

Breeding schedule and primary moult in Dunlins *Calidris alpina* of the Far East

Pavel S. Tomkovich

Tomkovich, P.S. 1998. Breeding schedule and primary moult in Dunlins *Calidris alpina* of the Far East. *Wader Study Group Bull.* 85: 29-34

On Chukotka, the breeding grounds of the subspecies *sakhalina*, the primary moult of Dunlin *Calidris alpina* starts in mid-June, at the beginning of the incubation period, and birds migrate southward from the beginning of August, when the moult is almost complete. On Kamchatka (*kistchinski*) and Sakhalin (*actites*), where breeding takes place earlier, primary moult starts in July, in the chick rearing period, or even later. These differences between northern and southern populations are similar to those found previously in Alaska (Holmes 1971). The timing of these events is not strictly related to latitude; it is thought that, with local variations, latitudinal differences in dates of breeding and primary moult are brought about through subspecific characteristics. Knowledge of subspecific breeding schedules and primary moult periods can be used together with biometrics to assign Far Eastern Dunlins to different populations in the post-breeding period.

P. S. Tomkovich, Zoological Museum, Moscow Lomonosov State University, Bolshaya Nikitskaya Street 6, Moscow 103009, Russia.

INTRODUCTION

Two new subspecies of Dunlin from the Far East, *Calidris alpina kistchinski* (Tomkovich 1986) and *C.a. actites* (Nechaev & Tomkovich 1987, 1988), were described recently, in addition to the well-recognised *C.a. sakhalina*, which breeds on Chukotka. *Calidris a. kistchinski* inhabits Kamchatka Peninsula, the eastern part of the northern coast of the Sea of Okhotsk and the northernmost islands of the Kuriles (henceforth referred to as Kamchatka Dunlin for brevity); the distribution of *C.a. actites* is restricted to coastal areas of northern Sakhalin Island (Lappo & Tomkovich, in press). The validity of these taxonomic innovations is confirmed by the studies of Browning (1991).

There is much published work in Europe and North America concerning Dunlins, but little is known about the biology, moult, and migration of birds in the Far East. Only a few papers deal specifically with Dunlins in this region (Norton 1971; Gromadzka 1985; Stiefel & Scheufler 1989; Tomkovich 1994; Kim *et al.* 1994). Apart from these, data on breeding dates and biology of the species are scattered through Russian faunistic publications (the most important are: Portenko 1972; Kondratyev 1982; Lobkhov 1986; Kistchinski 1988; Nechaev 1991). Phenology and numbers of migrating Dunlins in the Far East are also considered to some extent in faunistic publications. However, the data are difficult to interpret as there have been various attempts to assign migrants to populations (subspecies) and, in any case, subspecific differences in migration schedule, migration routes and even wintering grounds are to be expected. The main characteristics of migration are linked with breeding and the moult schedule of birds' flight feathers. Knowledge of the two latter features can be helpful in distinguishing populations, and thus may lead to further understanding of Dunlin migration along the East Asian-Australasian Flyway. Data on breeding dates and primary moult schedule in several Dunlin populations of the

Far East are compared in this study.

STUDY AREAS AND METHODS

The main data were collected during expeditions in 1978-1980 to the vicinity of Uelen (66°04'N, 17°042'W), and in 1986-1988 to Belyaka Spit, Kolyuchinskaya Gulf (67°05'N, 17°442'W), both on the northern coast of Chukotsky Peninsula and, in 1989, to the area of the Moroshechnaya River estuary, central West Kamchatka (54°30'N, 15°630'E). In addition, information was obtained from the literature and from personal communications on the breeding dates of Dunlins in different areas, especially the north of Sakhalin (52°-53°). The collection of the Zoological Museum of Moscow University (ZMMU) was an additional source of data; skins collected recently from Sakhalin were of particular interest.

Descriptions of the three main study areas are given in regional faunistic papers (Tomkovich & Sorokin 1983, Kretchmar *et al.* 1978 and Gerasimov *et al.* 1992 respectively). However, it is important to realise that Chukotka is an arctic area covered primarily by tundra, while Kamchatka and Sakhalin belong to the temperate zone, where open, usually marshy or boggy tundra-like landscape predominates on coastal plains due to the cooling effect of the sea. It should also be mentioned that the study areas at the Chukchi Sea coast have a severe arctic sea climate and deep snow, especially on the flat Belyaka Spit, which is surrounded by icy sea. So, delayed breeding of Dunlins can be expected there compared with inland areas of Chukotka.

