two sex series of Palearctic specimens were not significant at the 5% level

for either wing or bill measurements, but it is not unreasonable to suppose that in a larger series the sex differences would be similar to those indicated for the Nearctic population. As the means for the Palearctic series (Tables 2, 3) fall among those of the Nearctic series, comparisons between the two are of little interest.

The variance for wing length of males with locality effect removed was 53.64 mm. This gives a standard deviation of $7.32 \pm .36$. For females, the variance was 60.47, and the standard deviation, $7.78 \pm .42$. The corresponding figures for bill length were: $\delta \delta$ $s^2 = .920$, $s = .959 \pm .047$; $\phi \phi$ $s^2 = .934$, $s = .966 \pm .053$. In neither case is the difference between the variances of the sexes significant, although it may be supposed that the larger variance of the females is associated with their greater mean size. This is indicated by the similarity of the coefficients of variation. These, derived from the means of the whole male and whole female samples with locality differences disregarded, were: wing $\delta \delta$ 2.40, $\phi \phi$ 2.51; bill $\delta \delta$ 3.80, $\phi \phi$ 3.79. The variance of the whole Nearctic population within localities and sexes was 56.8 for wings and .926 for bills, giving standard deviations of $7.54 \pm .27$ and $.962 \pm .035$.

Correlation and Regression

The 401 Nearctic specimens, on which both bill and wing measurements were taken, offered a good opportunity to examine the correlation and regression of two external bird measurements, a subject which appears to have been neglected. Keeping males and females separate, it was found that for neither sex was there significant difference among the regression coefficients of the nine localities. The mean regression and correlation coefficients are:

Males: $b(\text{bill on wing}) = .021 \pm .009$; $(\text{wing on bill}) = 1.20 \pm .52$, $r = .158$, $s = .159 \pm .070$
 Females: $b(\text{ " " " }) = .023 \pm .009$; $(\text{ " " " }) = 1.48 \pm .60$, $r = .184$, $s = .186 \pm .076$

The positions of the regression lines, or, in other words, the adjusted means, differ significantly (Fig. 3).

Males: bill on wing: $F = 3.63$, $d.f. 207:8$, $P < .001$; wing on bill: $F = 2.10$, $P < .05$
 Females: " " " : $F = 3.98$, $d.f. 174:8$, $P < .001$; " " " : $F = 2.71$, $P < .01$

However, it is clear from Figure 3 that the regressions given above are too low for adjustment of the independent variate means to be worth while: the size order of these means would not be changed appreciably.

The above figures show that correlation between wing and bill length within populations is weak. However, if the nine locality samples are com-

bin into a single pair of male and female samples and the correlations recalculated, r for males becomes $.20 \pm .07$, and for females, $.29 \pm .07$. The increase is apparently associated with the greater correlation between sample means. These are $.61 \pm .38$ for males and $.97 \pm .38$ for females. (See Fig. 3 for regressions.)

Figure 3. Regressions of bill on wing (solid lines), and wing on bill (dashes), of *Stercorarius longicaudus*. Circles and squares indicate respectively the means of the samples of males and females from the nine Nearctic localities. The triangles represent the means of combined male and female samples after the latter have been adjusted by subtraction of the unbiased mean difference between the sexes. M and F give the position of the means for the Palearctic samples of males and females respectively.

The short lines represent the respective male and female regressions for individuals within the nine locality samples. The two pairs of long lines are the regressions of male (left) and female (right) sample means. They intersect at the means of the nine locality sample means for males and females respectively. The degree of correlation between the measurements is shown by the angle at which the regression lines intersect.

