MIGRATION AND MORPHOMETRICS OF EUROPEAN KNOT AND TURNSTONE ON ELLESMERE ISLAND, CANADA

By R. I. G. Morrison

INTRODUCTION

It was not until 1953 that Godfrey pointed out that the Knots (*Calidris c. canutus*) and Turnstones (*Arenaria i. interpres*) (nomenclature followed is that of B. O. U., 1971) breeding in the Canadian high arctic on Ellesmere Island could be referred on taxonomic grounds to the nominate races wintering in the Old World (Godfrey, 1953). Subsequent work has supported this conclusion (Parmelee and MacDonald, 1960; Nettleship, 1967a). However, banding records confirming movements between Ellesmere Island and Europe have been very few to date, involving a single Knot (Leach, 1962) and three Turnstones (Spencer, 1957; Parmelee and MacDonald, 1960; Nettleship, 1967b). The present paper reports eight further records involving movements of these species between Europe and Ellesmere Island, and draws attention to two other recent recoveries on Baffin Island (B. T. O., 1972). The yearly cycle and migration patterns are discussed in the light of the banding records and weight levels recorded at Alert and during migration in Iceland. Measurements of birds banded at Alert and of specimens from Eureka are presented to assist in defining racial criteria.

METHODS

Banding

Banding operations using mist nets were carried out on the garbage dump near the Weather Station at Alert, Ellesmere Island (82°30′N, 62°20′W) during the period 6-13 June 1974. Shorebirds were trapped on migration in Iceland using cannon nets during the period 4 April–4 October 1972.

Specimens

A sample of 18 Turnstones and 6 Knots was returned to the Canadian Wildlife Service for examination from a large number of these species found dead near the Weather Station at Eureka, Ellesmere Island (80°00′N, 85°56′W), during a period of bad weather in the middle of June 1974.

Measurements

Wing measurements were taken with a metal ruler and represent the maximum chord of the stretched and flattened wing. Bill measurements were made with calipers from the tip to the beginning of the feathers on the upper mandible. Birds were weighed using a 300 g Pesola spring balance. Tarsus and tail measurements were made with calipers as illustrated by Godfrey (1966).

Plumage

Sexual dimorphism of Knot plumage is generally not reliable enough to distinguish the sexes (Nettleship, 1967a), but Turnstones could be sexed in many cases using plumage characteristics described by Nettleship (1967a).

RESULTS

Banding

Banding operations at Alert resulted in the capture of 23 Knots and 35 Turnstones, including two Knots with European bands. The first carried both a Norwegian and a British band and had been marked originally as a first-year bird on autumn passage in southwest Norway on 30 August 1971. It was subsequently captured on the east coast of Britain on 30 July 1972 as a molting bird which had spent its first summer in Britain before being trapped on the breeding grounds at Alert in its third year. The second bird

TABLE 1.

Banding records of Knots and Turnstones

A. On Ellesmere Island, N.W.T., Canada, 1973–74

1.[a] *Knot:* Revtangen, Norway 7120133/Brit. Mus. CC88506
Banded: 1st year; 30 August 1971; Revtangen, Klepp, Co. Rogaland, Norway (58°45′N, 05°30′E)
Controlled: 30 July 1972 (molting); North Wootton, Norfolk, England (52°49′N, 00°26′E)
Controlled: 8 June 1974; Alert, Ellesmere Island, N.W.T., Canada[b] U.S. 762-30113 added

2. *Knot:* Brit. Mus. CC83548
Banded: Adult; 19 February 1971; Snettisham, Norfolk, England (52°51′N, 00°27′E)
Controlled: 7 June 1974; Alert, Ellesmere Island, N.W.T., Canada; U.S. 762-30102 added

3. *Knot:* U.S. 762-30120
Banded: Ad; 8 June 1974; Alert, Ellesmere Island, N.W.T., Canada
Controlled: 18 August 1974; Friskney, Lincs., England (53°05′N, 00°15′E) (molting)

4. *Knot:* Brit. Mus CX27808
Banded: juvenile; 6 September 1963; Dawsmere, Lincs., England (52°53′N, 00°09′E)
Found dead: ca 23 June 1974; Eureka, Ellesmere Island, N.W.T., Canada[b]