Breeding dates were obtained for Dunlins from 1) nests found with still incomplete clutches, 2) records of hatching in known nests, and 3) retrospective calculation for broods of small chicks. Three more cases were added when egg-laying females were collected on Chukotka. The following characteristics



were used in calculations: the interval between laying of successive eggs, incubation period (between laying and hatching of the last egg in a clutch), and duration of hatching period (from the first signs of hatching - 'starring' - to the hatching of the last chick). Dunlins usually lay eggs daily (Holmes 1966a; Kondratyev 1982; pers. obs.). An incubation period of 21 days has been taken, because in five nests at northern Chukotka it varied from 20.5 to 21.2 days, with an average of 20.8 ± 0.28 (s.d.) days. At Barrow, North Alaska, Dunlins incubate for 21-22 days (Holmes 1966a). The duration of hatching was 2-4 days, with 3 days being most usual (Kondratyev 1982; pers. obs.). Chick age was calculated from personal, unpublished data on the development of marked chicks with known hatching dates.

Moult of primary feathers was studied in Dunlins caught for ringing on their nests, near broods or in feeding areas on the banks of water bodies and in collected birds. A detailed description of moult state of each primary feather was recorded and this was used later for calculation of primary moult score according to Ginn and Melville (1983). In total 115, 104 and 23 moult score values are available for Uelen, Belyaka and Moroshechnaya respectively. Every effort was made to eliminate data relating to migrants from non-local populations which might have been present among birds caught in feeding areas or collected during the second half of the summer. In particular, only those Dunlins at Kamchatka which were caught as breeders or shot while showing breeding behaviour were considered. At Sakhalin, only Dunlins within the size range typical for *actites* (Nechaev & Tomkovich 1987) were considered, to exclude migrants and possible over-summering birds from other populations.

As the small size of Sakhalin Dunlins is diagnostic and biometrics for only a few males of the subspecies *actites* have been published, it is useful to update the biometric data on the basis of currently available museum specimens. Mean bill length of males is 29.0 mm (s.d. ± 0.99 , $n=12$, range 26.8-31.2), of females 34.0 mm (s.d. ± 0.40 , $n=3$, range 33.5-34.2), wing length of males 108.5 mm (s.d. ± 2.03 , $n=12$, range 105.5-111.5), of females 112.3 (s.d. ± 0.99 , $n=12$, range 111-113).

Analysis of variance (ANOVA) was chosen as the principal approach to study the dependence of moult score on the sex and origin of birds. To allow for the influence of calendar date, it was included in the model as a covariate. The moult score, though not continuous, was normally distributed and justified the use of parametric statistical methods. All analyses were carried out using SYSTAT 5.0 (Wilkinson 1990).

RESULTS

Breeding schedule

Hatching dates are usually the most abundant data that can be obtained in studies of the breeding schedules of northern waders and are used in Figure 1 to illustrate this in Dunlins in four areas of the Far East. It can be seen that the latest and the

most prolonged period of hatching in a population (27 days) was recorded at the northernmost site, Belyaka Spit, while the shortest period (7 days) was found in the southernmost breeding area, Sakhalin. It could be thought that, in the latter case, this results from too small sample size; however, data obtained by three different observers in different years agree closely on hatching dates at Sakhalin. Hatching date records from the second half of July on Chukotka probably belong to replacement clutches, as was shown for Alaska (Holmes 1966a, 1971), but there is no good evidence for this. The absence of a large hatching peak and delayed median hatching date on Belyaka Spit (Figure 1) are undoubtedly due to a local effect of the levelled area with gradual and late snow melting (see above); several wader species had anomalous laying dates there (Whitfield & Tomkovich 1996).

The following calculated ranges of dates of clutch completion correspond to the hatching dates shown in Figure 1: 9 June to 5 July on Belyaka Spit, 7 to 27 June near Uelen, 30 May to 12 June in Moroshechnaya and 3 to 9 June on north Sakhalin.