Weights

In the preceding section it has been shown that correlation between wing and bill lengths within populations was weak. This indicates that one, or perhaps both, of these measurements is a poor indicator of body size. Owing to variations in fatness, in gonad size, and in stomach contents, weight also is not an entirely satisfactory measure of size although it is difficult to think of anything better (Cf. Amadon, 1943). The two largest series are composed of specimens (10 ♂♂, 8 ♀♀) taken on Adelaide Peninsula in 1957 (Macpherson and Manning, 1959) and of those (8 ♂♂, 6 ♀♀) taken on Prince of Wales Island in 1958 (Manning and Macpherson, 1961). With one exception, these specimens were graded in the field from 1 to 6 according to their estimated fatness. Neglecting this grading, the correlation between weight and wing length within populations and sexes is: $r = .46$ ($s = .50 \pm .20$). Omitting the single ungraded specimen, it was found that a rather low fat grade—weight correlation ($r = .46$) and an unexpectedly high, presumably chance, fat grade—wing correlation ($r = .30$) combined to give a partial correlation for weight and wing length of .36, which is not quite significant in this small sample. If differences of sex, population, and fatness are neglected, the total correlation becomes: $r = .59$ ($s = .68 \pm .19$). This, although significant at the 1% level, is still not very high, and is frequently surpassed in measurements on mammalian skulls. Rand (1961) gives means of wing length and weight for a number of bird species but no actual correlation coefficients. He concludes that in some closely related populations wing length may be a fairly delicate indicator of weight. However, correlation based on means is very different from correlation in individuals, and may well be higher, as is shown above to be the case with wings and bills in this species. The correlation between weight and bill length within populations and sexes was .03, which is clearly not significant.

It may be objected that the relationship between weight and length is not likely to be linear. However, over the range of measurements normally met in adult birds, the curvature introduced by failure to convert to the correct power, perhaps 2 for wing length and 3 for bill length, is fortunately of little importance.

The mean weights for the Adelaide Peninsula series were: 10 ♂♂ 296.8 g, 8 ♀♀ 338.6 g; and for the Prince of Wales Island series, 8 ♂♂ 317.5 g, 6 ♀♀ 385.0 g. The unbiased difference between the means for the two places is 31.9 g and between the means for the sexes, 53.0 g. Both these differences are highly significant. However, the series from

Prince of Wales Island evidently averaged fatter than that from Adelaide Peninsula, perhaps because few jaegers were breeding on Prince of Wales Island in 1958, whereas the reverse was true for Adelaide Peninsula in 1957. The mean fat grades were: Adelaide Peninsula, ♂♂ 3.4, ♀♀ 3.1; Prince of Wales Island, ♂♂ 5.2, ♀♀ 5.3. When the regression for within sexes and localities, 13.9 per grade, is used to adjust the weights to a standard fat grade 4, they become: Adelaide Peninsula, ♂♂ 295.1 g, ♀♀ (seven only) 346.2 g, and Prince of Wales Island, ♂♂ 300.8 g, ♀♀ 366.9 g. The Prince of Wales Island specimens still averaged heavier, but the difference is probably no longer significant, and until more weights are available it does not seem worthwhile to carry the analysis further or attempt to draw conclusions.

Specimens, Tables, and Acknowledgments

Except for a few specimens which may have been missed inadvertently, all sexed specimens in suitable condition in the following museums at the dates indicated were color-graded and measured. The figures in standard type refer to *S. l. pallescens*; those in bold type to *S. l. longicaudus*. Until November, 1959: British Museum, 31 + **21**; University of Copenhagen Museum of Zoology, 59 + **30**; University of Oslo Museum of Zoology, 3 + **5**. Until February, 1960: National Museum of Canada, 95. Until July, 1960: California Academy of Sciences, 6; Chicago Natural History Museum, 17 + **1**; Colorado Museum of Natural History, 10; University of British Columbia Museum of Zoology, 4; University of California Museum of Zoology, 43; University of Michigan Museum of Zoology, 23. Until November, 1960: Academy of Natural Sciences of Philadelphia, 4; American Museum of Natural History, 50 + **13**; Carnegie Museum (color grades only), 37; Museum of Comparative Zoology, 28 + **5**; Royal Ontario Museum of Zoology, 32 + **7**; United States National Museum, 77 + **2**.

The tables give sums and sums of squares rather than standard error and standard deviation, as the latter seemed unnecessary for present comparison and the former will facilitate future work with additional material.

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Summary

Comparison of 474 Nearctic and 64 western and central Palearctic specimens of known sex shows that 87% are separable on the degree of pigmentation of the underparts, the character originally used by Løppenthin to separate the Nearctic form, *S. l. pallescens*. Iceland migrants match the western Palearctic material. Specimens from Spitsbergen and eastern Siberia match the Nearctic. There is no reliable evidence of intergradation on the Atlantic boundary. Recognition of the race, *S. l. pallescens*, is recommended.