5. *Knot:* Arnhem, Holland K388037
Banded: full-grown; 6 January 1973; Wieringen, Noord Holland, Nederland (ca. 52°54′N, 04°59′E).
Found dead: ca. 23 June 1974; Eureka, Ellesmere Island, N.W.T., Canada

6. *Knot:* Reykjavik, Iceland 723193
Banded: Adult; 2 May 1972; Hlidsnes, Bessastadahr., Gull., Iceland (64°05′N, 22°02′W)
Found dead: ca 23 June 1974; Eureka, Ellesmere Island, N.W.T., Canada

7. *Knot:* Brit. Mus. CK68040
   Banded: Adult; 27 August 1968; North Wootton, Norfolk, England (52°49′N, 00°26′E)
   Band found in Gyrfalcon pellet: August 1973, Eureka, Ellesmere Island, N.W.T., Canada
8. *Turnstone:* Brit. Mus CE03166
   Banded: Adult; 14 October 1973; Fifeness, Fife, Scotland (56°17′N, 02°36′W)
   Found dead: ca. 23 June 1974; Eureka, Ellesmere Island, N.W.T., Canada

B. Previous banding records of Knot and Turnstone between Europe and arctic Canada

9. *Knot:* U.S.A. 502-75260
   Banded: pullus; 9 July 1955; Eureka, Ellesmere Island, N.W.T., Canada
   Controlled: 22 August 1961; St. Kilda, Outer Hebrides, Scotland; 57°49′N, 08°34′W (Leach, 1962)
10. *Knot:* British Museum
    Banded: post-juvenile; 14 February 1971; Southerness, Solway, U.K.
    Killed: 11 June 1972; Broughton Island, Baffin Island, Canada. (B.T.O. 1972)
11. *Knot:* British Museum - CC84316
    Banded: adult; 19 March 1972; Snettisham, Norfolk, England (52°51′N, 00°27′E)
    Killed: 9 June 1972; Broughton Island, Baffin Island, Canada. (B.T.O. 1972)
12. *Turnstone:* Brit. Mus. T3533
    Banded: 13 January 1951; Wembury, Plymouth, Devon, England (50°19′N, 04°04′W)
    Shot: 14 June 1955 near Slidre Fjord, Ellesmere Island, N.W.T., Canada (ca. 80°00′N, 86°00′W). (Spencer, 1957, Parmelee and MacDonald, 1960)
13. *Turnstone:* K.225.015 Holland
    Banded: 10 September 1964; Vlieland, Holland (53°16′N, 04°59′E)
    Shot: 27 June 1966; Lake Hazen, Ellesmere Island, N.W.T., Canada (81°49′N, 71°18′W) (Nettleship, 1967b)
14. *Turnstone:* U.S.A. 502-75249
    Banded: pullus; 5 July 1955; Fosheim Peninsula, Ellesmere Island N.W.T., Canada
    Shot: 11 September 1955. Cavado River, Portugal. (Parmelee and MacDonald, 1960).

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[a]Numbers refer to records shown in Figures 1 and 2. A "control" is a banded bird caught again at a point more than 5 km from its original banding site and subsequently released.

[b]Alert, Ellesmere Island, N.W.T. 82°30′N, 62°20′W.
Eureka, Ellesmere Island, N.W.T. 80°00′N, 85°56′W.

had been banded as an adult while wintering on the east coast of Britain on 19 February 1971.

One Knot banded at Alert was subsequently captured during its postnuptial molt on the east coast of Britain on 18 August 1974.

Four more birds, three knots and one Turnstone, carrying European bands were found dead near the Weather Station at Eureka. The Turnstone was banded on the east coast of Scotland as an adult on 14 October 1973. The Knots were banded in Britain, Holland, and Iceland. The British bird was captured during its first autumn on 6 September 1963, and was thus 11 years old when recovered on the breeding grounds at Alert. The bird from Holland had been banded as an adult on the wintering grounds on 6 January 1973. The Icelandic bird was banded as an early spring migrant in southwest Iceland on 2 May 1972.

In addition, a British Knot band was found in the pellet of a Gyrfalcon (*Falco rusticolus*), collected by R. D. Muir of the Canadian Wildlife Service in the southern Fosheim Peninsula in August 1973, by Dr. W. Earl Godfrey, National Museum of Natural Sciences, Ottawa. It had been banded as an adult on the east coast of Britain on 27 August 1968.