The median hatching date on Sakhalin is later than that for west-central Kamchatka ($U=11$, $p<0.05$, Mann-Whitney U test) in spite of the more southerly position of the former site. This

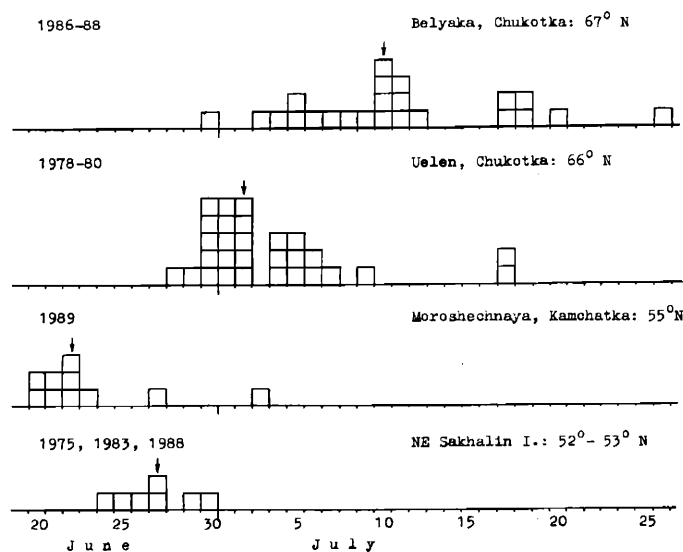


Figure 1. Hatching dates in nests of Dunlin in different areas of the Far East. Arrow indicates the median date for an area.

raises the question of how representative the data are, especially for Kamchatka where the few records that exist were collected during a single season. Breeding dates available for Dunlin from faunistic papers for the Far East mostly fall into the ranges of dates given in Figure 1. Moreover, the breeding dates of Dunlins in warmer inland areas of Chukotka fall mainly within the same period as in the Uelen area (e.g. Kitschinski *et al.* 1983). There are also a few records of even earlier hatching dates from the arctic coast of Chukotka: 27 June in Enurmino (67°) (Portenko 1972) and even 24 June in



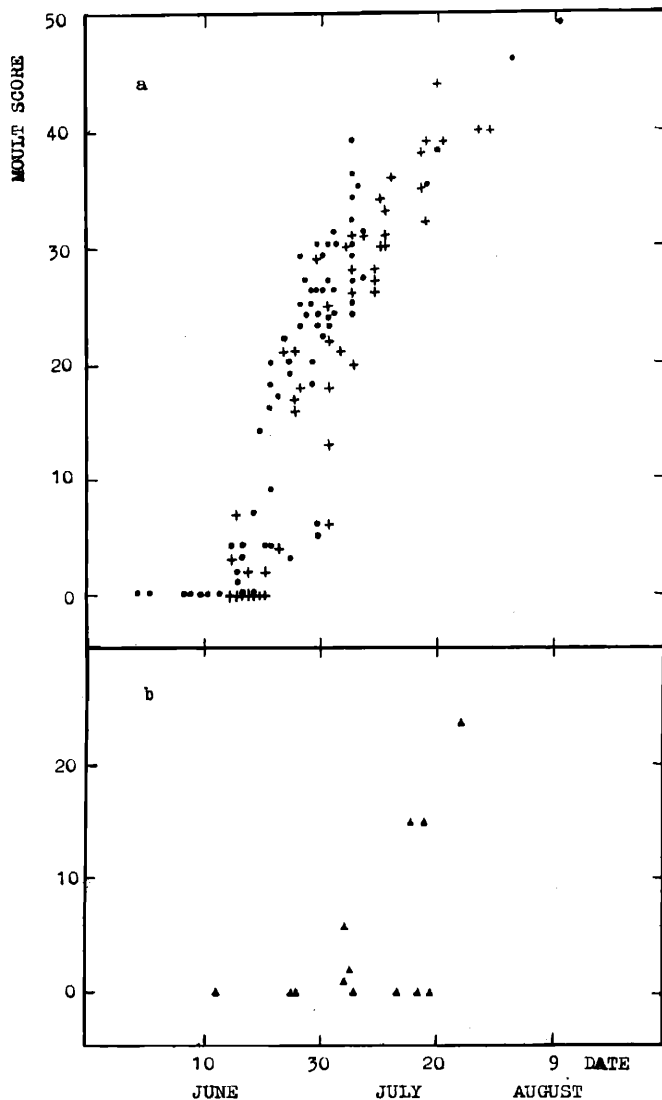


Figure 2. Moulting score for primaries of known local Dunlins on a) Chukotka and b) north Sakhalin. Dots refer to Uelen, crosses to Belyaka Spit, triangles to north Sakhalin.