The underparts of females are significantly darker than those of males of the same race, but the difference is small in comparison to the difference between races.

It is suggested that the two forms were isolated and became differentiated in the Atlantic and Pacific during the Wisconsin glacial advance.

The bills and wings of the Nearctic males are significantly shorter than those of females. There is also a significant difference among the samples from nine localities in the Nearctic. The northern, and particularly the northeastern groups, tend to have shorter wings and bills than those from farther south. The mean of the central and western Palearctic series falls within that of the Nearctic series.

Regression and correlation statistics for wing and bill measurements of the Nearctic samples are given and discussed. The correlation within populations for these two measurements is low ($r = .159 \pm .070$ for males and $.186 \pm .076$ for females).

The two largest available series of weighed specimens are from Adelaide Peninsula and Prince of Wales Island. The correlation between wing and weight within these populations and sexes is: $r = .50 \pm .20$. When the effect of weight is eliminated, the resulting partial regression is not significant in the small series available. Also the correlation between bill length and weight is not significant.

LITERATURE CITED

- Amadon, Dean. 1943. Bird weights and egg weights. *Auk*, 60:221-234.
- American Ornithologists' Union. 1957. Check-list of North American birds. 5th. ed. American Ornithologists' Union, Baltimore. xiii + 691 pp.
- Austin, Oliver Luther, Jr. 1932. The birds of Newfoundland Labrador. Mem. Nuttall Ornith. Club. No. 7. Cambridge, Mass. 229 pp.
- Dementiev, G. P., N. A. Gladkov, and E. P. Spangenberg. 1951. [Birds of the Soviet Union]. In Russian. Moscow. Vol. 3. 680 pp.
- Duncan, D. B. 1951. A significance test for differences between ranked treatments in an analysis of variance. *Virginia J. Sci.*, 2:171-189.
- Johansen, Hans. 1958. Revision und Entstehung der arktischen Vogelfauna. II. Revision der Grues—Passeres und Entstehung der arktischen Vogelfauna. *Acta Arctica*, Fasc. IX. 132 pp.
- Løppenthin, Bernt. 1932. Die Vögel Nordostgrönlands zwischen 73° 00' und 75° 30' N. Br. *Medd. om Grøn.*, 91 (6). 127 pp.
- . 1943. Systematic and biologic notes on the Long-tailed Skua *Stercorarius longicaudus* Vieill. *Medd. om Grøn.*, 131 (12). 26 pp.
- Macpherson, A. H., and T. H. Manning. 1959. The birds and mammals of Adelaide Peninsula, N.W.T. *Nat. Mus. Canada Bull.* 161. iii + 63 pp.
- Manning, T. H., and A. H. Macpherson. 1961. A biological investigation of Prince of Wales Island, N.W.T. *Trans. Roy. Canad. Inst.*, 33:116-239. (Publ. 1962)
- Manning, T. H., E. O. Höhn, and A. H. Macpherson. 1956. The birds of Banks Island. *Nat. Mus. Canada Bull.* 143. iv + 144 pp.
- Mayr, Ernst, E. Gordon Linsley, and Robert L. Usinger. 1953. *Methods and principles of systematic zoology*. N. Y. vii + 328 pp.
- Rand, A. L. 1961. Wing length as an indicator of weight: a contribution. *Bird-banding*, 32:71-79.
- Salomonsen, Finn. 1950-1. *Birds of Greenland*. Color plates by Gitz Johanssen. Copenhagen. 3 vols. 604 pp.

- Shortt, T. M. 1951. [Review of] Grønlands fugle: The birds of Greenland, Arctic, 4:218-219.
- Snedecor, George W. 1950. Statistical methods. 4th. ed. Ames, Iowa. xviii + 485 pp.
- Witherby, H. F., F. C. R. Jourdain, Norman F. Ticehurst, and Bernard W. Tucker. 1948. The handbook of British birds. London, Vol. 5, xii + 381 pp.

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