Figures 1 and 2 summarize all known movements of Knots and Turnstones, respectively, between arctic Canada and Europe: details of banding records are presented in Table 1.

Measurements and Postmigration Weights

Measurements of Knots and Turnstones banded at Alert and of specimens returned from Eureka are presented in Tables 2 and 3,

TABLE 2.

Measurements of Knots and Turnstones banded at Alert, June 1974

Sex[a]	n	Mean	Range	SD
KNOT				
Wing (mm)				
mixed	23	172.2	165-179	4.15
Bill (mm)				
mixed	23	32.0	30-35	1.47
Weight (g)				
mixed	23	135.4	111-158	13.01
TURNSTONE				
Wing (mm)				
mixed	35	156.9	151-165	3.40
♂	16	155.5	152-161	2.78
♀	7	159.0	154-165	3.56
Bill (mm)				
mixed	35	21.9	20.0-24.2	1.17
♂	16	21.7	20.0-24.0	1.21
♀	7	22.5	21.1-24.2	1.21
Weight (g)				
mixed	35	113.1	87-149	13.01
♂	16	110.3	97-149	11.95
♀	7	120.3	99-141	13.59

[a]Samples sexed on the basis of plumage only. See text.

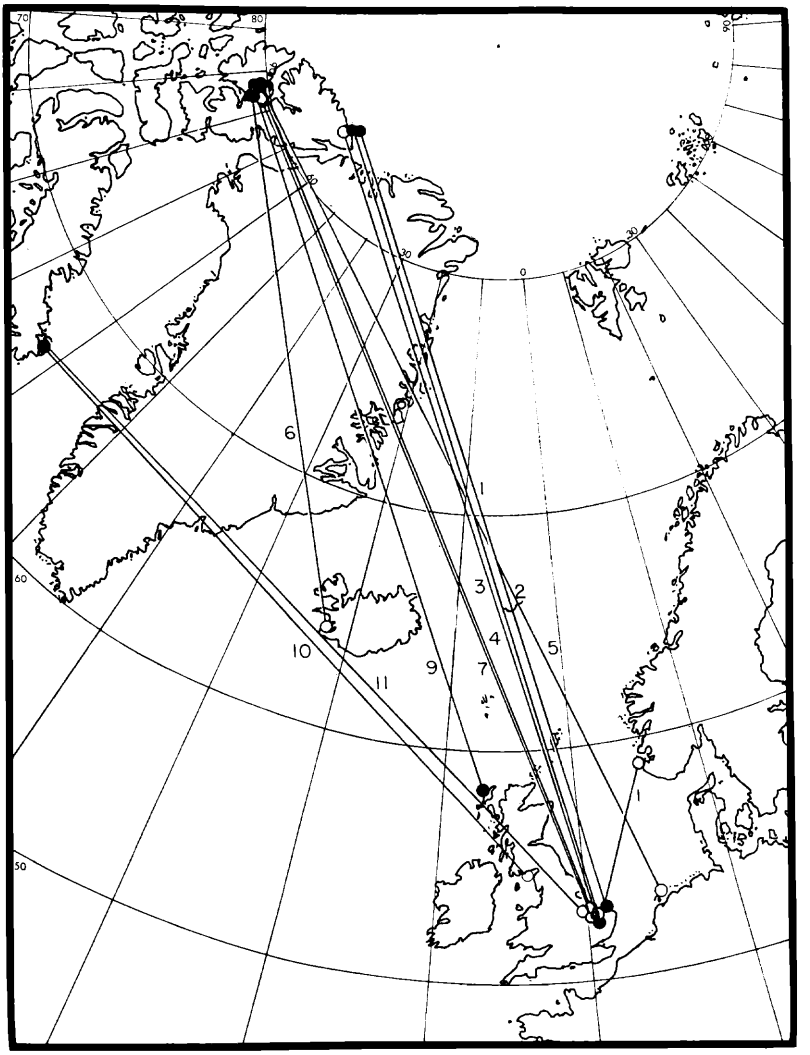

FIGURE 1. Summary of banding records of Knots between arctic Canada and Europe. Details of recent records are given in Table 1. The lines joining places of banding (○) and controlling or recovery (●) are not intended to represent migration routes: numbers refer to those in Table 1, in which details of banding records are given.