Chaun Lowland, northeast Chukotka (69°) (Kretchmar *et al.* 1991). Dates for the start of breeding in high arctic tundra on Wrangel Island (71°) vary from year to year by up to two weeks depending on the time of snow-melt. As a result, the first song may sometimes not be heard until mid-June, although the chicks still hatch before mid-July (Stishov *et al.* 1991), *i.e.* no later than on the mainland.

There are almost no comparable data for the Kamchatka Dunlin. In Geka Bay (60°), the northern part of the *kistchinski* subspecies' breeding range, birds probably bred a little later in 1976-77, than the dates shown in Figure 1, because "mass hatching of chicks started in late June" (Firsova & Levada 1982). The few records of nests and chicks, listed by Lobkhov (1986) for Kamchatka, also fell into the period depicted in Figure 1, and hatching only occurred unexpectedly late, on 15 July, in a single nest on the eastern coast of Kamchatka. Of five local females collected on 30 and 31 May 1983 by Gerasimov in the area of the Moroshechnaya estuary, two had an egg in the oviduct, two were also egg laying, and only one had not started her clutch (collection of ZMMU). Thus, breeding in these birds was in complete agreement with the

dates indicated for Kamchatka Dunlins in Figure 1. Although far from being complete, the data listed above suggest that the dates in Figure 1 reflect the real situation in populations, at least for peaks of hatching dates.

Primary moult

Chukotka

The largest set of data on primary moult came from Dunlins of the arctic coast of Chukotka, and these allowed the most detailed analysis. It begins in mid-June: no birds were found moulting before 13 June, while they were recorded on 14 June both in Uelen and on Belyaka Spit. Almost all Dunlins were in moult by 21 June. These results are identical to those reported by Holmes (1966b) from Barrow, north Alaska. Only two non-moulting females were caught on later dates, on 29 June and 5 July. These, and two more outliers with delayed moult, (female on 20 July and male on 11 August) were all found in Uelen. These four birds were excluded from further analysis, and their origin is discussed below.

Analysis of covariance performed on samples from Uelen and Belyaka revealed no differences between sexes in moult score ($p=0.163$). This allowed pooling of the data from males and females and adding of unsexed birds to the sample for further analysis. Dunlins in Uelen have a close, but statistically higher, average value of moult score ($p=0.013$) compared with those on Belyaka Spit, indicating earlier primary moult there (Figure 2a). Most birds checked after late July might be on their post-breeding dispersal and of uncertain origin, as both local birds and migrants from north Alaskan *arcticola* subspecies (MacLean & Holmes 1971; Norton 1971; Stiefel & Steuffer 1989) could be encountered. The moult score of the birds known to be local and those of unknown origin differed substantially ($p=0.01$). This difference can be inferred from the sample from Belyaka Spit, which included mostly August birds of unknown origin. We believe that these birds originated from non-local population(s). All checked Dunlins with completed primary moult belonged to birds of unknown origin. The first Dunlin with completed primary moult was caught on 5 August on Belyaka Spit and on 6 August in Uelen, the last moulting bird of unknown origin was recorded on 17 August on Belyaka.

The starting and finishing dates of primary moult on Chukotka show the earliest primary moult among all Dunlin subspecies, although probably coming from birds of different populations. Thus, it is possible to use the dates to determine the duration of primary moult in birds from Chukotka. It lasts for 54-58 days, a shorter time than in north Alaska, where Dunlins change their primaries in 60-70 days (Holmes 1966b).

Regression coefficients of primary moult scores on date do not differ ($p>0.1$) between Dunlins from Uelen and Belyaka, so the regression coefficient for the pooled sample of birds known to be local is 0.904 ± 0.056 (s.e.). As moult score for Dunlins of Alaska was calculated differently by Holmes (1971), we cannot compare his regression coefficient with ours.