respectively. Measurements of birds on migration in Iceland are shown in Table 4 for comparison. Wing and bill measurements of Knots and Turnstones from Alert were similar to those collected in Iceland. With the Knot, means from Alert were somewhat less, although the differences did not generally reach statistical sig-

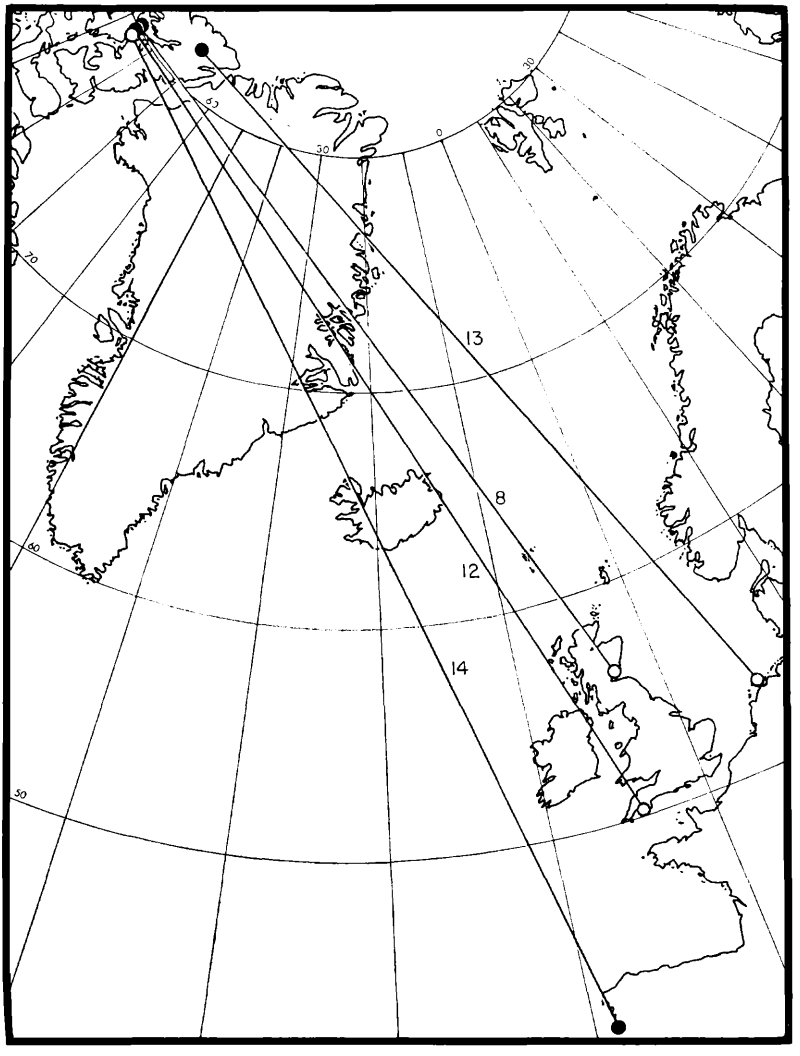

FIGURE 2. Summary of banding records of Turnstones between arctic Canada and Europe: see Table 1. The lines joining places of banding (○) and recovery (●) are not intended to represent migration routes; numbers refer to Table 1, in which details of banding records are given.

nificance. The possibility that a clinal difference in size may exist through the breeding range is given some support by the large variances of measurements collected in Iceland when compared with the smaller samples from Ellesmere (Tables 2, 3, 4 and unpubl. data) since migrants captured in Iceland might include birds from various parts of this range. With the Turnstone,

means of wing and bill were again similar to and smaller than those of birds trapped in Iceland, and bill lengths were generally statistically significantly different (t test, 5% level). Again, the possibility of a cline in size through the breeding range in Greenland and the high arctic in Canada was suggested. Bill measurements from Alert and Eureka were similar to those of both species reported by Parmelee and MacDonald (1960) and Nettleship (1967a). Differences in measuring techniques made comparison of wing lengths inappropriate.

The mean arrival weights of Knots and Turnstones at Alert (135.4g and 113.1g, respectively) were similar to those reported by Parmelee and MacDonald (1960) for a series of birds collected

TABLE 3.

Measurements of Knot and Turnstone specimens from Eureka, Ellesmere Island, June 1974

Sex	n	Mean	Range	SD
KNOT				
Wing (mm)				
mixed	6	170.0	166-174	2.68
Bill (mm)				
mixed	4	32.2	30.0-33.8	1.62
Tarsus (mm)				
mixed	6	34.5	32.4-37.6	1.98
Tail (mm)				
mixed	6	67.8	64.2-73.0	3.53
TURNSTONE[a]				
Wing (mm)				
mixed	18	155.9	150-165	4.00
♂	8	154.1	150-158	2.75
♀	9	157.9	153-165	4.23
Bill (mm)				
mixed	17	20.9	19.3-23.5	1.05
♂	8	20.8	19.3-23.5	1.33
♀	8	21.1	19.5-22.1	0.83
Weight (g)				
mixed	12	59.4	48-70	1.61
♂	8	57.3	48-64	4.98
♀	4	63.8	61-70	4.27
Tarsus (mm)				
mixed	18	26.2	24.7-28.3	0.91
♂	8	25.8	24.7-26.9	0.76
♀	9	26.6	25.4-28.3	0.91
Tail (mm)				
mixed	18	65.4	61.5-68.1	2.02
♂	8	65.0	61.5-67.6	2.46
♀	9	65.8	62.8-68.1	1.70

[a]Specimens sexed on the basis of plumage and by autopsy.

through the summer on the Fosheim Peninsula (134.7g for 13♂ and 9♀ and 113.1g for 9♂ and 9♀, respectively). One Knot collected at Alert in 1974, weighing 107g, was found still retaining some fat reserves around the neck and abdominal regions. These data indicate that Knots, and probably Turnstones, arrive on the breeding grounds with adequate fat reserves enabling them to survive if spring conditions make feeding difficult. Knots are able to regain weight after arrival as shown by one bird retrapped at Alert; it had increased 13g, from 111g to 124g, between 8 and 10 June 1974.

However, where a late thaw or bad weather makes feeding difficult or impossible, birds may have much lower weights and

TABLE 4.
Measurements of Knots and Turnstones from Iceland, 1972

Date	n	Mean wing length	SD	Mean bill length	SD	Mean weight	SD
KNOT							
2 May 1972	156	173.9	14.67	32.3	3.19	136.1	15.29
26 May 1972	33	174.5	31.08	31.7	5.86	198.4	37.37
21 July 1972	275	173.7	11.44	33.1	2.78	136.0	12.72
10 August 1972	254	172.7	11.91	32.8	2.70	133.9	14.28
TURNSTONE							
3 May 1972	33	157.2	4.17	22.9	0.98	117.4	9.09
23 May 1972	44	158.3	3.58	21.5	1.06	158.0	15.28
9 August 1972	24	156.7	4.34	22.3	1.04	115.5	12.87

starvation may occur. Examination of the birds that died at Eureka during bad weather in June 1974 indicated that starvation had been the cause of death. Turnstone specimens were extremely emaciated, weighing on average only ca. 60g (Table 3). Nettleship (1967a and pers. comm.) found Knots and Turnstones weighing as little as 90.6g and 71.1g, respectively, at Hazen Camp (81°49′N, 71°18′W) in early June 1966.

Plumage

Plumage of all birds handled both at Alert and from Eureka corresponded with those of the Old World races of Knots and Turnstones respectively. Sexes assigned to 12 specimens of Turnstones from Eureka on the basis of plumage characteristics described by Nettleship (1967a) were in all cases confirmed by autopsy; measurements of these sexed individuals are shown in Table 3. These results show that plumage characteristics are often a reliable indicator of sex in *A. i. interpres* in breeding plumage. However, whereas it may always be possible to identify the sex of both members of a pair seen together on their breeding territory, identification of every member of a series of birds in the field

is not usually possible due to intermediate types. Of 35 birds handled at Alert, 23 (66%) were assigned a sex on the basis of plumage, but the sample will be biased towards the extremes of plumage type. Measurements of these birds are included in Table 2.

DISCUSSION

The present records provide dramatic confirmation of the European wintering areas used by Knots breeding in the Canadian high arctic, and are the first banding records for the species between Canada and Holland, Iceland and Norway, respectively.