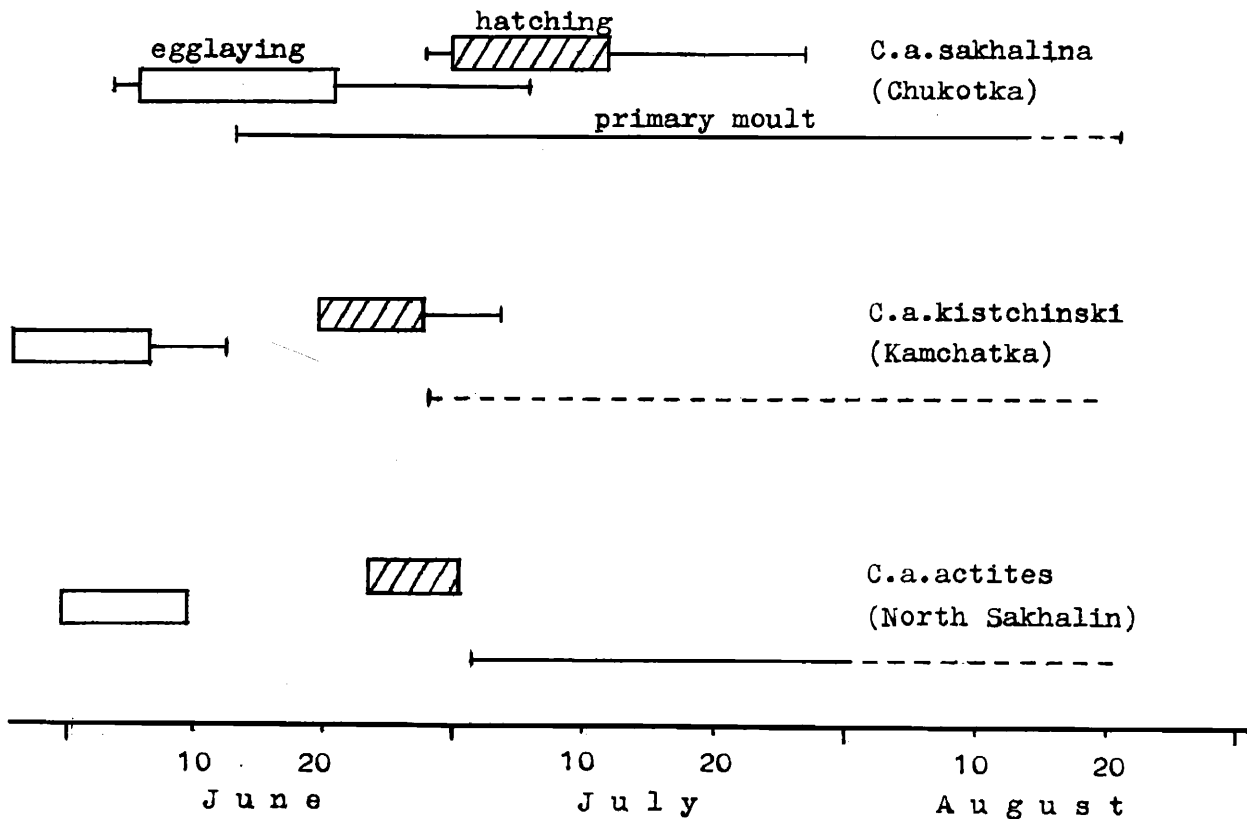


Figure 3 Overlapping of breeding events and primary moult in different subspecies of Dunlin in the Far East.

It is interesting to see the similarity of the primary moult in Dunlins from different areas of Chukotka. The moult score of 12 specimens from the Chaun Gulf (collection of ZMMU) does not differ from that of Uelen and Belyaka ($p > 0.05$). Molt score values from several specimens available in the collection from the Anadyr Lowland agree well with those in Figure 2. These data indicate the similarity of primary moult dates with *sakhalina* subspecies.

Kamchatka and Sakhalin

There are not enough data from Kamchatka and Sakhalin to analyse primary moult of Dunlins in the way described above. This is partly because of the later start of moult in birds of more southerly regions. In particular, no Dunlins checked in June in Kamchatka ($n=19$) and Sakhalin ($n=3$) had started their primary moult. Only two males of eight *kistchinskii* birds from Kamchatka which were checked on 1-21 July (mainly on 1-9 July), had started their primary moult, both having a moult score of 10 on 2 and 9 July respectively. Six of 10 males of Sakhalin subspecies *actites*, collected from near their chicks in July, were in primary moult (Figure 2b). The latest date on which a bird from this small sample had not started moulting was 19 July. These data on Sakhalin Dunlins differ markedly from those given in Figure 37 in Stiefel & Scheufler (1989), because migrants of other populations (*e.g.* all birds from August to October) were undoubtedly included by these authors.

Although extremely scarce, moult data on Dunlins from Kamchatka and Sakhalin are sufficient to conclude that the

dates of start of moult in birds of these two populations are close to each other and fall in the first half of July. The presence of some non-moulting birds in mid-July in Sakhalin leads to the conclusion that birds in this population start primary moult over a more prolonged period than in Chukotka.

DISCUSSION

Holmes (1971) considered that the scheduling of the major energy-requiring events of reproduction, moult and migration is among the strategies used in response to a harsh environment. He was able to show that at Barrow, the further north of two Alaskan areas compared, breeding and moult are compressed into a shorter period and necessarily overlap. Results from the Far East have shown some similarity with the situation in Alaska.

In Dunlins from Chukotka, unlike more southerly populations, primary moult broadly overlaps with breeding and is compressed in time (Figure 3). However, in spite of the greater latitudinal range, 13° - 15° in the Far East compared with 10° in Alaska, the differences in breeding dates in different Far Eastern Dunlin populations turned out to be the same or several days earlier than those in Alaska. In southern populations of the Far East, in contrast to Alaska, the breeding season is more compressed than in the north, on Chukotka. This effect can be partly explained by shortage of data, although Blokhin (in press) considers that Sakhalin Dunlins use spring water resources to raise chicks before the period of summer heat, drought and fires. So, in the southernmost temperate part of the breeding range, Dunlins probably suffer sometimes from even greater time limitations on breeding schedule depending on the environment.



Breeding and intensive primary moult are both energetically costly processes: temporal overlap of such functions is rare in birds. Holmes (1971) considers that with the long snow-free period at the breeding range of the southern Alaskan population of Dunlin, there is sufficient time for moult to be completed between the end of the breeding effort and the autumn migration, thus explaining the absence of overlap there. The same can be said about southern Dunlin populations in the Far East; these processes are usually separated there also. It is difficult, however, to agree with Holmes that breeding and moult necessarily overlap at Barrow (and also on Chukotka). Dunlins of subspecies *arctica* from Greenland breed at even more northerly latitudes (70°-80°) and do not undergo primary moult on the breeding grounds (Cramp & Simmons 1983). This means that northern populations of the Pacific subspecies of Dunlin could also, by evolution, have avoided the overlap of breeding and moult, delaying primary moult until winter. Nevertheless this does not happen, and is probably due to historical events in the Pacific populations of Dunlin, resulting in overlapping of these two processes.

In Dunlins of Chukotka, as in north Alaska, primary moult almost completely overlaps with the breeding season. As a rule, it starts soon after the beginning of the incubation period and reaches about half way at peak hatching in the first week of July. Post-breeding dispersal of Dunlins on Chukotka first becomes noticeable about a week after hatching, before mid-July. However, Chukotka Dunlins probably continue and almost complete their primary moult either on the breeding grounds or close to them, for instance on lagoons around Chukotka and in river mouths (Kistchinski 1988). Departure and long-distance migration of Dunlins from Chukotka and the northern Koryak Highlands start only at the very end of July and the beginning of August (Kistchinski 1980, 1988), and most probably it is these birds which initiate the mass migration of Dunlins on Kamchatka in the first half of August (Lobkhov 1986). Thus the beginning of the southward migration of Chukotka Dunlins precedes the primary moult completion (growing of the outermost primaries).

Dunlins of Kamchatka and Sakhalin do not moult in the nesting period, and some males start primary moult only during the chick-rearing period (Figure 3). Females of these Dunlins stay with the family for only a few days after hatching and then disappear from breeding habitats (Nechaev 1991; Gerasimov *et al.* 1992) to unknown areas. They may concentrate for further moult in nearby estuaries and lagoons, or may undertake longer-distance migration to special moulting areas. The latter idea is supported by the observations of Nechaev (1991) and Blokhin (pers. comm.) in northern Sakhalin, where hundreds and thousands of Dunlins form flocks on shallow waters of bays from the last week of June and stay there at least throughout July, when the migration of northern populations starts.

Holmes (1971) thought that latitudinal differences were

responsible for the timing of the breeding season and primary moult of Dunlins. If this supposition were correct, then the southern Dunlin populations of the Far East, situated further south than those studied in Alaska, should have progressively earlier breeding, completely separated from primary moult. Comparison of Figure 3 with breeding dates of Dunlins in west Alaska (61°N), where most chicks hatched before 20-29 June (Holmes 1971), shows that in the southernmost areas, Kamchatka and Sakhalin, breeding takes place not earlier but even somewhat later, with no reduction in the overlap of breeding and moulting periods.