The banding and mensural data illustrate a number of features of the yearly cycle and migratory movements of the Old World Knot. The northern European seaboard is the principal wintering area for the species, with over one-half of the population wintering in Britain and Ireland (Spitz, 1969; Prater, 1972, 1974). Wintering records of birds from Ellesmere Island have come so far from localities around the North Sea, including the important areas of the Wash on the east coast of Britain and the Dutch Waddensee (Table 1). It is not known to what extent Knots from the Canadian high arctic may visit the west coast of Britain.

The postnuptial molt takes place after autumn migration, as illustrated by the bird banded at Alert and subsequently caught during its molt in Britain (Table 1). Immature birds summering south of the breeding grounds may also utilize these areas as molting grounds, as shown by the bird banded in Norway in its first autumn and captured during its first summer molting on the east coast of Britain (Table 1 and see Minton, 1975). Extensive banding results in Iceland have confirmed that Knots usually do not migrate north to the breeding grounds before their second year (Morrison, 1971, and unpubl. data).

The recovery at Eureka of the Knot banded as an early spring migrant in Iceland provides the first proof that Canadian birds may use this route on spring migration.

Consideration of weight changes during migration indicate that Iceland is an essential stopover point for Knots migrating from Europe to breeding grounds in the Canadian high arctic. On the wintering grounds in Britain, autumn and spring weights average ca. 135-140g, rising and falling through a midwinter peak of 155-160 g (Minton, 1972, 1975). Knots pass through the west coast of Britain between late March and early May, with average weights reaching ca. 175-200g by the end of that period (Prater and Wilson, 1972). In Iceland, the average arrival weight of Knots at the beginning of May was ca. 135g, and weights rose steadily through the main arrivals of birds to 200-210g late in May (Table 4; Morrison, 1971, and unpubl. data). At Alert, arrival weights again averaged 135g, indicating that the birds had lost nearly all the weight gained during the stopover in Iceland, i.e. up to ca. 70g or 50% of their postmigration weight.

A similar pattern of weight change during spring migration was shown by Turnstones. In Britain, autumn and spring weights

averaged ca. 110g, with a midwinter peak of ca. 125g (Minton, 1972, 1975). In Iceland, arrival weights in late April and early May averaged 115-125g, this average rising steadily to ca. 160g by 21 May onwards (Table 4; Morrison, 1971, and unpubl. data). At Alert, the average arrival weight in the period 6-12 June was 113g, again indicating that the birds lost all the weight gained during their stopover in Iceland.

Thus, most of the weight put on before departure from European wintering grounds is lost on the flight to Iceland and the birds then require a stopover of several weeks to replenish fat reserves before the next segment of the journey. At this time of the year, in early to mid-May, feeding conditions are good in Iceland (personal observation) but would be impossible in areas farther north where thaw has not begun. The second part of the migration is timed so that the breeding season itself coincides with a peak of food abundance when the young are being raised (Nettleship, 1973, 1974). Feeding conditions for the adults may be difficult after arrival and starvation may occur under particularly bad weather conditions. Nettleship (1967a, 1973, 1974) showed that plant material forms an important part of the diet of both Knots and Turnstones in early June before insects become available. Plant items are uncommon in the diet of other shorebirds studied in Alaska (Holmes, 1966, 1970, 1972; Holmes and Pitelka, 1968).

Details of the migration route between Iceland and arctic Canada are unknown. Recoveries of Knots banded on the east coast of England have included 27 along the west and northwest coasts of Greenland (Minton, 1972), and a bird banded in Iceland, in the same catch as that of the bird found dead at Eureka, was recovered on Disko Bay, Greenland, in June 1972. These data suggest that Knots may enter Canada over a broad front across Greenland, and this idea is supported by the recovery in Britain of two other Knots banded farther south in the Canadian arctic (Fig. 1). The first was banded on the east coast on 19 March 1972, the second on the west coast on 14 February 1971, both birds being recovered on Broughton Island on the east coast of Baffin Island, on 9 and 11 June 1972, respectively (B. T. O., 1972).

However, possibly some Knots migrate to and from Ellesmere Island via the northern parts of Greenland. This suggestion is supported by Nettleship's (1974) description of the main influx of Knots passing along Lake Hazen in a southwesterly direction on 5 June 1966, and the description by Savile and Oliver (1964) of more than 75 birds departing from Lake Hazen in a northeasterly direction on 5 August 1962.