The results of this study do not contradict the general conclusion of Holmes (1971) that features of the breeding season and the period of moult are related to the length of time favourable for breeding. However, this relationship is not directly latitude dependent. The similarity in breeding dates of Dunlins in different parts of Chukotka suggests a common breeding period for the whole Chukotka subspecies *sakhalina*. This, in turn, may indicate that latitudinal differences in breeding and moult dates arise from differing geographical populations (subspecies in many cases). The quality of the environment in some localised areas may result in breeding taking place on earlier (*e.g.* Chaun Gulf) or later (Belyaka Spit, Wrangel Island) dates than those which are typical for the geographic population range. In the light of these data on population specific ranges of breeding dates, a record of a Dunlin pullus on 7 May in China (Greenwood 1980) seems completely unrealistic.

It was noted earlier that moult score outliers were found on Chukotka only in the Uelen area. This fact could be due to the local breeding population not being homogeneous. In an earlier study (Tomkovich 1986), it was emphasised that unusually long-billed Dunlins can be found among *C.a. sakhalina* on the eastern coast of Chukotka Peninsula, in particular in Uelen, which was thought to indicate an influx of long-billed birds of subspecies *pacifica* from west Alaska to the area. Bill length of two females (41.3 and 43.2 mm) among four moult score outliers from Uelen exceeded the range of variation of this feature in birds of the subspecies *sakhalina*. As relatively late primary moult is characteristic of *pacifica* birds, the presence of moult score outliers also suggests that small numbers of Dunlins of American origin are present in the local population in the Uelen area.

The subspecific differences in dates of breeding and moulting in the Far Eastern Dunlins can be used together with biometrics to distinguish adult birds of these subspecies in the post-breeding period. In southern areas, for example, in the first half of August, Dunlins with completed primary moult should belong to northern tundra populations (*sakhalina* and/or Alaskan *arctica*), while those still in active moult should be *kistchinski* birds if they are large, or *actites* birds if they are small. The first attempt to use these findings for understanding migration differences of Dunlin populations in the Far East has



been made above. Much more can be done now, paying special attention to the migration and population differences outlined here.

ACKNOWLEDGEMENTS

Field studies in Chukotka and Kamchatka were financed by the Zoological Museum of Moscow State University, and State Nature Reserve "Wrangel Island" provided transport for studies on Belyaka Spit in 1986-88. Invaluable help in gathering data in different years was received from V.V. Morosov, A.I. Oleksenko, M.Yu. Solovyev and A.M. Sokolov. Important information and museum specimens were received from A.Yu. Blokhin, N.N. Gerasimov, V.A. Nechaev, E.G. Lobkhov and V.A. Ostapenko. M.Yu. Soloviev helped greatly with statistics and comments on the early draft of the paper. I am extremely grateful to all these people as well as to Jean Patterson for correction of my English.