SUMMARY

Eight new banding records between the Canadian high arctic and Europe are reported for Knots and Turnstones. These include the first records for Knots between Canada and Holland, Iceland and Norway, respectively. Measurements and postmigration weights of birds banded at Alert and found dead at Eureka,

Ellesmere Island, are reported. Banding and mensural data are used to discuss the yearly cycle and likely migration pattern of the Knot. Reference to data collected in Iceland indicates that Iceland is an essential stopover point for many shorebirds on spring migration between European wintering grounds and breeding grounds in arctic Canada.

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LITERATURE CITED

B. O. U. 1971. The status of birds in Britain and Ireland, ed. by D. W. Snow. 333p. Oxford, London, and Edinburgh, Blackwell Sci. Publications.

B. T. O. 1972. Recent Recoveries. *B. T. O. Wader Study Group Bull.*, **7:** 2-4.

GODFREY, W. E. 1953. Notes on Ellesmere Island Birds. *Can. Field -Nat.*, **67:** 89-93.

——— 1966. The birds of Canada. *Nat. Mus. Canada Bull.*, 203: 428p.

HOLMES, R. T. 1966. Feeding ecology of the Red-backed Sandpiper (*Calidris alpina*) in arctic Alaska. *Ecol.*, **47:** 32-45.

——— 1970. Differences in population density, territoriality, and food supply of Dunlin on arctic and subarctic tundra. *In* Animal Populations in Relation to their Food Resources, A. Watson (ed.) 303-317. Oxford and Edinburgh, Blackwell Sci. Publications.

——— 1972. Ecological factors influencing the breeding season schedule of Western Sandpipers (Calidris mauri) in subarctic Alaska. *Amer. Midl. Nat.*, **87:** 472-491.

HOLMES, R. T., AND F. A. PITELKA. 1968. Food overlap among coexisting sandpipers on northern Alaskan tundra. *Syst. Zool.*, **17:** 305-318.

LEACH, E. P. 1962. Recoveries in Great Britain and Ireland of birds ringed abroad. *British Birds*, **55:** 544-556.

MINTON, C. D. T. 1972. Wash Wader Ringing Group, report 1971/2. 48 p. Mimeo. Shenstone, Staffs, U. K.

——— 1975. Waders of the Wash-ringing and biometric studies. 21 p. Mimeo. Wash Wader Ringing Group. Shenstone, Staffs., U. K.

MORRISON, R. I. G. 1971. Cambridge Iceland Expedition 1971. Expedition Report, 85 p. Cambridge, England.

NETTLESHIP, D. N. 1967a. Breeding biology of Ruddy Turnstones and Knots at Hazen Camp, Ellesmere Island, N.W.T. M. S. Thesis, University of Saskatchewan.

——— 1967b. Banded turnstone recovered at Lake Hazen, Ellesmere Island, N.W.T. *Bird Banding*, **38:** 236.

——— 1973. Breeding ecology of Turnstones *Arenaria interpres* at Hazen Camp, Ellesmere Island, N.W.T. *Ibis*, **115:** 202-217.

——— 1974. The breeding of the Knot *Calidris canutus* at Hazen Camp, Ellesmere Island, N.W.T. *Polarforschung*, **44**: 8-26.

PARMELEE, D. F., AND S. D. MACDONALD. 1960. The birds of West-central Ellesmere Island and adjacent areas. *Nat. Mus. Canada Bull.*, **169**: 1-103.

PRATER, A. J. 1973. Birds of estuaries enquiry. Report 1971/72. 32 p. B. T. O./ R. S. P. B./ W. T.

——— 1974. Population and movements of Knot in Britain (Abstract). *Ibis*, **116**: 412.

PRATER, A. J., AND J. WILSON. 1972. Aspects of spring migration of Knot in Morecambe Bay. *B.T.O. Wader Study Group Bull.*, **5**: 9-11.

SAVILE, D. B. O., AND D. R. OLIVER. 1964. Bird and mammal observations at Hazen Camp, Northern Ellesmere Island, 1962. *Can. Field-Nat.*, **78**: 1-7.

SPENCER, R. 1957. Report on Bird Ringing for 1955. *British Birds*, **50**: 37-72.

SPITZ, F. 1969. Present extent of knowledge of the number of waders wintering in Europe, the Mediterranean Basin and North Africa. *I.W.R.B. Bull.*, **27/28**: 12-14.

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