REFERENCES

- Blokhin, A.Yu. In press. Population of breeding waders at the marine coasts of north-eastern Sakhalin. In: Hotker *et al.* (eds.) *Migration and international conservation of waders: research and conservation on north Asian and European flyways*. International Wader Studies 10.
- Browning, M.R. 1991. Taxonomic comments on the Dunlin *Calidris alpina* from northern Alaska and eastern Siberia. *Bull. B.O.C* 111: 140-145.
- Cramp, S. & Simmons, K.E.L. (Eds.) 1983. *The Handbook of the Birds of Europe, the Middle East and North Africa: the birds of the Western Palearctic. Volume III*. Oxford University Press, Oxford.
- Firsova, L.V. & Levada, A.V. 1982. Ornithological records in the south of Koryak Highland. *Ornithologiya (Moscow)* 17: 112-118. (In Russian).
- Gerasimov, N.N., Sokolov, A.M. & Tomkovich, P.S. 1992. Birds of the ornithological sanctuary "Moroshechnaya River", Western Kamchatka. *Russ. J. Ornithol.* 1:157-208. (In Russian).
- Ginn, H.B. & Melville, D.S. 1983. *Moult in birds*. BTO Guide 19, Tring.
- Greenwood, J.G. 1980. Dunlin *Calidris alpina* breeding in China. *Bull. B.O.C.* 100: 172.
- Gromadzka, J. 1985. Dunlin *Calidris alpina*. In: Viksne, J.A. & Mihelsons, H.A. (Eds.) *Migrations of birds of eastern Europe and northern Asia: Gruiformes - Charadriiformes*. Nauka, Moscow: In Russian).
- Holmes, R.T. 1966a. Breeding ecology and annual cycle adaptations of the Red-backed Sandpiper *Calidris alpina* in northern Alaska. *Condor* 68: 3-46.
- Holmes, R.T. 1966b. Moulting cycle of the Red-backed Sandpiper *Calidris alpina* in western North America. *Auk* 83: 517-533.
- Holmes, R.T. 1971. Latitudinal differences in the breeding and moulting schedules of Alaskan Red-backed Sandpiper *Calidris alpina*. *Condor* 73: 93-99.
- Kim, H-B., Yoo, J.C. & Won, P-O. 1994. Seasonal fluctuations, biometrics and non-fat masses of Dunlins *Calidris alpina* migrating to Summok Island on the west coast of Korea. *The Korean J. of Ornith.* 1: 15-24.
- Kistchinski, A.A. 1980. *Birds of Koryak Highlands*. Nauka, Moscow (In Russian).
- Kistchinski, A.A. 1988. *Avifauna of north-east Asia: history and modern state*. Nauka, Moscow (In Russian).
- Kistchinski, A.A., Tomkovich, P.S. & Flint, V.E. 1983. The birds of the Kanchalan River basin, Chukotsky Autonomous Area. In: Flint, V.E. & Tomkovich, P.S. (Eds.) *Archives of Zool. Museum Moscow State Univ.* 21: 3-76. (In Russian).
- Kondratiev, A.Ya. 1982. *Biology of waders in the tundras of north-east Asia*. Nauka, Moscow. (In Russian).
- Kretchmar, A.V., Andreev, A.V. & Kondratyev, A.Ya. 1978. *Ecology and distribution of birds in north-east USSR*. Nauka, Moscow. (In Russian).
- Kretchmar, A.V., Andreev, A.V. & Kondratyev, A.Ya. 1991. *Birds of northern plains*. Nauka, Leningrad. (In Russian).
- Lappo, E.G. & Tomkovich, P.S. In press. Breeding distribution of Dunlin in Russia.
- Lobkhov, E.G. 1986. *Breeding birds of Kamchatka*. Far-eastern branch, Russian Acad. of Sci., Vladivostok. (In Russian).
- MacLean, S.F. & Holmes, R.T. 1971. Bill length, wintering areas, and taxonomy of North American Dunlins *Calidris alpina*. *Auk* 88: 893-901.
- Nechaev, V.A. 1991. *Birds of Sakhalin Island*. Far Eastern Branch, Russian Academy of Sci., Vladivostok. (In Russian).
- Nechaev, V.A. & Tomkovich, P.S. 1987. A new subspecies of the Dunlin *Calidris alpina littoralis* ssp.n. (Charadriidae, Aves), from Sakalin Island. *Zool. Zhurnal* 66: 1110-1113. (In Russian).
- Nechaev, V.A. & Tomkovich, P.S. 1988. A new name for Sakhalin Dunlin (Aves, Charadriidae). *Zool. Zhurnal* 67: 1596. (In Russian).
- Norton, D.W. 1971. Two Soviet recoveries of Dunlins banded at Point Barrow, Alaska. *Auk* 88: 927.
- Portenko, L.A. 1972. *Birds of Chukchi Peninsula and Wrangel Island, Part 1*. Nauka, Leningrad. (In Russian).
- Stiefel, A. & Scheufler, H. 1989. *Der Alpenstrandlaufert: Calidris alpina*. (Die neue Brehm-Bucherei; 592). Ziemsen, Wittenberg Lutherstadt.
- Stishov, M.S. Pridatko, V.I. & Baranyuk, V.V. 1991. *Birds of Wrangel Island*. Nauka, Novosibirsk. (In Russian).
- Tomkovich, P.S. 1986. Geographical variability of the Dunlin in the Far East. *Bull. of Moscow Soc. of Naturalists Biol.* Section 91: 3-15. (In Russian).
- Tomkovich, P.S. 1994. Site fidelity and spatial structure of population in the Rock Sandpiper *Calidris ptilocnemis* and Dunlin *Calidris alpina* on Chukotsky Peninsula. *Russ. J. Ornithol.* 3: 13-30. (In Russian).
- Tomkovich, P.S. & Sorokin, A.G. 1983. The bird fauna of Eastern Chukotka. *Archives of Zool. Mus. of Moscow State Univ.* 21: 77-159. (In Russian).
- Wilkinson, L. 1990. *SYSTAT: the system for statistics*. SYSTAT Inc., Evanston, IL.

